申报	系列：教师
	专业：农业经济管理
	职称：副教授

业绩成果材料

（申报人的业绩成果材料包括论文、科研项目、获奖以及其他成果等）

单　位（二级单位）经济管理学院

姓　名　　李慧

材料核对人：　　单位盖章：

核对时间：

华南农业大学制

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广东省本科高校物流管理与工程类专业教学指导委员会

粤物教字 2018[5]号

2018 年度广东省本科高校物流管理与工程类专业教学指导委员会教改教研课题立项通知

各有关本科高校：

经广东省本科高校物流管理与工程类专业教学指导委员会审议，下列项目获得立项。具体如下：

题目	申请人	单位
物流类专业本科生国内交换培养创新实验区	谢如鹤	广州大学
广东省物流管理专业学科竞赛现状、问题及对策研究	董振宁	广东工业大学
广东省物流管理专业教材体系的改革与创新研究	张良卫	广东外语外贸大学
教学游戏在物流与供应链管理课程应用的研究	李慧	华南农业大学
数据驱动的物流管理特色专业教学质量评估与管理对策研究	邬文帅	广州大学
基于项目体验的物流类专业应用型人才培养模式的构建	周艳	广州航海学院

《物流管理专业》教学模式的创新、应用与实施研究	洪树权	东莞理工学院城市学院
独立学院物流管理专业人才培养方案的比较研究与优化设计	王　兴	东莞理工学院城市学院
虚拟集成环境下的一体化课堂设计与创新研究—基于“互联网+”新业态的教学改革与实践	杨亚娟	东莞理工学院城市学院
服务国际航运中心的应用型本科物流管理专业特色建设研究	王峰	广州航海学院
应用型本科交通运输类专业校企合作人才培养标准研究	夏新海	广州航海学院
基于创新应用型人才培养的港口装卸工艺实务本科课程教学改革与实践	易燕	广州航海学院

广东省本科高校物流管理与工程类
专业教学指导委员会

2018 年 6 月 18 日

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附件：华南农业大学2012年度教育教学改革与研究立项项目一览表

编号	项目名称	类别	主持人	经费(单位：元)
JG12036	大学生朋辈课外学业互助平台的建设与实践	一般项目	苏镇松	4000
JG12037	工科大学物理与专业相结合的实践教学研究	一般项目	杨小红	4000
JG12038	动物科学专业实践教学管理体系的改革与实践	一般项目	付晓兰	4000
JG12039	我校公共基础课程——《Java 程序设计》教学改革与实践	一般项目	彭红星	4000
JG12040	《植物学》课程野外实习教学改革与实践	一般项目	张荣京	4000
JG12041	设立毕业设计激励机制的研究与探索	一般项目	程良鸿	4000
JG12042	IE 专业《人因工程》课程的教学改革研究与探索	一般项目	曹　咏	4000
JG12043	面向“卓越工程师”培养的交通运输专业人才培养模式探索与实践	一般项目	何效平	4000
JG12044	兽医内科动物体液检测标准化操作模式（SOP）的构建	一般项目	郭剑英	4000
JG12045	《水污染控制工程》课程中典型工艺 3D 模拟图库的建设研究	一般项目	余光伟	4000
JG12046	计算机硬件实验教学中的计算思维培养（探讨/研究）	一般项目	黄沛杰	4000
JG12047	工科类工业设计专业学生造型能力培养的研究与实践	一般项目	郭　涵	4000
JG12048	实践类专业课教学模式改革的探索——以《养牛学》课程为例	一般项目	孙宝丽	4000
JG12049	结合科研探讨《试验设计与数据处理（双语）》实践教学	一般项目	张亚莉	4000
JG12050	兽医病理动物疾病模型制备的标准化研究	一般项目	宁章勇	4000
JG12051	TBL 教学法及多层次实践在《食品鉴伪》课程教学中的探索与实践	一般项目	杨瑞丽	4000
JG12052	《兽医流行病学原理》课程教学方法的创新与实践	一般项目	曹伟胜	4000
JG12053	自选型电类实验课程教学体系的探索与研究	一般项目	陆健强	4000
JG12054	《普通昆虫学》课程实习教学的创新与实践	一般项目	刘经贤	4000
JG12055	《高等数学（经济类）》教学方法的创新与实践	一般项目	周裕中	4000
JG12056	基于少学时的高等数学教学改革与研究	一般项目	方　平	4000
JG12057	建筑测绘与调研类课程教学体系改革与研究	一般项目	姜　磊	4000
JG12058	《蛋白质组学》课程教学改革与实践	一般项目	王玉琪	4000
JG12059	以应用为导向的《化学文献检索与论文写作》课程内容的优化与实践	一般项目	刘有芹	4000
JG12060	卓越计划背景下力学课程教学内容改革的研究与实践	一般项目	卢玉华	4000
JG12061	光信息处理仿真系统的开发与研究	一般项目	徐初东	4000
JG12062	物理科技创新基地建设的研究与实践	一般项目	劳媚媚	4000
JG12063	基于资源整合的工业工程专业实验课程的改革与研究	一般项目	欧阳庆	4000
JG12064	《真菌学》课程教学内容及方法的创新与实践	一般项目	李敏慧	4000
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JG12067	旅游管理专业本科人才培养模式改革与实践	一般项目	唐　松	4000
JG12068	基于实践技能培养的《禽病学》课程实验教学改革与实践	一般项目	徐成刚	4000
JG12069	基于.Net 的校级质量工程项目申报与评审系统的设计与实现	一般项目	林宇健	4000
JG12070	独立学院实践育人质量管理体系的构建与实践	一般项目	陈文艺	4000

编号	项目名称	类别	主持人	经费(单位：元)
JG12071	三维教育质量观视角下的高校立体教学质量监控系统建设研究	一般项目	朱　蕾	4000
JG12072	英语四级考试数据应用于大学英语分级教学改革评价的探索	一般项目	刘　江	4000
JG12073	基于实践能力培养的《财务管理》课程的教学方法创新与实践	一般项目	周小春	4000
JG12074	经济管理学院实验中心信息化平台建设研究	一般项目	潘　逵	4000
JG12075	专业承诺、择业意向及其影响因素——农科专业学生培养模式改革研究与实践	一般项目	田金梅	4000
JG12076	社会主义核心价值视阈下“中国近现代史纲要”课专题教学内容体系的构建	一般项目	李　韬	4000
JG12077	大学生朋辈辅导员人本主义体验式培训课程的研究	一般项目	钟向阳	4000
JG12078	应用型房地产专业本科人才培养模式研究	一般项目	望晓东	4000
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JG12080	大学生创业教育的改革与研究	一般项目	李　慧	4000
JG12081	艺术设计专业《视觉传达设计》课程教学模式的改革与研究	一般项目	曾迪来	4000
JG12082	艺术设计专业《构成基础》课程教学的改革与研究	一般项目	盘湘龙	4000
JG12083	大类招生培养模式下教务管理的研究与实践	一般项目	李艳丽	4000
JG12084	公共应急管理专业人才培养的教学探索与实践研究	一般项目	高青莲	4000
JG12085	高校管理岗位设置及其人员聘用之问题研究	一般项目	杨玉浩	4000
JG12086	优质数字化教育资源共享应用推广模式的研究	一般项目	巫莉莉	4000
JG12087	行政管理专业人才培养模式改革的研究与实践	一般项目	曾小龙	4000
JG12088	本科双学位教学管理的改革与研究——以人文与法学学院为例	一般项目	王　慧	4000
JG12089	广播电视编导专业应用型人才培养模式改革与实践	一般项目	胡　辉	4000
JG12090	图书馆多媒体资源在专业教学中的应用研究	一般项目	严一梅	4000
JG12091	英语作文自动评分系统对大学生英语写作能力发展研究	一般项目	钟建玲	4000
JG12092	基于大学生就业视角探索体育教学创新设计	一般项目	吕　立	4000
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JG12094	华南农业大学国际派出交流生管理模式研究与实践	一般项目	肖豫涵	4000
JG12095	思维导图（Mind Mapping）在基础英语教学中的应用研究	一般项目	严晓蓉	4000
JG12096	基于接受美学之大学英语教学与学生非智力因素培养的互动教学模式构建	一般项目	杜龙鼎	4000
JG12097	《TRIZ 理论与创新方法》课程改革与研究	一般项目	蒋艳萍	4000
JG12098	农业院校毕业生服务新农村建设机制的探析——以计算机专业学生为例	自筹项目	罗　璇	自筹
JG12099	建设植物生理学教学团队的探索	自筹项目	钱春梅	自筹
JG12100	应用于植保专业的《生物统计学》课程教学改革与优化	自筹项目	陈科伟	自筹
JG12101	农学专业本科生学风建设实证分析及对策研究	自筹项目	李　伟	自筹
JG12102	基于CSI模型的实践课程建设探索——以农业院校IT类课程为例	自筹项目	蔡贤资	自筹
JG12103	《病毒学》课程教学改革探讨	自筹项目	马金成	自筹
JG12104	农学专业课程生产实习体系的构建	自筹项目	潘圣刚	自筹
JG12105	面向非工科类专业工程训练课程建设的研究与探索	自筹项目	何剑飞	自筹
JG12106	新形势下构建我校种子科学与工程人才培养模式的探索	自筹项目	刘永柱	自筹

关于公示 2018 年度华南农业大学教改立项项目的通知

来源： 教学研究与评估科 2018-08-28 17:31:52 点击量：1849

各学院、部处、各单位：

根据华南农业大学《关于开展 2018 年本科教学类项目申报工作的通知（含质量工程、教改、新增专业）》，经组织申报、资格审查、专家评审等环节，现确定“面向生态文明建设与乡村振兴战略的资源环境生态类专业教学综合改革研究”等 40 个项目入选校级教改重点项目，“人工智能背景下信息管理与信息系统专业综合实践教学模式探究与实践”等 51 个项目入选校级教改一般项目，“新媒介环境下古代文学课程教学优化研究与实践”等 40 个项目入选校级教改自筹项目，“园林建筑学”等 3 个项目入选校级继续教育类项目，现予以公示（见附件）。公示时间为 2018 年 8 月 28 日至 9 月 1 日，如有异议请于 8 月 31 日前以书面形式提交至教务处教学研究与评估中心，并署真实姓名附联系方式，匿名及其他形式的异议恕不受理。

联系人： 林宇健、曹广祥

地址： 行政楼 329

联系电话：85280052

邮箱： jgxm@scau.edu.cn

华南农业大学教务处

2018 年 8 月 28 日

附件:

序号	项目名称	项目负责人	类别
111	不同背景学生《农事技能通识训练》课程安排的研究及优化	陈丽君	自筹项目
112	基于提高实践能力与创新精神的数学教学实践与研究	金玲玉	自筹项目
113	基于需求分析的大学英语课程体系建设与优化研究	刘华	自筹项目
114	基于沉浸理论的茶艺实训课程教学改革研究与实践	张凌云	自筹项目
115	基于素质教育的传统文化课程建设研究	余格格	自筹项目
116	《生物化学》教学中慕课设计与建设的探索	巫光宏	自筹项目
117	学分制改革下特色农业史课程群建设与教学模式探索	赵艳萍	自筹项目
118	《植物病原真菌学》教学标本资源的整合与编目	习平根	自筹项目
119	以法律诊所为载体的法学实践教学改革探索	王慧	自筹项目
120	家蚕解剖生理图谱制作与教学实践	黄志君	自筹项目
121	需求视角下的全英课程教学改革研究	李慧	自筹项目
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华南农业大学文件

华南农教〔2017〕56号

关于公布学校第一批全英教学课程建设项目的通知

各学院、部处、各单位：

为进一步推进我校全英课程建设，培养具有创新精神和国际视野的高素质人才，促进学校国际化办学，经个人申请，学校组织评审确定《公共管理学》等13门课程入选学校第一批全英教学课程建设项目，每门课程资助经费1万元，现予公布（具体名单详见附件）。

请各位教师认真做好课程的开设准备工作，确保2017学年正式开出课程；同时，应加强课程建设，并根据学科的发展及时补充反映最新知识、技术和成果的内容，确保课程建设的质量。

附件：第一批全英教学课程建设项目名单

华南农业大学

2017年9月28日

第一批全英教学课程建设项目名单

序号	学院	教师姓名	课程名称
1	公共管理学院	吴　彦	公共管理学
2	资源环境学院	蔡昆争	农业生态学
3	园艺学院	黄旭明	国外园艺
4	农学院	卡　森	遗传学综合性实验
5	经济管理学院	李　慧	物流管理
6	经济管理学院	张奕婧	农林产品国际贸易学
7	经济管理学院	刘一明	资源与环境经济学
8	经济管理学院	汪凤桂	公司治理，风险与伦理（P1）
9	经济管理学院	姜百臣	商务谈判
10	经济管理学院	于健南	管理会计
11	经济管理学院	左　伟	管理学原理
12	经济管理学院	马秋卓	管理学研究方法——数据挖掘与其商业价值
13	经济管理学院	王雄志	运筹学

华南农业大学文件

华南农教〔2018〕24号

关于公布学校第二批全英教学课程建设项目的通知

各学院、部处、各单位：

根据《华南农业大学双语教学管理办法》（华南农办〔2017〕135号），为进一步推进我校全英课程建设，培养具有创新精神和国际视野的高素质人才，促进学校国际化办学，经个人申请，学校组织评审确定《植物化学保护》等28门课程入选学校第二批全英教学课程建设项目，每门课程资助经费1万元，现予公布（具体名单详见附件）。

请各位教师认真做好课程的开设准备工作，确保2018-2019学年正式开出课程；同时，应加强课程建设，并根据学科的发展

附件

第二批全英教学课程建设项目名单

号	学院	教师姓名	课程名称
	农学院	曾鑫年	植物化学保护
	农学院	张亚锋	分子生物学
	农学院	王波	基因组学
	农学院	SHAUKAT ALI	生物防治
	农学院	张彤	植物病毒学
	农学院	林伯荣	植物线虫学
	林学与风景园林学院	葛良法	普通遗传学
	林学与风景园林学院	陈曙	草坪学
	动物科学学院	孟立	动物繁殖学
)	资源环境学院	谈凤笑	普通生态学
L	资源环境学院	陈澄宇	水污染控制工程
2	资源环境学院	陈澄宇	环境毒理与评价
3	海洋学院	刘懿莹	水产动物疾病防治学
4	生命科学学院	陈远玲	遗传学
5	生命科学学院	庞学群、龚维	植物生物学
5	生命科学学院	文继开、黄晓	微生物学（国家理科基地班、中爱国际班）
7	工程学院	韩宇星	信号与系统分析
3	食品学院	兰雅淇、宋明月、吕慕雯	食品化学 C
)	食品学院	魏韬、郑倩望、王涓	食品微生物学
)	经济管理学院	李慧	市场营销
L	经济管理学院	王雄志	投资学
2	经济管理学院	牛卫平	外贸函电
3	经济管理学院	马亚男	会计师与企业
4	经济管理学院	董莹	投资学
5	公共管理学院	贾昕珊	社工专业英语
5	公共管理学院	陈忱	问卷设计和数据采集
7	公共管理学院	陈忱	高级社会统计和 STATA
3	艺术学院	欧阳文昱	网络交互设计

MUDANJIANG
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XUEBAO

ISSN 1009-2323

牡丹江教育学院学报

牡丹江教育学院

学报

二〇二一年第九期

中国·牡丹江 2021.9

JOURNAL OF MUDANJIANG COLLEGE OF EDUCATION

牡丹江教育学院学报
(月刊)

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期刊基本参数:CN23-1462/G4 * 1983 * B * A4 * 128 * ZH * P * ¥15.00 * 1000 * 39 * 2021-09

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责任编辑:曾　宏　毕鲁欣　丛爱玲　陈　达

互联网＋管理类案例的教学创新：以互联网的无限信息替代案例文本的有限信息

李　慧

(华南农业大学经济管理学院，广州　510642)

[摘　要]　案例是高校管理类理论应用的重要教学方式，受到教育部、高校和学生的重视。然而，现行主流的案例教学普遍存在案例编制难，课堂组织难的问题。基于互联网的广泛应用，文章提出互联网＋案例分析教学，其核心是教师和学生都在课前根据管理理论主题，利用互联网信息，自主、自由、开放地还原企业的市场环境和管理行为，以互联网的无限信息替代传统案例文本的有限信息；在课堂上，教师和学生分享、讨论互联网所得信息，用理论解释企业管理行为。互联网＋案例教学具体操作如下：课程不提供案例材料，课前仅给出案例企业名称和理论分析视角，要求学生课前利用互联网收集材料，归纳总结；上课时，给出案例问题，先带领学生领略案例企业的发展历程，然后与学生一同就案例问题展开讨论。教学评估数据表明“互联网＋管理类案例”是一门提高学生管理素质，培养高阶能力的课程。

[关键词]　案例教学；教学创新；互联网＋；案例文本

[中图分类号] G640　[文献标识码] A　[文章编号] 1010-2323(2021)09-0107-04

一、引言

案例教学始于150年前哈佛大学法学院，随后在哈佛商学院，及全球其他高校商学院得到广泛的应用，被认为是最好的培养学生解决问题能力的教学法[1]。我国教育部也早在2015年发出关于“加强大学生案例教学”的意见，具体包括要加强案例教学和改革教学方法。实用主义教育家杜威是进步主义教育运动的代表，针对学校传统教学专注课本内容的讲述提出：“最好的教学，就是牢牢记住学校教材和实际经验二者相互联系的必要性，使学生养成一种态度，习惯于寻找这两方面的接触点和相互联系”[2]。理想的案例教学正是体现杜威这个观点，案例教学应该要强化已学知识，应用已学理论，所训练的分析、讨论、决策、展示能力都是学生离开学校，进入社会工作、生活的重要技能，而这又是普通“课堂讲授”所难以实现的。案例教学探究理论与现实的差别，能够训练学生思辨的能力，创新性思维，激发学习兴趣和钻研精神[3]。

二、管理类案例教学的难点

对包括北大光华管理学院在内的我国6所重要工商管理学院，超过1000份的大样本问卷调查“中国工商管理案例教学现状研究”显示：只有不到20％的学生对案例教学很满意或比较满意，而对案例教学不满意集中在案例质量、教师点评、学生准备和课堂组织[4]。笔者在案例教学实践和学生反馈中归纳现行主流管理类案例教学的两大难点。

(一)教学案例编制难

中国案例研究会会长余凯成定义教学案例为：“案例是为一定的教学目的，围绕选定的问题，以事实为素材，而编写成的某一特定情景的描述”[5]。从案例编制的角度，案例就是围绕既定教学目标，确定了问题，以事实为素材的整理编辑。由此可以推测，隐含着明确教学目标的案例问题的答案已经在案例材料中。这种案例教学与应用题类似，与材料题更为接近。因此，现行主流的教学案例质量很大程度上取决于案例编制的质量。一个出色的案

[收稿日期] 2021-07-20

[作者简介] 李慧(1982－)，女，讲师，研究方向：三农问题、游戏教学、全英教学。

[基金项目] 广东省本科高校物流管理与工程类专业教研教改课题2018[5]，及华南农业大学教学改革项目(项目编号：JG1812)成果之一。

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例应该是关于某种复杂情景的记录，长的案例可以让学生学习筛选材料，找出重要的、有用的信息[6]。然而，教学案例是有篇幅约束的，这对案例编写提出一个不可能实现的要求。

（二）案例课堂组织难

案例教学是根据教学目的的要求，在教师的指导下，组织学生通过对案例的阅读、分析、讨论和交流等活动，传授分析问题的方法，进而提高解决问题的能力，加深对概念和理论的理解[7]。在极有限的课堂时间内，学生要了解企业情况，明晰问题实质，提出行动方案，对教师和学生都是富有挑战性的[3]。

在案例分析课堂，教师不是传统的知识传授者，而更多的是案例讨论的组织者，要启发、引导学生，要总结企业行为和行业特征。案例教学不是讲理论，而是讲理论的应用。案例教学的教师不但要熟悉专业知识，具有专业理论体系，还要了解案例企业，能够领悟商业的逻辑，有一定的商业感觉（business sense）。现代市场瞬息万变，各行业千差万别，要理解企业和市场的行为，对案例教学的教师提出了相当高的要求。

绝大多数学生对现实市场、行业特征、企业运作并无接触。这样的背景下，要求学生讨论企业的行为，甚至企业决策是十分困难的。此外，学生更习惯于在课堂上听讲，调动学生进行思考和讨论不是容易的事情。

综上所述，现行主流教学案例在难度上需要平衡和把握。一方面，简单的为了实现教学目标，体现和应用某个理论，以非常短小的篇幅描述案例，俨然成了扩展版的课堂举例[8]。另一方面，要求学生从课堂到课堂的，从理论文字到案例文字，去讨论企业市场环境，给出经营决策，也是不现实的。

三、管理类案例教学的创新：互联网替代文本

互联网的普遍应用，较大型企业都有官方网站对外主动披露信息，传统媒体电子化，自媒体等新兴媒体信息量丰富。互联网硬件和软件得到普及，教师和学生都能通过互联网强大的搜索功能，以极低成本获取丰富的企业和市场信息，从而能够勾勒出企业的经营现状与发展路径。经过多年的教学实践，对管理类案例教学进行了互联网＋的教学创新，让学生通过互联网近乎无限的信息资源，去解读企业，去思考理论。“互联网＋管理类案例教学”的具体实施如下：

（一）课前给出案例企业名字和理论角度，不提供案例材料

与现行主流案例教学把案例文本材料编制好，分发给学生不同，创新的案例教学只向学生公布案例企业名称和讨论的理论角度。一方面，这绕开了案例文本编制的难题，不把案例内容局限在有限的文字内，更不是为问题的答案而提供材料。另一方面，这样极大地调动了学生的能动性，因为学生必须在课前对案例企业，甚至所在行业的背景有充分的认识，对理论角度进行复习，并把两者结合进行思考，否则在课堂上是茫然的。

学生在上课前，需要回顾理论知识，然后进行大量互联网阅读。这时的阅读不是无目的性的泛泛阅读，而是在理解理论后，带着理论去收集、阅读、理解，从而整理企业资料。这个过程是理论应用的过程，是理论真正理解的过程，就杜威所说的“教材与实际的联系”。

互联网普及前，资料收集工作主要是图书馆的文本材料，相比互联网信息搜索效率极低。今天，互联网信息资料丰富，搜寻功能强大，学习的难度和挑战已经从获取资料信息，到理解、辨析和筛选资料信息。在互联网的帮助下，学生能够轻易地获得企业环境、背景与现状，但针对“理论角度”，学生需要寻找有效信息，理清企业与市场的关系脉络，挖掘事实真相，得出认知结论，形成决策选择。

本案例教学课程的创新是：要求学生利用课前更充裕的时间，互联网更广阔的空间去搜寻理论相关的企业信息，进行理解、辨析和整理，其本质是学生在进行企业案例的创作[9]。

（二）课堂给出案例问题，带学生解读企业，完成讨论、汇报和点评

现行主流的案例分析问题是案例材料的一部分，一般附在案例描述后面。本案例教学的创新是学生课前做好案例准备，教师在课堂才公布案例问题，要求学生在课堂时间内完成讨论，形成 PPT，并进行汇报。课堂时间极为有限，要求学生针对问题，在短时间内形成结论，学生必须在课前有良好的准备，课堂上充分调动已有的知识储备，以相关理论、基本的管理学原理和逻辑去解释问题。“互联网”对时空的无限制性，在此凸显其优势，学生在课堂上随时利用互联网查询更进一步的、具体的信息。此外，案例问题应该十分聚焦，是与给出理论角度直接相关的具体问题。

学生毕竟没有或极少参与企业的实际运作，更不要说管理决策。即使给予丰富的案例材料，要求仅有理论知识的学生，去分析行业与市场，做出决策，几乎是不可能完成的任务。在互联网＋案例教学课堂上，教师是带着学生解读企业，解读行业，解读市场环境。每个企业具有不同的文化，在不同行

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业，不同阶段会有不同的生存发展方式，教师带着学生领略不同企业的个性，学生从中领悟企业管理理论的内涵和外延。

在较好理解现实企业发展的基础上，教师才与学生就案例问题展开讨论。讨论是开放的、轻松的、自由的。教师尽量顾及更多的学生，营造讨论的氛围。因此，除了学生自主发言外，教师可以从任意学生开始挨个要求对很具体的问题发表见解，迫使学生认真听教师的案例企业讲解，及其他学生的见解，并积极思考问题。在学生回答的过程中，教师一边总结，一边启发，对每一个回答进行简要的点评。

四、管理类案例教学创新的实践

理论课堂和案例课堂差别很大，前者主要是理论知识讲授，后者主要是理论应用讨论。案例教学的教师需要从“教”到“导”角色的转变，要营造讨论的氛围，让学生既认真听讲，又积极思考，大胆设想，热情讨论。创新的案例教学是在互联网丰富信息的基础上，不提供具体的案例材料，把课前的案例准备实质上纳入到课程内容里，训练学生利用互联网信息搜索、信息筛选、信息整理的能力。在课堂上，教师不是围绕固定的案例材料进行解读，而是带着学生从更丰富的视角、企业的成长、市场的变化去解读企业、行业、市场，甚至社会，用抽象的理论去解释表象复杂的现实企业和市场。在此基础上，引导学生就案例问题展开讨论，让学生真实体验理论应用于实际。

（一）互联网＋案例教学的课前准备

教师对案例企业的背景及发展必须十分了解，特别对“理论角度”所涉及的内容要深入透彻，尽量阅读互联网能得到的所有相关信息。在此基础上，教师思考并确定一个案例问题，一份解读理论和企业的 PPT，一份案例问题解答的 PPT。

案例问题是案例教学创新的核心，特别在没有给定案例材料的背景下，案例问题尤为重要。如果说现行主流案例教学的质量很大程度取决于案例文本材料的撰写，那互联网＋案例教学的质量很大程度取决于案例问题的提出。案例问题的难度要适中，既不能有现成的答案，也不能是已有互联网公开信息所不能解答的。案例问题的推导还应该是能够反映理论，企业、行业、市场的特征。

解读理论和企业的 PPT 内容包括：基本理论原理、企业基本状况的信息、理论角度下企业和相关市场具体信息。这部分要求条理清晰地展示企业主要、重要、最新的数据，勾勒出企业的发展路径、主要业务和核心竞争力。

案例问题解答 PPT 内容包括：教师对案例问题的理解和逻辑解释，对案例企业的总结和对案例体现的市场规律的总结。此部分力求简洁明了，逻辑清晰。

（二）互联网＋案例教学的课堂安排

每个案例教学安排 3 课时课堂时间，指定 2 个小组（2－3 名学生组成 1 个小组）的学生做案例问题汇报。

教师提前一周公布“案例企业”和“理论角度”，要求全班学生课前做以下准备：1.复习理论；2.通过互联网了解企业的基本情况；3.从理论角度收集，分析案例企业的具体情况。指定小组的学生要准备简短的理论介绍 PPT 和企业介绍 PPT。

课堂分三个部分，第一部分是“理论与企业介绍”，为热身阶段，约 30 分钟。两小组分别从“理论”和“企业”向全班学生进行 PPT 汇报，教师即时对汇报进行简单和必要的提问，然后公布案例问题。第二部分是“讨论问题”，为案例教学的主体，约 60 分钟。针对教师给出的案例问题，两小组在课室外分别对问题进行小组讨论，并把结论制作成 PPT。同时，教师在课室内与指定两小组外的其他学生进行理论回顾和企业解读，然后针对问题展开充分的讨论。第三部分是“讨论案例问题结论”，为高潮阶段，约 45 分钟。两小组分别以 PPT 报告展示案例问题的理解，给出结论。教师即时提出问题，学生进行答辩，也就是教师与指定小组学生进入较深入的、问答式的讨论。最后，教师用 PPT 展示自己对案例问题的理解和总结，并对案例企业本身及所在的行业进行归纳总结。

（三）互联网＋案例教学的评分标准

全班每位学生都会分配进入一个小组，以小组团队的形式对一个企业案例进行 PPT 解读和问题回答。2－3 人的小组基本不会出现搭便车行为，特别是讨论问题部分，由于时间非常有限，小组团队成员要既分工又合作。

每个案例指定两小组同时进行分析活动，形成直接竞争的关系，在 PPT 展示和答辩结束后，教师做点评并即时给出评级。由于不同案例的分析难度有差异，不能进行横向比较，但同一案例问题回答的前提和背景是相同的，从而实现评分的相对公平。

五、互联网＋管理类案例教学创新的成效

“互联网＋管理类案例教学”在笔者所在学院已进行了 5 年的实践，从学校评教数据显示学生对课程认可度非常高，常年排在评教系统前 10%。任课教师通过亲身实践、课堂观察及课后与学生就

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互联网＋案例教学进行小组访谈，学生认为管理素质得到训练和提高。具体反馈信息总结如下：

（一）理论联系实际得到落实

在互联网的帮助下，案例课堂是开放的，是与现实对接的。教师和学生利用互联网工具获得企业和市场信息，通过理论知识和管理工具分析企业问题。虽然，这与企业的实际决策，解决实际问题仍然有相当差距，但或许已经是校园里能做到的最贴近现实的做法。教师和学生带着理论知识进行信息收集、理解、筛选、分析，在这个过程中了解企业、行业在现实中的发展。另一个方面，这个过程又帮助教师和学生理解理论知识在现实中因为环境和时间等因素的差异，会有不同的表现。

（二）综合应用技能得到提升

互联网＋案例教学能够提升学生和教师多方面的应用技能，包括互联网信息搜索能力、时间控制能力、PPT 制作能力、口头表达能力、团队合作能力等。其中，互联网搜索能力是新的，也是互联网时代的重要技能，更是本案例教学创新的基础。利用互联网去了解一个企业应从最基本的企业官方网站和官方微博获取企业主动公开的信息，再到主流媒体对企业事件的报道，主要业务相关专业网站的报道与评价，再到知乎等大众社区对企业相关事件的评述。互联网＋案例教学能够训练学生和教师从互联网纷繁复杂的信息中找寻企业信息，辨析出有价值的部分，勾勒出企业的概况，理清企业发展的技能。

（三）逻辑分析能力得到训练

互联网＋案例教学提高学生逻辑分析和思考辨析能力。案例问题没有现成答案，更没有标准答案。学生要在对案例企业比较熟悉，对所在行业有一定理解的基础上，对案例问题进行思考，理清其中的逻辑关系。无论是课前的准备，还是课堂上对案例问题的思考，从勾勒出企业的真实概貌，到不断细化所关注的理论相关要点，学生都是在不断辨析信息的真伪和相关度。

（四）学习热情得到激发

创新的案例教学以互联网为基础，互联网是案例企业信息的主要来源，因此教师和学生从获取信息的角度来说是平等的。这一方面要求教师必须做好充足的课前准备，以应对学生课堂的提问；另一方面，激励学生课前做好充分的准备，在课堂可以与教师进行讨论交流。总之，在开放的互联网环境，教师和学生共同去搜寻企业资料，讨论、思考、总结，相互促进，教学相长。

六、管理类案例教学创新的保障

理想的案例课堂是在案例企业背景和企业发展介绍后，教师引导学生应用理论，理清企业行为事实背后的动机和含义，最后给出带有普遍意义的总结。这要求教师十分熟悉案例企业，有广博的知识、较强的逻辑分析、要点概括和驾驭课堂的能力。优秀的案例教学教师需要投入热情，把案例如放电影般展播，提出案例问题，引导学生讨论，让尽量多的学生发言。案例课堂的气氛应该是热烈而有序，最后的案例总结是水到渠成，学生能真切感受到理论与实际的联系。

案例教学不同于理论教学，对教师提出了特殊的要求。案例教学的教师应该有相应的培训，要对现实市场有所了解。哈佛大学对从事案例教学的教师进行专门的培训，帮助教师熟悉并熟练运用这种教学方法，整个过程至少要 2 年[7]。若教师能深入企业调研，追踪案例企业，甚至为企业做咨询，担当独立董事，对案例教学有莫大的帮助。

此外，在我国现行的科研体制下，绝大多数高校对教学案例没有经费支持，也不计为科研成果，而这又是因为教学案例不被科研期刊所接收。农业经济管理 A 类期刊《美国农业经济》（American Journal of Agriculture Economics）每年都设教学案例专题，公开发表优秀的教学案例。国际食品和农业企业管理协会（IFAMA）全球性的年度研讨会每年都设有教学案例专场，向全球征集优秀的教学案例，进行学生案例竞赛，到 2019 年已经举行了 29 届。因此，我国发展案例教学，需从科研经费上给予资助，从科研体制上给予认可。

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中国期刊网收录期刊
中国学术期刊（光盘版）全文收录期刊
中国期刊全文数据库全文收录期刊
中国学术期刊综合评价数据库源期刊
万方数据——数字化期刊群全文收录期刊
中国核心期刊（遴选）数据库收录期刊

牡丹江教育学院学报（月刊）
2021年第9期（总第228期）
2021年9月28日出版

JOURNAL OF MUDANJIANG
COLLEGE OF EDUCATION
No.9 2021 (Serial No.228)
Published on Sep. 28, 2021

主管单位 黑龙江省教育厅
主办单位 牡丹江教育学院
编辑出版 《牡丹江教育学院学报》编辑部

地　　址 牡丹江市康佳街181号
邮　　编 157013
电　　话 0453-6955905
网　　址 http://mdjj.chinajournal.net.cn
电子信箱 mdjjyxyxb@126.com

主　　编 万炳月
印　　刷 牡丹江市赢美教育印刷有限责任公司
发行范围 国内外公开发行

Directed by: The Education Department of Heilongjiang Province
Sponsed by: Mudanjiang College of Education
Edited, Published by: Editorial Department
of Journal of Mudanjiang College of Education
Address: No.181 Kangjia Street, Mudanjiang City
Postcode: 157013
Tel: 0453-6955905
Website: http://mdjj.chinajournal.net.cn
E-mail: mdjjyxyxb@126.com

Chief Editor: WAN Bing-yue
Printed by: Mudanjiang YingMei Education Printing Co.,Ltd
Distribution Scope: Distributed at Home and Abroad

广告经营许可证 牡工商广字2310004004003号

ISSN 1009-2323
CN 23-1462/G4

定价:15.00元

ISSN 1009-2323

ISSN 1674-893X
05>
9 771674 893168

ISSN 1674-893X
CN 43-1503/G4

创新与创业教育

Journal of Innovation and Enterprise Education

教育部主管，中南大学主办
教育部高等学校创业教育指导委员会协办
中国高等教育学会创新创业教育分会协办

电子阅读 扫一扫

3
2016
第7卷

创新与创业教育

第7卷第3期
（总第39期）

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2016年6月25日出版
（双月刊）

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期刊基本参数:CN43-1503/G4 * 2010 * B * A4 * 148 * ZH * P * 25.00 * 1800 * 42 * 2016-6

我国高校创业教育的现状与反思

李慧，张光辉，文晓巍

（华南农业大学经济管理学院，广东广州，510642）

[摘要] 为我国高校创业教育在实践上更好的发挥效用，通过创业教育实践与相关文献整理，首先概述了我国高校创业教育的发展历程与现状，然后从理论探讨创业本身的特性及其与创业教育的关系，进而对我国现行高校创业教育进行反思分析，发现多数高校以创业率评价创业教育成效背离创业的规律；部分高校营造全校性创业氛围可能影响学校的均衡发展；大部分高校脱离社会与市场，仅依靠自身力量开展创业教育，实践效果有限。对此，建议高校推行创业教育从战略上重视创业的特性与规律，培养学生创业素质，从策略上一方面要有针对性的利用校内资源，另一方面重视并加大对学校外部市场资源与社会资源的利用。

[关键词] 高校创业教育；现状反思；创业特征

[中图分类号] G64 [文献标识码] A [文章编号] 1674-893X(2016)03−0013−04

1999 年，我国国家级纲领性文件《面向 21 世纪教育振兴行动计划》首次明确提出“ 加强对教师和学生的创业教育 ”。随后，各高校在全国各地对创业教育开展各种探索。近年来，高校创业教育更是得到高度重视，发展迅猛。“ 高校是否有必要开展创业教育 ” 的讨论已经不再受关注，创业教育已经获得学生、学校和社会的广泛认可。2010 年，《国家中长期教育改革与规划发展纲要（2010-2020）》直接表明“ 要加强高等学校就业创业教育 ”。

笔者首先通过在华南农业大学实践创业教育，并对相关文献进行梳理，整理出我国高校创业教育的发展脉络及基本现状，然后归纳提炼创业及创业教育的特点及关系，对两者进行对比，分析反思我国高校创业教育，并提出相应建议。

一、我国高校创业教育的发展历程及现状

高校创业教育最初提出的社会大背景是扩招后大学生就业困难，大部分高校在“ 以创业带动就业 ” 的口号下，定位高校创业教育是：学生创建企业，最好毕业就创业，甚至在校就能够创业[1]。

我国高校创业教育可追溯到 1998 年 5 月，清华大学举办了我国首届创业计划大赛，随后成立“ 创业中心 ” 加以推广[1]。这是我国影响力最大的创业比赛，现在简称“ 挑战杯 ”，被誉为“ 当代大学生科技创新的奥林匹克 ”。2015 年第十四届挑战杯吸引了全国 2 000 多所高校 200 多万大学生直接参与。创业竞赛一直是我国高校创业教育的重要组成部分，学生对创业比赛热情很高。从首届创业高峰论坛的资料了解到，围绕创业比赛开展创业教育的师资绝大部分来自校内，并且以教辅人员（团委，就业指导中心）为主，专业老师（学院专职教师）为辅。

2003 年，教育部高教司举办“ 创业教育骨干教师培训班 ”，共青团中央、全国青联和国际劳工组织开展 KAB（Know About Business）等创业教育项目。现在，大部分高校均已开设创业教育课程，创业教育成为很多毕业生就业教育的必修内容，以创业为主题的各种活动在各高校蓬勃开展[2]。

我国典型的高校创业教育模式以宁波大学“ 课程，实训，管理 ” 为代表，即以创业教育课程为基础，培养大学生创业意识与能力；以创业实践训练为导向，强化大学生的创业技能；以创业教育管理服务为保障，服务于创业教育课程开设和创业实训，促使大学生顺利走上创业之路[3]。温州大学也是实践该创业教育模式的优秀代表，在创业教育有相当基础后，正逐步把创业教育从第二课堂向教学

[收稿日期] 2015-11-24；[修回日期] 2016-03-20

[基金项目] 华南农业大学教育教学改革与研究（JG12080）；华南农业大学教育教学改革与研究（BKJX2015018）；华南农业大学教育教学改革与研究（BKJX2015023）

[作者简介] 李慧（1982-），女，广东茂名人，华南农业大学讲师，主要研究方向：农产品运销管理，创业教育；张光辉（1962-），男，湖南衡阳人，博士，华南农业大学教授，主要研究方向：企业管理，市场营销；文晓巍（1973-），男，湖南湘潭人，博士，华南农业大学教授，主要研究方向：供应链与物流管理，教育管理

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主渠道渗透。2013 年 11 月，温州大学组织承办首届高校创业教育高峰论坛，全国 80 余所高校创业教育负责人与专业教师参与会议。

无论是学术探讨还是实践经验，高校创业教育被公认为是一个系统，是高校内外各种资源的整合。如郭万牛总结高校创业教育是“五位一体”的教育体系：以政府为创业教育保障，以高校为创业教育关键，以大学生为创业教育主体，以社会为创业教育支撑，以企业为创业教育基地[4]。也就是说，高校创业教育除了校内资源，还需要政府、社会与企业的参与。其中，政府的支持，特别是创业资金上的支持常被寄予厚望。

教育部 2010 年《关于大力推进高等学校创新创业教育和大学生自主创业工作的意见》指出将创新教育与创业教育相结合，提出“创新创业教育”。这标志着我国高校创业教育在政策层面进入了新的发展阶段，从“企业家速成导向”向培养大学生创新能力，提高人才综合素质方向转变。但是从整体看，我国绝大部分高校创业教育在实施过程中仍存在“创办企业”的逻辑归属[1]。

二、创业与创业教育的特性与关系

得到较广泛认可的创业（Entrepreneurship）定义是：“识别机会，整合资源，将创业付诸实施的一种精神与能力”。由此看，创业应该是精神与能力的概括，体现为日常的行为方式[5]；创业是一个过程，一个与社会环境紧密结合的过程。创业的机会不是随时随处都有，不是适合每一个人，也不是适合每一个受高等教育的人。创业需要事业心，进取心，开拓精神，敢于承担风险等特殊的能力与品质[2]。这很大程度由个人幼年成长环境所造就，如所在地区的文化和家庭环境，特别是家庭成员的创业经历。

创业教育除了需要传播创业知识与创业理论，以帮助形成创业能力，还需要激发创业精神，而这两个部分是相辅相成，不可偏废的。正如很多作家并没有接受高等教育，而高等教育“文学创作”专业毕业的学生绝大多数没有成为作家，而成为文学评论者。创业教育要帮助学生形成创业能力，而对创业精神只能“点燃”，难以传授。若提到创业教育是“终身教育”，那不仅包括高等教育毕业后的教育，还应该包括高等教育前的教育。正如严毛新指出创业教育一定不是短期，能够速成的教育[3]。创业的精神与个性的发展是密切相关的，创业精神的培养有赖于个性的发展，个性的发展促进创业精神的养成。这也就是说，只有少数大学生的个性能够与创业精神相匹配。

高校创业教育应该是开发和提高大学生创业素质的教育，培养学生事业心，进取心和开拓精神。对个性匹配，有主观创业意愿的学生（数量很少）给予创业知识、信息等各方面的支持，使他们的创业素质得到更好的发展。

三、对我国高校现行创业教育的反思

（一）高校以创业率评价创业教育，背离创业的规律

高校创业教育的提出及大发展的背景是高等教育扩招，而带来巨大的大学生就业压力。尤其是党的十七大报告（2007）中明确指出“促进以创业带动就业”。因此大多数高校都把创业教育功利地推向了就业保障。

但是，高校创业教育不应该是教会大学生创立企业，因为创立企业所需要的素质不是通过模拟竞赛或讲座，更不是课堂所能够传授的。美国百森商业学院蒂蒙斯教授对美国功利主义创业教育倾向的评述“用拔苗助长的方式造就所谓的创业者，无法满足以创立高新技术为标准的创业革命的需要”[2]。功利主义创业教育所“速成”的创业者甚至不能驾驭正常的市场风险与社会风险。熊丙奇的调查显示中国大学毕业生选择创业的比例远小于 1%[6]，郑如霞的调查统计得出大学生创业成功率是 2%-3%，且成长性差，长效发展困难[7]。高校创业教育不应该是教大学生创业，而是培养大学生创业素质，启发大学生认识创业，仅对有创业行动需求的大学生进行创业行动的协助。

以创办企业为目的及最终落脚点的高校创业教育所培养的学生在实践创业方面绝大多数是不成熟的，在“看不见的手”的市场经济下，其获取创业资金成为最大的障碍，而这一点正好反映出市场的理性。但是，大多数的学生，乃至高校把政府作为创业资金获取的来源，简单的认为政府应该支持创业教育，甚至提出政府是创业教育的保障。这都是不合适的，因为政府的职责是公共服务。政府在创业教育中的角色走得最远也只能是引导更多的风险投资关注高校创业。政府没有责任，也不应该直接参与高校创业的投资，或募资。因为，这样无法保证纳税能够获得的正常收益。对于创业者，市场应该是平等的，同样不应该顶着高校创业的帽子，就减少对风险的关注。

（二）高校大范围营造创业氛围，影响自身的均衡发展

创业教育仅是高等教育的一个部分，每个高校

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有学科优势和发展历程，大学生在学校的时间与精力也是有限的。若过分强调创业教育，无限制的扩大创业教育的比例[8]，乃至要在全校范围营造创业氛围，以“创业型大学”为学校发展目标，很可能影响自身的正常发展。我国学科发展经过几十年的努力，已经形成一个较完整成熟的体系，各个学科皆有创业的基础与可能性。但是，如果整个高校大范围推进创业教育，过分强调创业氛围，各学科的教育将演变成单一的创业教育，这对绝大多数高校是不合适的。

创业教育应该与高校的其他教育相互平衡。首先，高校学生有各自的专业，除了创业管理专业的学生都需要，而且主要是学习创业外的自己专业的知识。因此，不应该营造全校性的创业氛围。从整个社会看，创业本来就是小部分人的事业。同样，学校的创业氛围也应该局限在创业社团、创业孵化基地及创业比赛时段的小范围内。

此外，任何氛围不是短时间急功近利能够形成的，需要社会经济发展到知识经济时代。社会本身有创业大气候，高校才有健康的创业教育土壤，通过时间的积累，方能形成。麻省理工学院是创业教育的标杆，创业传统由来已久，校友资源丰富，创业网络广泛，其中 10 万美元创业大赛（MIT $100K）可见财力投入之大。我国某些高校在并无实质创业教育基础上，目标定位在“创业型大学”，动员所有学校管理人员，教师，学生向创业型大学的方向努力，去营造全校性的创业氛围，是难以实现其目标的，并且会破坏学校传统的优势与特色。

高校自上而下创业氛围的营造应局限在创业社团与创业活动。学校应为其提供校外的联系，搭建创业教育支持体系。社团创业活动的成功开展（特别是校友企业的不断发展）将扩大创业教育的辐射面与影响力，使更多的学生，甚至教师受到启发与鼓励。真正创业氛围还是自上而下，通过时间沉淀形成的。

（三）高校仅依靠自身力量开展创业教育，脱离社会与市场

创业教育不同于高校其他专业的教育，与实践紧密联系。创业教育不应运用学术思维，而应运用市场思维，这单纯依靠学校师资是不能胜任的。因此，高校不能仅依靠自身力量进行创业教育，学校更应该是一个平台。创业理论知识，创业技术的传授是高校本身资源能够实现的，而创业实践指导，甚至是模拟创业比赛的指导更多需要依靠校外导师。高校在此应发挥桥梁的作用，充分利用校友资源，鼓励、吸引企业家参与到高校创业教育中。对澳大利亚创业大赛参赛学生的调查表明：创业指导导师与人脉构建（如与风投企业建立联系）是评价创业竞赛吸引力的重点[9]。这里的创业导师可以是高校内部有商业运作经验的教师，更多的是校外有实业界经验的企业管理者和风险投资人。而人脉的构建，就更是走出校门的现实社会。正如金津等研究美国顶级创业大赛的结论是：校外创业资源的广泛介入是创业教育有效实施的重要前提，这包括丰厚的赞助，专业的评审和完善的指导[10]。

四、对我国高校创业教育的总结与建议

学生发展与社会需求互动互利，教育是其中的媒介，是为社会发展服务的。随着中国社会的发展与进步，社会需要越来越多的创业者及具有创新创业精神的企业家，高校创业教育应运而生。创业教育实践性的特征决定了其既依赖高校教学的特点，又必须植根于特定的经济环境[1]。因此，高校创业教育需要突破就业指导的范畴，遵循创业精神培养的规律，与社会发展的大环境相配合，对有符合创业个性，有创业潜力的学生进行创业启蒙，激发、传授创业知识与创业理论，在各种活动中进行创业精神与能力的培养。

（一）高校创业教育需要符合创业规律的学校内部资源

除了创业管理专业的学生，高校创业教育应既给予学生选择的空间，又给予学生选择的机会。学生来自不同地区，不同的家庭，成年后来到高校，不是所有的学生都需要提升创业素质。针对创业素质启蒙，高校可面向全体学生，以企业家讲座的形式，由学生自主自愿参与，主要是唤醒和激发大学生对创业的兴趣与热情。针对有创业兴趣的学生，学校鼓励学生发挥主观能动性，由高年级学生组织创业相关社团，向低年级学生宣传，并吸纳有创业潜力的学生进入学生社团组织。创业学生组织内部很容易形成创业氛围，学生之间相互学习，相互促进，思想相互碰撞，创业知识与信息得以快速传递。学校由经济管理类的专业教师以全校选修课的形式开设创业知识与创业理论的课程，学生可以自由选择学习基础的金融、财务、营销、物流等创业相关的技术知识。依托“挑战杯”大学生创业计划大赛等创业策划竞赛，模拟创业实践，体验创业团队合作。高校根据自身资源协助学生准备竞赛，由专业教师与实业界导师进行全过程的指导，可使用“研讨会”“训练营”等方式，使学生接触实业的人际资源，习得创业技能，并在商业计划展示阶段

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模拟实践募资过程。

我国现有高校创业教育的管理组织大多设在团委或教育指导中心，这样的优势在于管理层级高，在学校资源应用及对外联系相对有优势。对照全球创业教育标杆的斯坦福大学及麻省理工，创业教育组织都是商学院下设管理中心，因为与创业的运作联系最紧密的是管理学院。我国高校可利用原有的创业教育管理中心与管理学院合作的方式，对管理学院的专业资源与实业界资源进行进一步挖掘。

（二）高校创业教育需要适合创业的外部社会环境

高校创业教育的基地在高校，但要真正的发展必须要有创业需求的社会。从整体来看，我国经济虽持续发展，也面临转型升级。企业，特别是新的企业是经济继续发展的重要动力。政府不断加大对小微型民营企业的鼓励与支持，形成有利于创业的政策环境。随着分工的细化，企业专业化不断加强，更多的社会辅助性行业得以发展，如法律事务所、会计事务所等，使新创立的小微型企业能够专注于核心竞争力，也使整个社会的经济活动更加规范，更加有活力，更加有利于创业。

高校创业教育仅靠高校的力量是难以推动，应该靠社会需求的拉动。高校创业教育真正的发展是社会需要更多拥有良好创业素质的人才，在知识经济中去识别机会，整合资源，将创业付诸实践。包括苹果与雅虎在内的硅谷经济，就是在斯坦福大学的创业教育下影响世界。这是高校与社会发展的联动，高校创业教育应该是其中的桥梁，点燃大学生创业的激情，获得创业知识，给予创业支持。

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[编辑：汪晓]

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邮　编　410083
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电　话　0731-88877882
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印　刷　湘潭市霞城社会福利印刷有限公司
国内邮发　42-374
国内定价　25.00元

全国首届《CAJ-CD规范》执行优秀期刊

CN 11-3776/G4
ISSN 1007-0079

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学科专业建设

基于知识管理的学科核心竞争力研究

ISSN 1007-0079

4

2012

第11期（总第234期）

中国电力教育

CHINA ELECTRIC POWER EDUCATION

2012年第11期（总第234期）

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电　话　投稿咨询 010-51976818
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网　址　http://www.cepe.cc
电子邮箱　dianlijiaoyu@vip.163.com
国际刊号　ISSN1007-0079
国内刊号　CN11-3776/G4
印　刷　山西三和印刷有限责任公司
出版日期　2012年4月10日
定　价　12.00元

本刊为中文科技期刊数据库收录期刊、中国知网（CNKI）全文收录期刊、中国学术期刊（光盘版）全文收录期刊、中国学术期刊综合评价数据库来源期刊、万方数据——数字化期刊群入网期刊、龙源期刊网收录期刊。如作者不同意将文章编入以上数据库，请在来稿时说明，本刊将做适当处理。

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DOI编码：10.3969/j.issn.1007-0079.2012.11.065

我国高校创业教育现状及对英美的借鉴

李 慧 张光辉

摘要：创业教育在中国经历了15年的发展，虽然有政府的积极推动和学生的强烈需求，但由于各方面原因，其仍然属于探索阶段，没有找到适合发展的模式，在学术界也有各种不同的意见，其中有极端者提出创业教育应代替传统的就业教育。通过借鉴美英两国创业教育的发展历程及现状，结合我国创业教育的现实状况，提出我国高校创业教育应具有选择性。

关键词：创业教育；选择性；美国；英国

作者简介：李慧（1982-），女，广东茂名人，华南农业大学经济管理学院，讲师；张光辉（1962-），男，湖南衡阳人，华南农业大学经济管理学院，教授。（广东 广州 510642）

中图分类号：G645 文献标识码：A 文章编号：1007-0079（2012）11-0126-02

创业教育是开发和提高学生创业基本素质的教育，是一种培养学生事业心、进取心、开拓精神和冒险精神，从事某项商业规划活动的教育。（卢小珠，2004）创业教育主要包括传授理论知识、职业知识、创业知识。因此，创业教育可以在一定程度上弥补创业实践经验的不足，可以系统地培养创业技能。（木志荣，2006）

创业教育起始于美国，众多学者认为1947年哈佛大学开设的“新创企业管理”是美国大学教育中的第一门创业课程。（熊飞等，2005）创业活动被称为经济发展的基本推动力之一，推动着技术创新及生产力提高（Busenital etc.，2003），受到各国政府及学术界的重视。

一、我国高校推动创业教育的背景

1.我国政府积极推动高校创业教育

创业教育的快速发展是在世界失业率高企的大背景下，从创业教育发展最成熟的美国的创业教育发展历程可以看到，创业教育的发展是与失业率及中小型企业的发展相适应的。（邓汉慧等，2007）受金融危机等因素影响，我国的就业形势严峻，而这与逐年扩大的高校毕业生规模形成尖锐的矛盾，高校毕业生就业压力成为政府关注的重点，新企业的创立是创造就业机会的重要举措。因此，创业教育的提出及推广更加受到政府的重视与支持。（柴径，2002）

2002年，教育部明确提出创业教育在高等教育中的试点工作。2005年，中共中央办公厅和国务院对高校毕业生就业的指导意见中提到“积极鼓励、支持高校毕业生到基层自主创业和灵活就业。”

2.高校学生对创业教育有自主需求

陈艳等（2006）对广州5大高校1400多名在校学生的问卷调查得出：近80%的被访者认为自己的创业能力完全没有或者远远不够，而相应的有超过80%的被访者希望能够培养自己的创业素质。木志荣（2006）对厦门大学511名在校学生的调查中显示：超过90%的受访者认为学校开展创业教育有必要或非常必要。徐玉芳（2008）对河南4所本专院校的210名在校大学生的调查结果同样表明84%的学生对创业很有兴趣，同时也表明有92%的学生认为自己创业能力不强。从以上三个不同省份在校大学生的调查中可以明显看出大学生对创业教育的需求。

3.其他创业教育的有利因素

社会从大工业时代向知识经济时代的转变，要求新企业的出现，并与之相适应。社会消费需求的多样性，且随之形成的“多品种，小批量”的特点，为新创小企业出现提供了空间。互联网的普及，使电子商务能以低成本接触到远程的顾客及供应商。总之，当今社会为小企业的创立提供了更多的有利条件，但利用这些有利的条件需要更多的创业相关知识。

综上所述，从政府的宏观角度考虑，创业教育有利于社会发展；从学生角度，创业教育是自发的要求；且社会整体的发展对企业的创立是有利的，但对创业教育提出了更高更迫切的要求。

二、借鉴国外创业教育的先进经验

1.美国的创业教育

硅谷对美国乃至世界的经济及社会发展起了重要的推动作用，而斯坦福大学被誉为“硅谷的心脏”，其中的创业教育与硅谷的发展相辅相成。（张帏等，2006）斯坦福大学的创业教育体系（见图1）可分为课程教育、非课程教育，且整个创业教育体系受到相关学术研究的支持，并与美国国内外企业及机构交流密切。其主要特点是：在斯坦福大学“西部先驱精神，创业精神，大胆承担风险”的传统与文化的鼓舞下，课室内师生积极参与，学校内各项目及组织有效开展交流合作，学校外部资源给予大力支持（见图2）。

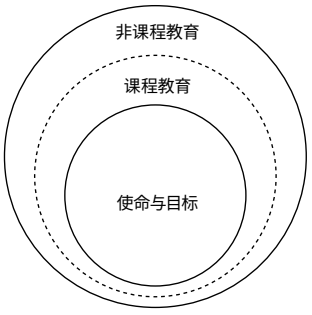

图1 斯坦福大学创业教育体系

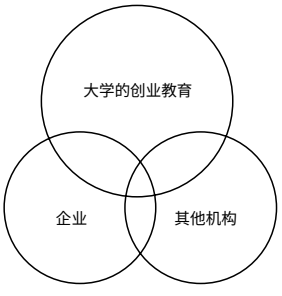

图2 斯坦福大学创业教育与外部联系

统计截止到2005年，美国有1600多个学院开设了超过2200门关于创业的课程，成立了100多个创业有关的研究中心，44个主流期刊就创业相关问题进行讨论。（Kuratko，etc.，2005）从整体看，美国创业教育是一个完整的体系，不但包括学士、硕士、博士的高等教育学科体系，还涉及到小学、中学、专科及职业培训的完备体系；美国的创业教育有专职的机构；雄厚的教师队伍，包括学者型的专职教师和有丰富业界实践经验的客座教授等；课外实践活动多样化，

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包括影响面广的创业计划比赛、俱乐部、交流会、咨询日等；创业资金渠道多，包括政府、基金会、个人捐赠等；创业及创业教育研究深入，并取得丰硕的成果。（邓汉慧等，2007）

2.英国的创业教育

在严重的就业压力下，英国政府大力推动创业教育。英国的创业教育自20世纪80年代兴起，始于高等教育创业计划（Enterprise in Higher Education Initiative）的提出。首先，英国创业教育的主要特点是以创业项目带动创业教育，任何学科背景、任何年级的大学生均可申请创业项目，项目配备创业导师。其次，英国建立了创业教育的专门管理机构，包括英国科学创业中心及全国大学生创业委员会。再次，英国政府为创业教育提供了大量的资金，主要是高等教育创新基金及科学创业挑战基金，当然还包括部分民间资本的投入。最后，政府为高校创业提供服务，成立如商业连接（Business Link）等帮助大学生创业的服务机构。（牛长松，2007）

三、我国高校创业教育的理论及实践现状

国内学者对中国创业教育的研究主要集中在三个方面：对国外创业教育经验的对比分析（张帏等，2006；邓汉慧等，2007；牛长松，2007，等）、对某地区在校学生关于创业教育的问卷调查（陈艳等2006；木志荣，2006；徐玉芳，2008，等）及对高校创业教育模式的探讨（柴径，2002；木志荣，2006；邓立志，2009，等）。

部分学者认为创业教育将是中国未来高等教育的全部。其中，江西财经大学的姜红仁（2007）认为：“我国高等教育应从过去的被动性就业教育转变为开拓性创业教育”，以创业意识和能力的提高改变就业难，创业教育的对象将是全体学生。此外，广西师范大学唐德海教授（2001）提出：“从就业教育走向创业教育，既是世界高等教育发展的总的趋势，也是中国高等教育改革和发展的必然选择”，就业教育与创业教育被严格划分成两种不同的模式，并认为就业教育将被创业教育所取代。然而，华南理工大学的陈艳等（2006）在学生调查中发现大部分受访者愿意并希望接受创业教育，但他们认为“创业是一个人发展与自我提升的过程”，并不是必须创立企业。

我国创业教育的兴起应追溯到1997年清华大学举行的第一届大学生创业大赛。2002年，教育部确定清华大学、北京航空航天大学等9所高校为创业教育试点高校。

几乎所有关于创业教育的文献都提及师资的问题，认为创业教育的师资是其的关键点及难点，因为创业教育可以说是学科跨越最多，最综合的学科，同时又是实践性最强的学科，经验的引导往往多于概念的讲授，对创业教师本身提出相当高的要求，同时对教学方法也提出新的要求。然而，我国的现实情况是创业教育师资严重缺乏。（木志荣，2006）

根据调查研究（熊飞等，2005；陈浩凯，2006，等），中国现阶段的创业教育处于起步阶段，没有形成系统的创业教育，创业教育模式仍然处于探索阶段，高校在各自的实践中出现各种模式，也在学术上形成不同的思想。

四、我国高校创业教育应具有选择性

陈艳等（2006）对广州5大高校1400多名高校在读学生的问卷调查中，选择一定要创业的被访者仅占7.57%，而根本不打算创业的学生超过30%。大多数被访者（大于80%），希望能够培养自己的创业素质，但其中又有超过一半的被访者认为不是必须的。

作为经济第一强国的美国，其创业教育的体系经历了超过60年的实践，已经成系统。这是我国乃至其他发达国家所不及的，但在其发展前期同样也是从简单到复杂的过程。因此，我国的创业教育在借鉴美国完善的创业教育体系的基础上，必须根据中国高等教育的实际情况，创业教育不可遍地开花。全方位地实施创业教育不现实，既不符合教育资源的现实情况，也不符合实际的社会需要。

英国的创业教育也仅有约30年的实践，从直接经验来看，对我国更有借鉴意义。政府在英国创业教育中起着重要的推动作用，大量投入资金，努力营造创业的文化氛围。但对比来说，我国高校的人均教育资源比英国低得多，与社会企业的联系比较缺乏，在校大学生的实际操作能力也相对较弱，这同样使我国的创业教育需要把有限的资源放在最需要的地方，有选择地进行创业教育。

总之，创业教育在我国仍然处于新兴阶段，发展时间较短，没有形成完整的学科体系，但可预期将得到高速发展。参考美国创业教育发展的经验，创业教育的发展同当地中小型企业产生的数量，即创业的需求成正比。但强大的需求与创业教育资源的不足形成更为突出的矛盾，特别是创业师资的不足，而创业课程及本地化的理论也需要时间的积累等。因此，高校创业教育在我国当前的状况下应该是有选择性地实施，在探寻适合中国创业教育模式的过程中，做好典型示范作用。

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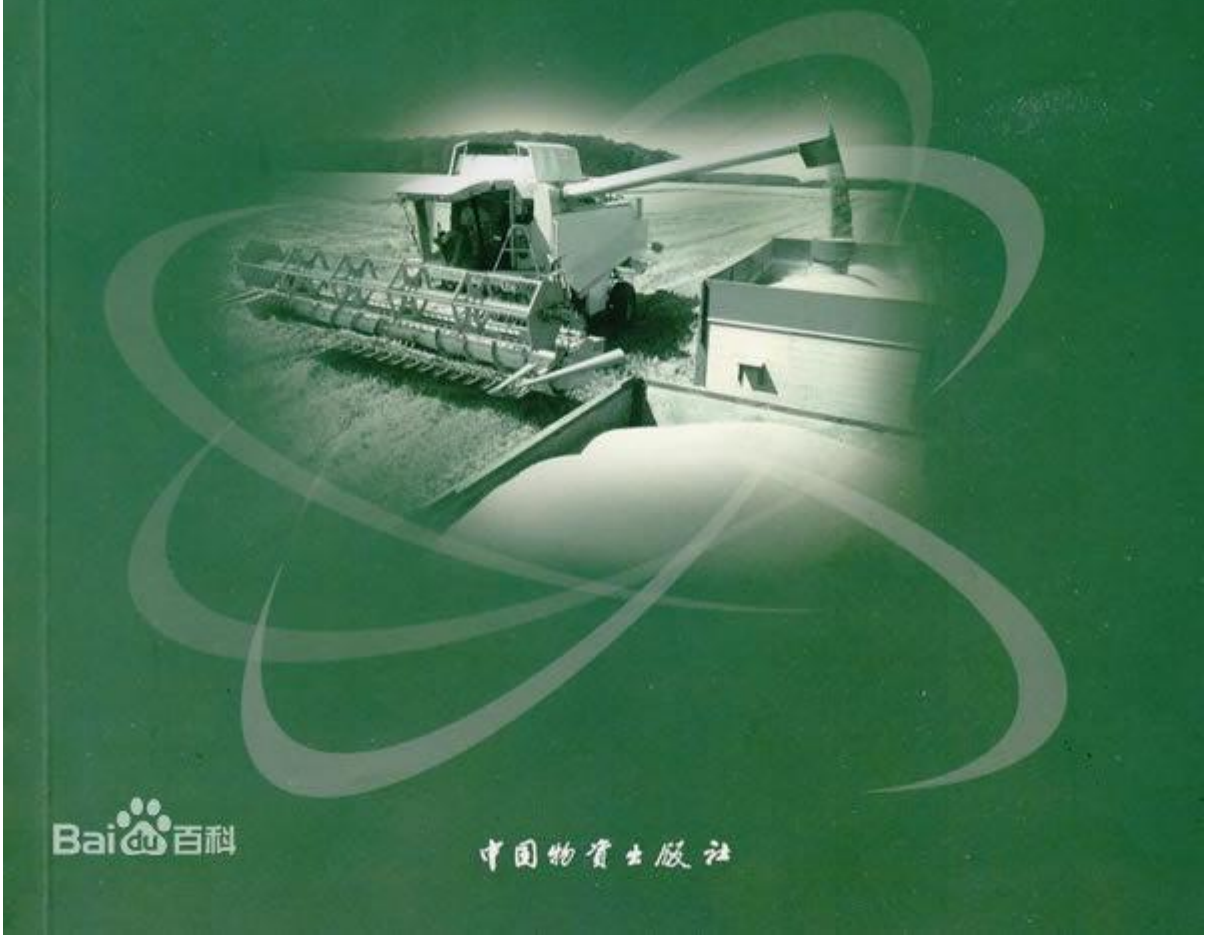

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前　言

我国是一个农业大国，农业是国民经济的基础产业，农产品的生产、分配、交换和消费共同构成了农业再生产的有机链条，任何一个环节缺失或不畅势必影响农业的健康发展。改革开放30年来，我国农业和农村经济取得了长足发展，农产品全面短缺的时代已经结束，部分农产品出现了区域性、结构性过剩，而农产品流通不畅日益成为农业经济发展的重要制约因素，大力发展农产品物流迫在眉睫。然而，在目前的物流理论研究和实践中，人们往往将物流和工业品流通联系在一起，农产品物流至今还没有受到应有的重视。

农产品物流是全社会物流的重要组成部分，它的发展状况与经济的持续发展密不可分。我国农产品物流整体处于时间长、消耗大、效率低、效益差的低水平状态，很难适应社会经济迅速发展的需要，造成这一状况的主要原因是农产品的运输、储存、包装、加工等各个物流环节相互脱节，农产品物流系统并没有有效地建立起来。国际经验表明，完善、高效的农产品物流体系是实现农业现代化和经济可持续发展的重要前提和保障。因此，如何完善农产品物流体系，降低农产品物流成本，提高农产品物流效率，已成为当前物流理论和实践探索的重要问题。因此，我们在借鉴和吸收国内外学者研究成果的基础上，编写了《农产品物流与运营实务》一书，从农产品物流管理与运作的角度，探讨农产品物流的相关问题，以期进一步丰富农产品物流理论，并为农产品物流实践提供有益的指导。

本书共分为十四章，由广东省惠州学院和华南农业大学的专业教师完成书稿的编写工作。其中，第一章、第十二章、第十四章由张敏编写，第二章由李慧编写，第三章、第七章由陈炜颖编写，第四章由王发良编写，第五章由贾卫丽编写，第六章由王雄志编写，第八章由谈海霞编写，第九章由刁丽琳编写，第十章、第十一章由左两军编写，第十三章由文晓巍编写。全书由张敏统稿并担任主编，左两军、朱永德任副主编。

本书受到惠州学院出版基金的资助，在编写过程中得到了中国物资出版社的大力支持，廖廷水先生为本书的出版给予了许多关心和帮助，在此一并致以诚挚的谢意。本书的编写还参阅了大量国内外文献资料，作者已尽可能地在书中对文献出处进行注明，衷心感谢这些学者和专家对物流研究所做出的贡献。

由于农产品物流理论研究和实践正处于发展阶段，需要不断充实与发展，有关农产品物流的论著也比较少，我们所做的努力仅仅是开始。由于作者的水平有限，书中疏漏之处在所难免，恳请同行专家和读者批评指正。

编　者

2009年5月

教育部司局函件

教社科司函〔2018〕154号

2018年度教育部人文社会科学研究一般项目立项通知书

华南农业大学李慧同志：

您申报的《农业社会化服务改善我国小农发展空间的研究》项目，经我部组织专家评审并经公示，正式批准为2018年度教育部人文社会科学研究青年基金项目。

项目批准号：**18YJC790079**

批准经费：8 万元。请按照《高等学校哲学社会科学繁荣计划专项资金管理办法》（财教〔2016〕317号）以及国家有关科研经费管理制度，合理合规使用经费，提高经费使用效益。

立项时间：**2018年7月24日**。项目研究周期一般为3年。我部将于2020年统一组织项目中期检查，年度预算执行情况是项目中期检查的内容之一。中期检查情况将作为后续拨款的重要依据。

请按照《教育部人文社会科学研究项目管理办法》（教社科〔2006〕2号）的要求和您提交的申请评审书中设计的研究内容及研究计划开展项目研究，确保项目按期保质保量完成。项目鉴定、结项按照《教育部人文社会科学研究项目成果鉴定和结项办法》（教社科司函〔2007〕145号）进行。所有出版或发表的项目研究成果，须在显著位置标明“教育部人文社会科学研究规划基金/青年基金/自筹经费项目”字样和项目批准号，否则项目中期检查及鉴定结项不予通过。

教育部社会科学司

2018年7月24日

教育部人文社会科学研究项目

结项证书

项目类别：一般项目(青年基金项目)

项目名称：农业社会化服务改善我国小农发展空间的研究

负责人：李慧

主要参加人：张蓓；齐文娥；钟文晶；左两军；谢琳；彭思喜

批准号：18YJC790079

本项目经审核准予结项，特发此证。

教育部社会科学司

2023年12月25日

证书编号：2023JXZ2919

广州市社会科学规划领导小组办公室文件

穗社规办〔2023〕7号

关于广州市哲学社会科学发展“十四五”规划2023年度共建课题立项的通知

各有关单位科研管理部门：

经专家评审、社会公示，报广州市社会科学规划领导小组领导审批同意，广州市哲学社会科学“十四五”规划2023年度共建课题立项349项（立项名单见附件）。现将有关事项通知如下：

1.本年度课题立项时间为2023年6月9日，课题结项时间为2025年6月9日前。因故不能按期完成结项的，应在结项时间截止前10天提出延期申请。

2.课题名称以本通知附件所列的名称为准，请课题负责人对应修改《广州市社会科学规划课题申请书》（以下简称《申请书》）。课题研究应按照《申请书》的设计进行。未经市社科规划办同意不得擅自更改研究方向、内容和成果形式，不能变更或调整项目

负责人和管理单位。

3.共建课题研究经费由课题申报人所在单位保障，原则上每项资助经费3万元（具体由各单位结合自身实际确定）。

4.请各单位科研管理部门及时将本通知有关事项告知各课题负责人，并组织课题负责人签订《广州市哲学社会科学发展“十四五”规划2023年度课题立项协议》一式3份（模板下载请联系市社科规划办），于2023年6月26日前送达我办审定盖章。随协议同时报送《申请书》纸质版一式1份，需签字盖章。原申报其他课题转共建课题获立项的可更改《申请书》的课题类别、预期成果和经费预算等相关内容。

5.未签订《广州市哲学社会科学发展“十四五”规划2023年度课题立项协议》的，视为课题负责人自动放弃课题立项。

附件：广州市哲学社会科学发展“十四五”规划2023年度共建课题立项名单

广州市社科规划领导小组办公室

2023年6月9日

（联系人：姬老师；联系电话：020－89815149）

附件

广州市哲学社会科学发展“十四五”规划2023年度共建课题立项名单

（349项）

序号	负责人	单位名称	课题名称	学科类别	课题类别	课题编号
1	肖万	华南理工大学	广州专精特新企业高质量发展的金融支持研究	经济学	共建课题	2023GZGJ01
2	周锐波	华南理工大学	科创活力轴战略定位与广州城市轴线总体发展规划研究	经济学	共建课题	2023GZGJ02
3	杨茁	华南理工大学	广州推动战略性新兴产业融合集群发展路径研究	经济学	共建课题（羊城青年学人）	2023GZGJ03
4	李桦	华南农业大学	广州构建“双碳”与乡村振兴协同发展体系研究	经济学	共建课题	2023GZGJ04
5	李慧	华南农业大学	粤港澳大湾区经济发达地区小农绿色生产的决定机制研究	经济学	共建课题	2023GZGJ05
6	杨昌安	广东外语外贸大学	产业数字化影响广州企业信息披露违规的作用机制研究	经济学	共建课题	2023GZGJ06
7	余燕团	广东外语外贸大学	碳普惠制对绿色低碳转型的影响机制研究	经济学	共建课题	2023GZGJ07
8	刘倩	广东外语外贸大学	大湾区绿色金融市场发展研究：基于数字技术的视角	经济学	共建课题	2023GZGJ08
9	董峰	广东外语外贸大学	广州加快壮大民营经济规模、提升市场经济活力的战略路径和对策研究：基于开放式创新的视角	经济学	共建课题（羊城青年学人）	2023GZGJ09
10	赵雨	广东外语外贸大学	广州强化粤港澳大湾区核心引擎功能研究	经济学	共建课题（羊城青年学人）	2023GZGJ10
11	赵九茹	广东外语外贸大学	广州促进数字经济与实体经济深度融合研究	经济学	共建课题（羊城青年学人）	2023GZGJ11
12	刘三林	广东工业大学	人工智能发展对广州劳动力就业极化的影响及就业保障缓冲机制研究	经济学	共建课题	2023GZGJ12
13	朱宁	广州大学	广州强化粤港澳大湾区核心引擎功能研究：基于区域一体化高质量发	经济学	共建课题（羊城青	2023GZGJ13

广东省哲学社会科学规划专项小组

粤社科规专通〔2023〕31号

广东省哲学社会科学规划2023年度一般项目立项通知书

李慧同志：

经专家评审及省哲学社会科学工作领导小组审批，您申报的广东省哲学社会科学规划2023年度一般项目《农户绿色生产自我实现机制研究：基于合约匹配视角》获准立项，批准号：GD23CYJ07，资助经费3.0万元，第一次拨款2.1万元，预留经费0.9万元。请于6月28日前登录广东省哲学社会科学规划项目管理平台认真填写立项回执，并通过责任单位审核后提交省社科规划专项小组。

填写立项回执后，项目申请书即成为立项协议，对项

见“广东社科规划”网站。

6.成果鉴定等级分为优秀、良好、合格和不合格四个等次。不合格者即未能通过结项，不予拨付预留经费。项目成果的最终鉴定等级均通过“广东社科规划”网站予以公布，并通知项目负责人所在单位。

以上规定，项目负责人及所在单位应严格遵守。如有异议，可不接受资助（在回执中注明），立项协议自行废止。

联系人：冯甜恬

电话：（020）83825078

地址：广州市天河北路 618 号广东社科中心 B 座 928 室

邮编：510635

广东省哲学社会科学规划专项小组

2023 年 6 月 28 日

广东省哲学社会科学规划项目

关于国家自然科学基金资助项目批准及有关事项的通知

华南农业大学 黄松先生/女士:

根据《国家自然科学基金条例》的规定和专家评审意见，国家自然科学基金委员会（以下简称自然科学基金委）决定批准资助您的申请项目。项目批准号：71301055，项目名称 考虑顾客策略行为时的零售商预售策略研究，资助金额 19.00 万元，项目起止年月：2014 年 01 月至 2016 年 12 月，有关项目的评审意见及修改意见附后。

请尽早登录科学基金网络信息系统（https://isis.nsfc.gov.cn），获取《国家自然科学基金资助项目研究计划书》（以下简称计划书）并按要求填写。计划书电子文件通过科学基金网络信息系统（https://isis.nsfc.gov.cn）上传，由依托单位确认后，自然科学基金委进行审核；计划书纸质文件（一式两份）由依托单位审核并加盖单位公章后报送至自然科学基金委项目材料接收工作组。

自然科学基金委接收依托单位提交计划书电子版截止时间为 2013 年 9 月 11 日 16 点前，提交计划书电子修改版截止时间为 2013 年 9 月 18 日 16 点前；计划书纸质版于计划书电子版通过自然科学基金委审核后再行打印（建议双面打印），自然科学基金委接收计划书纸质版截止时间为 2013 年 9 月 27 日 16 点前。

请按照依托单位规定时间，及时将计划书电子版和纸质版先后提交依托单位进行确认审核。对于有修改意见的项目，请按修改意见及时调整计划书相关内容；如对修改意见有异议，须在计划书电子版报送截止日期前提出。计划书电子文件和纸质文件内容应当保证一致。

未说明理由且逾期不报计划书者，视为自动放弃接受资助。

附件：项目评审意见及修改意见

国家自然科学基金委员会

管理科学部

2013 年 08 月 15 日

关于国家自然科学基金资助项目批准及有关事项的通知

张蓓　先生/女士：

根据《国家自然科学基金条例》的规定和专家评审意见，国家自然科学基金委员会（以下简称自然科学基金委）决定批准资助您的申请项目。项目批准号：71503085，项目名称：农产品伤害危机责任归因与消费者逆向行为形成机理研究，直接费用：19.00万元，项目起止年月：2016年01月至 2018年 12月，有关项目的评审意见及修改意见附后。

请尽早登录科学基金网络信息系统（https://isisn.nsfc.gov.cn），获取《国家自然科学基金资助项目计划书》（以下简称计划书）并按要求填写。对于有修改意见的项目，请按修改意见及时调整计划书相关内容；如对修改意见有异议，须在计划书电子版报送截止日期前提出。**注意：请严格按照《国家自然科学基金资助项目资金管理办法》填写计划书的资金预算表，其中，劳务费、专家咨询费科目所列金额与申请书相比不得调增。**

计划书电子版通过科学基金网络信息系统（https://isisn.nsfc.gov.cn）上传，由依托单位审核后提交至自然科学基金委进行审核。审核未通过者，返回修改后再行提交；审核通过者，打印为计划书纸质版（一式两份，双面打印），由依托单位审核并加盖单位公章后报送至自然科学基金委项目材料接收工作组。计划书电子版和纸质版内容应当保证一致。

向自然科学基金委提交和报送计划书截止时间节点如下：

1、提交计划书电子版截止时间为**2015年9月11日16点**（视为计划书正式提交时间）；

2、提交计划书电子修改版截止时间为**2015年9月18日16点**；

3、报送计划书纸质版截止时间为**2015年9月25日16点**。

请按照以上规定及时提交计划书电子版，并报送计划书纸质版，未说明理由且逾期不报计划书者，视为自动放弃接受资助。

附件：项目评审意见及修改意见

国家自然科学基金委员会

管理科学部

2015年8月17日

项目批准号	71503085
申请代码	G030502
归口管理部门	
依托单位代码	51064208A0499-0932

国家自然科学基金委员会

资助项目计划书

资助类别：青年科学基金项目

亚类说明：

附注说明：

项目名称：农产品伤害危机责任归因与消费者逆向行为形成机理研究

直接费用：19万元　　间接费用：3.8万元

项目资金：22.8万元　　执行年限：2016.01-2018.12

负 责 人：张蓓

通讯地址：广东省广州市天河区五山路483号华南农业大学经济管理学院

邮政编码：510642　　电　　话：020-85280216

电子邮件：windyzhang@139.com

依托单位：华南农业大学

联 系 人：全锋　　电　　话：020-85280070

填表日期：2015年09月03日

国家自然科学基金委员会制

Version：1.006.696

简表

申请者信息	姓　　名	张蓓	性 别	女	出生年月	1978年04月	民 族	汉族
	学　　位	博士			职称	副教授		
	电　　话	020-85280216		电子邮件		windyzhang@139.com		
	传　　真			个人网页				
	工 作 单 位	华南农业大学						
	所 在 院 系 所	经济管理学院						
依托单位信息	名　　称	华南农业大学					代码	51064208A0499
	联 系 人	全锋		电子邮件		kycjhk@scau.edu.cn		
	电　　话	020-85280070		网站地址		http://web.scau.edu.cn/kjc/		
合作单位信息	单　位　名　称							代　码
项目基本信息	项 目 名 称	农产品伤害危机责任归因与消费者逆向行为形成机理研究						
	资 助 类 别	青年科学基金项目			亚 类 说 明			
	附 注 说 明							
	申 请 代 码	G030502:农业产业管理						
	基 地 类 别							
	执 行 年 限	2016.01-2018.12						
	直 接 费 用	19万元			间 接 费 用	3.8万元		
	项 目 资 金	22.8万元						

项目组主要成员

编号	姓名	出生年月	性别	职称	学位	单位名称	电话	证件号码	项目分工	每年工作时间（月）
1	张蓓	1978.04	女	副教授	博士	华南农业大学	020-85280216	440602197804120024	项目负责人	9
2	文晓巍	1973.06	男	教授	博士	华南农业大学	020-85280150	430312197306133011	理论分析、对策研究	6
3	杨学儒	1980.05	男	副教授	博士	华南农业大学	020-85280216	513622198005271716	模型构建、实证分析	6
4	陈有华	1984.02	男	讲师	博士	华南农业大学	020-85280216	360481198402142414	数据处理、实证设计	8
5	李慧	1982.02	女	讲师	硕士	华南农业大学	020-85280216	440102198202234427	对策研究、实地调研	8
6	杨炳成	1990.08	男	硕士生	学士	华南农业大学	020-85280216	440681199008155595X	问卷设计、实地调研	9
7	卢梓杰	1991.07	男	硕士生	学士	华南农业大学	020-85280216	440103199107111219	数据处理、实地调研	9
8	吴雅君	1980.02	女	硕士生	学士	华南农业大学	020-85280216	441623198002090369	数据处理、实地调研	9
9	陈敏琪	1987.09	女	硕士生	学士	华南农业大学	020-85280216	441602198709220620	文献检索、实地调研	9

总人数	高级	中级	初级	博士后	博士生	硕士生
9	3	2	0	0	0	4

校内合同号：

科研项目外拨合同书

项目名称：Systemic Risk Management of Food Supply Chains in China

委托方（甲方）：浙江大学

受托方（乙方）：华南农业大学

签订日期：

签订地点：浙江省杭州市

有效期限：叁年（2019.1.1-2021.12.31）

浙江大学社会科学研究院制

科研项目外拨合同

委托方（甲方） 浙江大学

住所地：浙江省杭州市西湖区余杭塘路 866 号

法定代表人：吴朝晖

电话：0571-88981583 传　真：0571-88981583

开户行：杭州市农行浙大支行紫金港支行（行号 103331004223）

账号：19042201040000014

项目负责人：周伟华 联系电话：13858100365

受托方（乙方）：华南农业大学

住所地：广东省广州市天河区五山路 483 号

法定代表人：刘雅红

电话：020-85285508 传　真：

开户行：广州市工商银行五山支行

账号：3602002609000310520

纳税号/机构代码证号：124400004554165634

本合同由甲方委托乙方就 Systemic Risk Management of Food Supply Chains in China 项目进行咨询、服务和开展研究，并支付相应的报酬，双方经过平等协商，在真实、充分地表达各自意愿的基础上，根据《中华人民共和国合同法》的规定，达成如下协议，并由双方共同恪守。

第一条　甲方委托乙方开展课题研究的内容如下：

1. 研究目的: 为了开展国际合作与国内校际合作，华南农业大学、浙江大学和美国麻省理工学院组成研究团队合作研究 Systemic

Risk Management of Food Supply Chains in China 的课题。该课题是美国麻省理工学院委托浙江大学共同研究的一个课题（合同号：S17-520104-003）。鉴于乙方在食品安全供应链、尤其是食品大数据理论与实践方面的专业资格，甲方委托乙方在广东开展进一步研究。

华南农业大学拥有开展科学研究的良好条件。现有亚热带农业生物资源保护与利用国家重点实验室、国家植物航天育种工程技术研究中心、国家生猪种业工程技术研究中心、人兽共患病防控制剂国家地方联合工程实验室、畜禽育种国家地方联合工程研究中心（广东）、国家兽医微生物耐药性风险评估实验室、畜禽产品精准加工与安全控制技术国家地方联合工程研究中心（广东）、国家精准农业航空施药技术国际联合研究中心等国家级科研平台。拥有农业经济管理国家重点学科、农林经济管理广东省攀峰重点学科，建立华南农业大学食品安全管理研究中心。

2. 研究内容: ①双方本着互惠互利、合作共赢原则开展合作，建立研究合作伙伴关系。双方共同开展食品安全供应链的理论探索与实践路径、方法、工具研究。②双方合作进行食品批发市场调查的模型开发和数据分析，在广东开展食品供应链梳理映射，了解政府监管、供货商（经纪人或生产者）的安排，共同提升双方学术与社会影响力。③双方合作申请国家级或地方产学研合作重大项目。④争取基于双方合作的科研成果，联名在重要期刊上发表论文。⑤其他双方友好协商的内容。

第二条 甲方责任、权利和义务： ①为确保项目日常运营及持续发展，甲方外拨项目经费：人民币大写陆拾壹万元整（¥610,000）给乙方，研究期限为 2019 年 4 月至 2020 年 04 月，分两次支付。②为双方的合作研究提供必要的帮助和支持（如研究方法、非涉密数据等）。③和乙方合作申请软著、专利，联合发表论文，双方共同享有共同申请软著、论文和专利所有权。④双方协商的其他合作事宜。

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2. 课题研究经费由甲方 两次 （一次或分期）支付乙方。

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合同内容完成后支付剩余的20%，即 12.2 万元。

第五条 双方确定因履行本合同应遵守的保密义务如下：

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3．保密期限：2019年4月至2020年04月 。

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1．保密内容（包括技术信息和经营信息）：双方协商后所规定的属于项目的机密，包括技术信息和科研信息 。

2．涉密人员范围：参与项目的所有成员及相关人员 。

3．保密期限：2019年4月至2020年04月 。

4．泄密责任：交由人民法院定责。

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2．依法向人民法院起诉。

第九条 本课题因研究需要，约定协作单位及课题组的其他人员为：1. 浙江大学（周伟华、周洁红、梁巧及其他研究人员）；2.华南农业大学（文晓巍、李慧、练建军、范晓菲及其他项目成员）。

第十条 双方约定本合同其他相关事项为：严格按照《浙江大学涉密载体管理十不得》（附件一）、《浙江大学保密工作要求及注意事项》（附件二）的相关条例保密项目涉及的所有材料及数据。

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1	Factors Influencing the Technology Adoption Behaviours of Litchi Farmers in China	SUSTAINABILITY 出版年：2020 出版日期：JAN 卷期：12 1页码：- 文献号：271 文献类型：Article	1	B类	South China Agriculture University	SSCI, SCI	IF2-year=3.251 IF5-year=3.473 （2020）	环境科学与生态学 4区 Top期刊：否 （2020）
2	Villagers' attitudes and behaviors toward rural solid waste management under environmental authoritarianism in China	FRONTIERS IN ENVIRONMENTAL SCIENCE 出版年：2023 出版日期：JUL 13 卷期：11 页码：- 文献号：1150838 文献类型：Article	1	B类	South China Agriculture University	SCI	IF2-year=4.6 IF5-year=5.3 （2022）	环境科学与生态学 3区 Top期刊：否 （2022）

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1	Role of self-actualization in green production behavior: Evidence from rice smallholders in China	HELIYON 出版年：2024 出版日期：JUN 15 卷期：10 11 页码：- 文献号：e30950 文献类型：Article	第一作者	B 类	华南农业大学	SCI	IF2-year=3.4 IF5-year=3.9 （2023）	综合性期刊 3 区 Top 期刊：否 （2023）

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1	Understanding cross-cultural chicken consumers' behaviour	AGRICULTURAL ECONOMICS-ZEMEDELSKA EKONOMIKA 出版年：2024 出版日期： 卷期：70 2 页码：73-90 文献号： 文献类型：Article	共同通讯作者（倒数第一）	B 类	华南农业大学经济管理学院	SSCI	IF2-year=1.9 IF5-year=2.0 （2023）	经济学 4 区 Top 期刊：否 （2023）

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1	Understanding cross-cultural chicken consumers' behaviour	AGRICULTURAL ECONOMICS-ZEMEDELSKA EKONOMIKA 出版年：2024 卷期：70 2 页码：73-90 文献类型：Article	共同通讯作者（倒数第一）	B 类	华南农业大学经济管理学院	SCI	IF2-year=1.8 IF5-year=1.9 （2024）	经济学 3 区 Top 期刊：否 （2025）

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1	Emerging market for pork with animal welfare attribute in China: An ethical perspective	MEAT SCIENCE 出版年：2023 卷期：195 页码：- 文献号：108994 文献类型：Article,Early Access	共同通讯作者	T2类	华南农业大学	SCI	IF2-year=7.1 IF5-year=6.6 （2022）	农林科学 1区 Top期刊：是 （2023）
2	Consumer Preferences for Animal Welfare in China: Optimization of Pork Production-Marketing Chains	ANIMALS 出版年：2022 卷期：12 21 页码：- 文献号：3051 文献类型：Article	共同通讯作者	A类	华南农业大学	SCI	IF2-year=3.0 IF5-year=3.2 （2022）	农林科学 2区 Top期刊：否 （2022）

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1	Knowledge of Animal Welfare and Consumers' Behavioral Intentions in China: A Moderated Mediation Model of Product Cognition and Empathy	ANIMALS 出版年：2022 卷期：12 8 页码：- 文献号：1043 文献类型：Article	共同通讯作者（倒数第一）	A 类	华南农业大学	SCI	IF2-year=3.0 IF5-year=3.2 （2022）	农林科学 2 区 Top 期刊：否 （2022）

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Heliyon 10 (2024) e30950

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Role of self-actualization in green production behavior: Evidence from rice smallholders in China

Hui Li [a,b,c], Yaoming Liang [c,d], Lingling Shi [b], Jiaen Zhang [a,**], Fengbo Chen [c,*]

[a] College of Nature Resources and Environment, South China Agricultural University, Guangzhou, 510642, China
[b] College of Public Administration, South China Agricultural University, Guangzhou, 510642, China
[c] College of Economics and Management, South China Agricultural University, Guangzhou, 510642, China
[d] College of Veterinary Medicine, South China Agricultural University, Guangzhou, 510642, China

ARTICLE INFO

Keywords:
Self-actualization
Green production behavior
Chinese smallholder
Planting area
Production purpose

ABSTRACT

Understanding who adopt green production and why they choose this strategy is an important issue that needs to be addressed in the context of increasingly severe agricultural pollution. Previous studies have generally investigated subsistence-oriented smallholders, typically employing profit maximization or risk minimization models. However, Chinese farmers have differentiated, and have unique characteristics. This study collected data from 960 random samples of rice farmers and conducted quantitative analysis. The findings reveal that 94.9 % of the farmers had less than 2-ha rice-planting area, and 80.21 % of farmers reported that their purpose of planting rice was for family self-feeding. Furthermore, the new standard to define smallholder based on whether their production purpose is self-feeding or selling and found that non-smallholders had an overall advantage and passed the *t*-test. Even more non-smallholder (76.32 %) intentionally chose green pesticide than smallholders (66.1 %), but their decision-making logic was different. Binary logistic regression results show that three aspects of self-actualization (environmental, market, and personal) positively and significantly affected the green production behavior of smallholders, but not significant for non-smallholders. This study suggests that in China, where smallholders are the mainstay of agriculture production, green production by smallholders will greatly improve the ecological environment and provide high quality agricultural products.

1. Introduction

China cultivates less than 9 % of the world's arable land, but feeds about 20 % of the world's population [1], making a significant contribution to global food security and poverty reduction. One key strategy in achieving this is continually increasing the use of chemical fertilizers and pesticides to boost grain yield [2]. Owing to their high capability against pests to ensure high crop yields, pesticides are essential for modern agricultural production worldwide [3,4]. However, pesticides have negative effects on non-target organisms and present high environmental risks to the air, soil, water, human health, and other animals and plants [5]. China consumes the largest amount of pesticide globally; the average value of pesticide application in China is 1.5–4.0 times higher than the

** Corresponding author.
* Corresponding author.
E-mail addresses: jeanzh@scau.edu.cn (J. Zhang), cfb@scau.edu.cn (F. Chen).

https://doi.org/10.1016/j.heliyon.2024.e30950
Received 22 November 2023; Received in revised form 29 April 2024; Accepted 8 May 2024
Available online 9 May 2024
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global average [6]. In China, the key stakeholders in the planting industry are smallholders, the most prominent characteristic of whom is scattered. Data from China Rural Statistical Yearbook 2017 demonstrate that 85 % of rural households operate on land less than 0.66 ha (10 mu, 1 ha = 15 mu), and up to 97 % less than 3.33 ha (50 mu). Therefore, this study focused on the green production behaviors of Chinese smallholders.

Farmers are micro subjects who decide on agricultural production activities which are affected by many factors. In addition to demographic factors and family characteristics (e.g., age, education, and family income [7,8]), studies on green production behaviors also emphasize farmers' farming experience and learning ability [9,10], social norms and neighbourhood effects [11], risk preference, and green awareness [12,13]. In China, various new agricultural production modes, such as cooperative, outsourcing, and contract farming [14–16], affect farmers' green production behaviors in the context of industrial development and agricultural policy reform. Furthermore, the newly issued land transfer policies attracted the attention of researchers [17,18].

With the development of industrialization and urbanization, the population of smallholders has changed, therefore their green production behaviors are bound to change. Prof. Jan Douwe van der Ploeg [19], based on his observation of smallholder farming worldwide, wrote the book *The New Peasantries: Struggles for Autonomy and Sustainability in an Era of Empire and Globalization*, pointing out that, firstly, the phenomenon of re-smallification has emerged around the world; secondly, in Europe, agriculture had changed from specialization to multi-functionality since the 1990s, and most operators are smallholders. In Japan, non-operational farmers (also called 'self-sufficient farmers') had risen rapidly from 22.5 % in 1990 to 44.4 % in 2017 [20]. In the United States, a new phenomenon is that small-scale family farms have become an important way for retirees to return to nature or for people to pursue quality life and leisure [21]. Most current studies adopted the rational economic man hypothesis, which assumes that farmers pursue either profit maximization or risk minimization in agricultural production. Some studies found that farmers increased their use of agricultural chemicals to replace family labour loss caused by urbanization [22,23]. Some studies highlighted the vulnerability of farmers' livelihoods. Owing to risk aversion, the overuse of agricultural chemicals, especially pesticides, has been widespread to prevent production reduction [24–26]. In addition to the economic perspective, many studies considered farmers' green production behavior from the perspectives of psychology and sociology, among which the planned behavior theory is most commonly used [27–29]. Zhang et al. [26] attempted to determine the hidden mechanism of Chinese smallholders' over-fertilization and found agricultural marginalization and urban-rural dichotomy as root causes. Chinese smallholders' livelihood structures and production logic have fundamentally changed [26,30,31]. Zhang [30] focused on smallholder differentiation, and found Chinese smallholders had evolved into life-oriented smallholders and production-oriented smallholders, who are motivated differently by fertilizer and pesticide reductions. 'Easterling's paradox' shows that income is not the only thing people pursue. Luo [32] empirically demonstrated the inverted U relationship between income and well-being based on 3622 farmers in China, whereas a good ecological environment can sustainably improve farmers' well-being. Self-actualization is the higher-level need in Maslow's hierarchy of needs theory, and is a central aspect of well-being after the satisfaction of physiological needs [33], and might be an important factor influencing today's Chinese smallholders' green production behaviors.

In order to govern non-point agriculture pollution, it is necessary to consider smallholder differentiation. Today's Chinese farmers have differentiated a large number of life-oriented smallholders, whose production behaviors cannot be explained by rational economic model. Our objective is to argue that self-actualization is an important influencing factor ignored by existing studies. This study contributes to extant literature in several ways. First, as mentioned earlier, Chinese farmers have differentiated themselves. Therefore, we adopted a new standard to define current Chinese smallholders based on whether the farmers' production purpose is self-feeding or selling. Second, we developed a conceptual framework specific to current Chinese smallholders' green production behaviors that considers their self-actualization. Third, we analysed first-hand farmer-level data collected in 2021 and provided an updated perspective and empirical evidence.

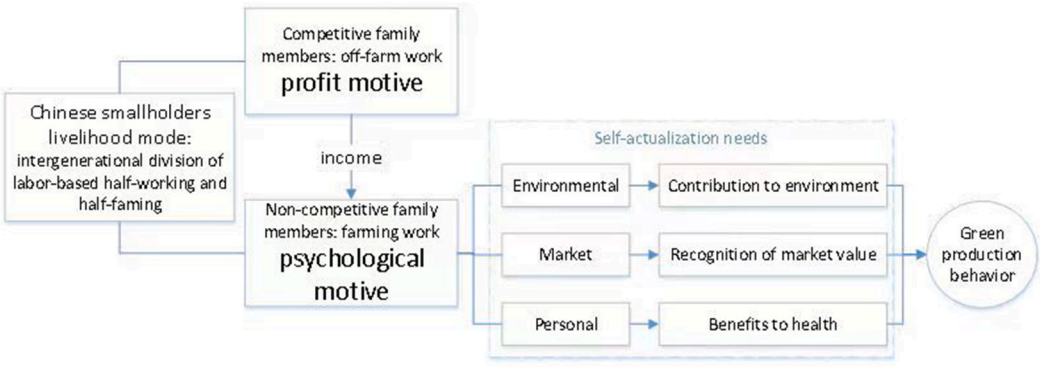

Fig. 1. Conceptual framework of current Chinese smallholders' green production behavior. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

2. Conceptual framework and hypotheses

The persistence and further differentiation of Chinese smallholders are based on the intergenerational division of labour–based half-working (off-farm working) and half-farming livelihood mode[34,35]. Therefore, this study developed a conceptual framework to analyze self-actualization on smallholders' green behavior based on their unique livelihood mode (see Fig. 1). In current Chinese smallholders' livelihood mode, capable family members are income-driven and prefer to engage in non-farm work, which is the main source of family income; whereas, older family members farm to keep the family running at low cost, which includes free contracted land, free residential land, free study and low-cost medical service. Therefore, smallholders primarily farm for well-being rather than profit [30,34]. In this study, farmers whose production purpose is self-feeding are identified as smallholders, whereas those whose production purpose is selling for profit are identified as non-smallholders [36]. Huang and Luo [37] classified Chinese farmers as either ration- or profit-oriented based on their grain sales, with a threshold of 50 %. They found that the decision-making mechanism for biological pesticide application differs depending on farmers' production purposes. Lu et al. [38] found that production for selling reduces the positive effect of land property rights stability on farmers' organic fertilizer application.

The production purpose of smallholders' decision making is to maximize utility [39]. As noted above, Chinese smallholders' family income is mainly from non-farm work, so psychological issue and family rations are important influencing factors to their productive behaviors. Luo et al. [40] put forward the S-shaped hypothesis of the importance of agriculture (Fig. 2), explaining the importance of agriculture corresponding to Maslow's five levels of human needs, which discusses the utility of farming from a new perspective. As shown in Fig. 2, the hierarchy of needs from low to high is as follows: in terms of satisfying human physiological needs, agriculture obviously has an irreplaceable role; in terms of safety, love, and esteem needs, with the Engel's coefficient declining, the importance of agriculture is decreasing; but in terms of self-actualization, due to the fact that agriculture has multiple functions about production, living, ecology, and even life, the importance of agriculture is rapidly recovering. Based on this, self-actualization is incorporated into the green production decision-making model of smallholders and measured in three dimensions, macro, meso and micro, namely, ecological dimension, market dimension and personal dimension.

Environment dimension. Green production behavior can maintain and improve ecological environments, but has externalities. Therefore, farmers' subjective value judgments and environmental awareness play important roles in green production behaviors [7,8]. Levinson [41] used self-reported happiness to estimate environmental quality and found a significant relationship between environmental quality and personal well-being. A study in China calculated the willingness to pay for a $1ug/m^3$ reduction in PM2.5 to be $88 or 3.80 % of annual household per capital income [42]. Therefore, smallholders, who are motivated by environmental concerns, tend to undertake green production for self-actualization. Based on this, we propose hypothesis 1.

H1. Green production behaviors satisfy smallholders' self-actualization needs for better environment.

Market dimension. Current Chinese smallholders with limited land mostly produce grain for family consumption [30,37]; while surplus grains are purchased by local traders at low prices. In reality, high market prices of green products do not generate income for smallholders. Nevertheless, smallholders achieve self-actualization through market recognition of their products when they believe that their produces are worth high price. Therefore, smallholders are more likely to undertake green production when they receive high-price signals for green agricultural products. Based on this, we propose hypothesis 2.

H2. Green production behaviors satisfy smallholders' self-actualization needs for market value recognition.

Personal dimension. Self-actualization at the individual level is most directly about health, which can be subdivided into mental and physical parts. Agricultural production activity is the labor of human beings using the forces of nature, completely different from the industry production, which has to be placed in nature and co-produced with nature. Especially for smallholders, its self-employment attribute leads to stronger sense of self-control and easier to achieve self-actualization [19]. Physical health is a foundational goal

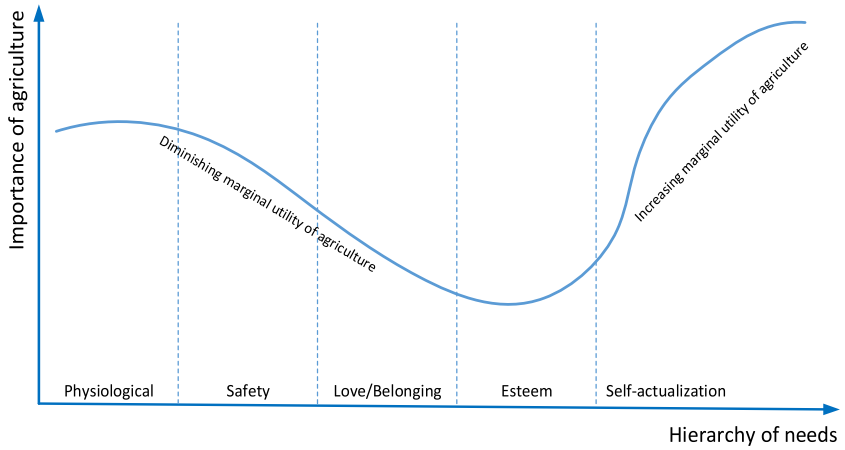

Fig. 2. S-shaped hypothesis of the importance of agriculture.

pursued by all individuals [43,44]. Smallholders produce seasonal food according to their needs, and green food is also more favorable to health. Additionally, green pesticides are less hazardous to operators. Because smallholders rarely employ others to apply pesticides, the green pesticide adoption is primarily beneficial to their own health [45]. Therefore, smallholders have a direct intrinsic motivation to undertake green production. Based on this, we propose hypothesis 3.

H3. Green production behaviors satisfy smallholders' self-actualization needs for better health.

3. Data and methods

In July of 2021, we conducted survey in 19 villages of 13 cities located in Guangdong Province, China. Stratified random sampling methodology was applied and 1076 questionnaires were completed. The data were analyzed using descriptive statistics, *t*-test, and logistic regression.

3.1. Data

The data used in this study were collected through a primary survey of rice production behavior among farmers in Guangdong Province, China. The survey included a quantitative component with rice farmers (n = 960) and in-depth follow-up interviews with their village committee administrators responsible for agriculture (n = 19). This study was approved by the Ethics Committee of the Economic and Management School, South China Agriculture University (Ethics approval reference 510051). Informed consent was obtained from all the participants.

The reasons for selecting this region are as follows: first, Guangdong Province is representative of regions with large populations and scarce land resources, in which the average land per household is only half of the national average; second, Guangdong is the most economically developed province in China, with the largest GDP for 34 consecutive years, making it a forerunner in China's economic and societal development; finally, Guangdong Province experiences abundant rainfall and high temperature throughout the year, resulting in severe pest damage.

The main survey was conducted by the research team of the Guangdong Provincial Rice Industry System during July, 2021. In May of the same year, the team conducted a pilot survey under the Guangdong Provincial Rice Industry System Station to determine a list of villages for large-scale survey through stratified random sampling methodology. The formal survey covered 13 of the 21 municipal cities in Guangdong Province, including all major rice-producing areas (Fig. 3). To make the sample more respresentative, our survey is based on administrative stratified (province, cities, counties, and villages) random sampling, which is as follows: first, two counties were randomly selected from each prefecture-level city; then, one or two villages were randomly selected from each county; finally, 30 rice farmers were randomly selected from each village. A total of 1076 questionnaires were completed, of which 960 were valid, resulting in a sample efficiency of 89.22 %. All questionnaires were administered face-to-face, and each lasted for more than 1.5 hours.

To gain a deeper understanding, comprehensive interviews were conducted with village committee administrators from all 19 sample villages. These administrators were familiar with the villagers and most of them planted rice themselves. The semi-structured interviews consisted of two parts: the first part is to gather basic information about the village, including population structure, farmland use, labour transfer, and production conditions, with special attention to rice production and sales; the second part consists of a series of open-ended questions about living conditions, rice production purposes, environmental attitudes, and understanding of

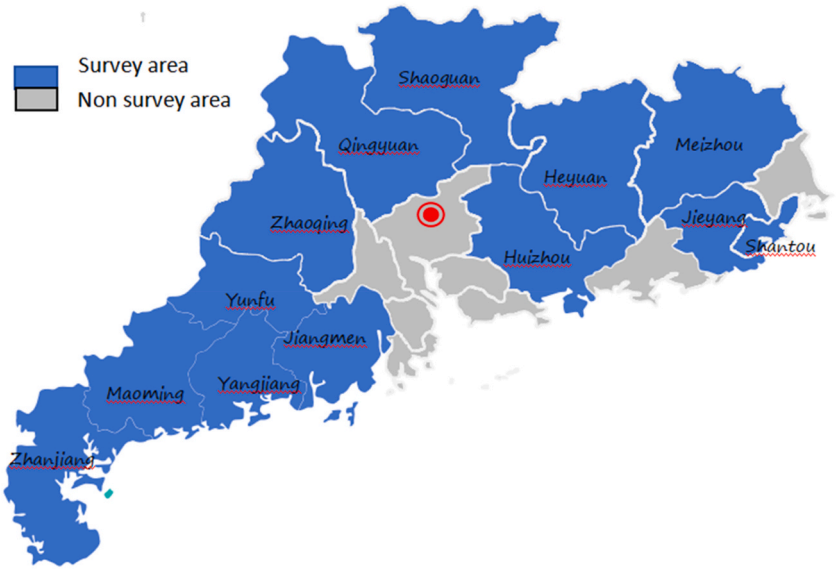

Fig. 3. Location of the sample areas in Guangdong Province, China.

green technologies. All interviews were conducted face-to-face and lasted for over 2 hours.

3.2. Variable description

Practically, almost all Chinese farmers use pesticides. Owing to the diverse array of pesticides and the complex situation of pest infestations, it is difficult to determine whether pesticide application is appropriate based on the application rate. This study used farmers' pesticide selection decision-making behavior as the dependent variable. According to the questionnaire, farmers' green production behavior was measured by the question, 'Do you intentionally apply low-toxicity or low-residue pesticides in production?', where the value is 1 if the response is 'yes'. If the response is 'no', then the value is 0.

According to the concept framework (Fig. 1), the core independent variables in this study are smallholder' self-actualization in three aspects: environmental, market, and personal. Environmental self-actualization refers to the importance of improving the agriculture ecological environment, which is measured on a scale of 1–5, with 1 indicating that it is 'very important' and 5 indicating that it is 'not important at all'. Market self-actualization refers to the market perceptions. This is measured using the question, 'Do you believe that current rice sales reflect high quality and high price?' with a response of 'yes' being valued as 1; a response of 'no' is valued as 0. Personal self-actualization is measured using the question 'How green production can benefit health status?', which is measured on a scale of 1–3, with 1 indicating 'poor', 2 indicating 'acceptable', and 3 indicating 'excellent'.

Based on extant literature [37], this study included regular control variables to avoid biased model estimates caused by missing variables, which are gender, age, and education. Considering that this study is concerned with the green production behaviors, the control variables also included farming experience, information acquisition ability, family income, dependency ratio, rice yield and sale in 2020. (Table 1).

3.3. Methods

Whether intentionally apply low-toxicity or low-residue pesticides is a binary variable, and with reference to Huang and Luo's [37] analysis of bio-pesticide adoption behavior for rice farmers who both sell and eat rice, we constructed a logistic regression models to explore the impact of self-actualization on smallholders' green production behavior. In the model, Y is dependent variable. Y = 1 denotes the smallholders with intentionally applying low-toxicity or low-residue pesticides; whereas Y = 0 denotes the smallholders without intentionally applying low-toxicity or low-residue pesticides. E, M, and P are core independent variables indicating self-actualization in the environment, self-actualization in the market, and self-actualization in their health, respectively. X stands for the control variables. The binary logistic regression model settings are as follows:

$$P(Y=0|E_m, M_m, P_m, X_m) = \frac{1}{1+e^{-(\beta_0+\beta_1 E_m+\beta_2 M_m+\beta_3 P_m+\beta_4 X_m)}} \quad (1)$$

The logarithmic transformation of equation (1) yields

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 E_m + \beta_2 M_m + \beta_3 P_m + \beta_4 X_m \quad (2)$$

where p is the probability of green production behavior occurrence; m denotes different sample rice farmers; β_0 is a constant term; β_1, β_2, β_3, and β_4 are coefficient estimators of corresponding variables, respectively; ε_m is a random disturbance term.

Table 1
Variable definitions and descriptive statistics.

Variables	Definition	Mean	SD
Green production	Do you intentionally apply low-toxicity or low-residue pesticide? 1 = Yes, 0 = No	0.681	0.466
Environmental self-actualization	How important is improving the agriculture ecological environment? 1 = not important at all; 3 = general; 5 = very important	4.248	1.157
Market self-actualization	Do current rice sales reflect high-quality and high-price? 1 = Yes, 0 = No	0.548	0.498
Personal self-actualization	How green production betefit your health status? 1 = poor; 2 = acceptable; 3 = excellent	2.720	0.548
Gender	1 = man; 0 = woman	0.721	0.449
Age	Age of the farming decision-maker	59.182	9.581
Education level	Years of education of the farming decision-maker	6.955	3.346
Farming experience	Are you familiar with farm work? 1 = do not know at all; 3 = average; 5 = very familiar	4.799	0.620
Ability of information acquisition	Do you use a smartphone? 1 = use smartphone; 0 = do not use smartphone	0.701	0.458
Family income	Ln (Family income in 2020)	10.762	1.283
Dependency ratio	The ratio of the number of working people in a household to the number of non-working people.	0.653	0.909
Household rice yield	Ln (Household rice yield in 2020)	8.391	0.908
Income from rice sales	Ln (Income from rice sales in 2020)	5.499	4.073

4. Results

4.1. Understanding current Chinese smallholders

Farmland area of less than 2 ha is the most commonly used standard for smallholder [35,46]. Table 2 shows the rice-planting area of the 960 sampled farmers. Of these, 49 had rice planting area exceeding 2 ha, 59 had rice planting area of 1–2 ha, and 89 had rice planting area of 0.66–1 ha. Nearly 80 % had rice planting area less than 0.66 ha, and half less than 0.33 ha.

Based on the survey, of the 960 rice sampled farmers, there were a total of 6180 family members involved. Table 3 displays that 2102 of them did not make cash income, including minors, students, housewives, patients, unemployed individuals, and retirees. Among the income earners, 1944 (47.67 %) mainly derived agricultural production income from contracted land, whereas 2134 (52.33 %) derived income outside their own land. These results align with current Chinese smallholders' livelihoods, which is half-working and half-farming [30,34].

At the household level, of the 960 rice farmers surveyed, only 49 reported that no one in their family took contracted land as their main work, which means that about 95 % of the sampled households family had at least one family member taking contracted land as their main job. Additionally, 212 households reported that no one was primarily engaged in off-farm work in 2020, indicating that more than 80 % of the households had family members who took off-farm jobs. The livelihood mode of the remaining 699 households (72.81 %) was 'half-working and half-farming' (Table 4). Among the 212 households without off-farm income, 156 reported that their family income exceeded 10,000 yuan in the first half of 2021. It is worth noting that the COVID-19 pandemic and related policies affected the off-farm employment and income. Despite this, the survey suggests that approximately 95 % estimating family income in 2021 exceeding 10,000 yuan, and approximately 88 % estimating family income exceeding 20,000 yuan, which is obviously higher than the income from contracted land alone.

Regarding living expenses, rural households can obtain sufficient grains and vegetables from their contracted land. Additionally, all the sampled households had self-built houses on free-use housing sites, and 114 of sampled farmers also owned other residential real estate outside their villages. Furthermore, compulsory education and rural medical cooperative insurance are available, which provide nine years of free education and basic medical treatments. Cash expenditures in rural China is very low[34]. Therefore, even with a low cash income from the land, villages offer rural population an affordable living option.

In summary, Chinese smallholders currently do not earn much money through farming because of their limited land scale. The main purpose of farming is to provide food to their families (80.21 % of the sampled farmers; Table 5). Farming serves a dual purpose: to reduce cash expenses and provide leisure [34]. As Zhang [30] showed, Chinese smallholders have differentiated into production-oriented smallholders and life-oriented smallholders.

4.2. Major characteristics of smallholders and non-smallholders

In this study, the standard for smallholders is based on farmers' production purposes (self-feeding or selling), according this standard, the smallholder group consisted of 770 farmers, about four times the farmer size of the non-smallholder group (Table 5). In the full sample, family farming decision-makers were predominantly men, with an average age of almost 60 years and less than seven years of education. However, about 30 % did not use smartphones, and most were familiar with farm work and in excellent health conditions.

Non-smallholders are more positive in all indicators except for familiarity with farm work. By comparison, smallholders were older, poorer health, less education and family income. These differences were more pronounced in rice production output, which was more than five times higher for non-smallholder than smallholder, and income from rice sales was even 14 times higher also for non-smallholders than smallholders.

4.3. Green production behavior of farmers with planting areas

Among the 960 surveyed farmers, 654 intentionally used low-toxicity or low-residue pesticides during production, whereas 306 did not. As shown in Table 6, the highest proportion of farmers using green pesticides was in the group with a rice planting area of 1–2 ha, reaching 84.75 %. The proportion of the group with a rice-planting area greater than 2 ha was 77.55 %. Groups with a rice-planting area of less than 1 ha had a comparatively low proportion of green pesticide use. Pearson's chi-square test ($p = 0.020$) indicated a significant difference in green production behavior among farmers with different rice-planting areas.

4.4. Influencing factors to smallholders' green production behavior

Stata 17.0 was used to estimate the impact of farmers' self-actualization on their green production behavior. Above all, collinearity

Table 2
Number and the corresponding percentage of farmers with different rice planting areas.

	≥2 ha (≥30 mu)	1–2 ha (15–30 mu)	0.66–1 ha (10–15 mu)	0.33–0.66 ha (5–10 mu)	<0.33 ha (<5 mu)
Number of farmers	49 (5.10 %)	59 (6.15 %)	89 (9.27 %)	287 (29.90 %)	476 (49.58 %)

1 mu = 666.67 m^2 or 1 mu = 1/15 ha.

Table 3
Number and the corresponding percentage of people with different income sources.

	Income from contracted land	Income from outside contracted land	No income
Number of people	1944 (31.50 %)	2134 (34.50 %)	2102 (34.00 %)
Percentage of income generators %	47.67	52.33	–

Table 4
Number and the corresponding percentage of family with different income sources.

	Families with little farming income	Families with little off-farm working income	Half working and half farming families
Number of families	49	212	699
Percentage %	5.11	22.08	72.81

Table 5
Descriptive statistics of smallholders and non-smallholders.

Characters	Smallholders	Non-smallholders	Difference	t value
Number of farmers	770 (80.21 %)	190 (19.79 %)	–	–
Green behavior (%)	66.1	76.32	−10.22	2.891***
Gender: male (%)	69.20	84.20	−15	−4.787***
Age (year)	60.015 (9.347)	55.805 (9.793)	4.21	−5.355***
Education (year)	6.841 (3.384)	7.415 (3.155)	−0.57	2.214**
Familiarity with farm work (5 = very familiar)	4.809 (0.597)	4.757 (0.700)	0.05	−0.927
Smartphone usage (%)	68.20	78.40	−10.2	−2.984***
Family income in 2020 (yuan)	71650.60 (73006.05)	115935.40 (195380.60)	−44284.8	3.072***
Family rice output in 2020 (kg)	4053.98 (2795.52)	23207.32 (39665.04)	−19153.34	6.652***
Cash income from rice sales in 2020 (yuan)	2031.36 (3248.69)	28966.28 (51382.68)	−26934.92	7.222***
Dependency ratio	0.678 (0.955)	0.549 (0.686)	0.129	−2.133**
Environmental awareness	4.201 (0.043)	4.439 (0.706)	−0.24	2.851***
Market awareness	0.525 (0.018)	0.642 (0.349)	−0.12	2.992***
Self-awareness	2.696 (0.202)	2.816 (0.034)	−0.12	2.997***

Values before and in the parenthese present mean and the corresponding standard deviation, respectively.

Table 6
Farmers' green production behavior with different rice planting areas.

	≥2 ha	1–2 ha	0.66–1 ha	0.33–0.66 ha	<0.33 ha	Full sample
Non green production behavior	11 (22.45 %)	9 (15.25 %)	32 (35.96 %)	90 (31.36 %)	164 (34.45 %)	306 (31.88 %)
Green production behavior	38 (77.55 %)	50 (84.75 %)	57 (64.04 %)	197 (68.64 %)	312 (65.55 %)	654 (68.12 %)
Chi-square test	11.6859**					960

diagnosis on the variables was conducted. The VIF value ranges from 1.01 to 1.50, which is much lower than 10, indicating that the strength of the collinearity relationship between the variables is extremely weak and meets the requirements of logistic regression. Secondly, in order to avoid the effects of possible heteroskedasticity, autocorrelation and outliers in the model setting, following Huang and Luo's [37] approach, the maximum likelihood method was adopted and the model was robustly estimated. Additionally, the Wald test for the full sample regression of the model is significant, indicating that the overall regression coefficients of the model are significant and the parameter estimates are robust. As shown in Table 7, all three aspects of self-actualization significantly influenced the green production behavior of smallholders, whereas none were statistically significant for non-smallholders.

Environmental self-actualization had a significantly positive effect on green production behavior among smallholders ($p < 0.01$), with an odd ratio of 1.216. Smallholders who prioritized improving the agricultural ecological environment were more likely to intentionally apply low-toxicity or low-residue pesticides. This trend was more pronounced among smallholders than the full sample of farmers, as indicated by the larger coefficient. These results support Hypothesis 1.

Market self-actualization also had significantly positive effects on green production behavior among smallholders ($p < 0.1$), with an odd ratio of 1.328. Smallholders who recognised the high-quality and high-price market were more likely to intentionally apply low-toxicity or low-residue pesticides. Smallholders' need for market self-actualization was satisfied if they perceived the market to be of high-quality and high-price, regardless of whether the real market reflected this perception. These results support Hypothesis 2.

Personnel self-actualization had significantly positive effects among smallholders ($p < 0.1$), with odd ratio of 1.290. Smallholders who believed that green production had a more positive impact on their health were more likely to intentionally apply low-toxicity or low-residue pesticides. These results support Hypothesis 3.

Regarding the other factors affecting green production behavior, gender and education were statistically significant. Among both

Table 7
Impact of self-actualization on farmers' green production behavior.

	Full sample farmers		Smallholders		Non-smallholders	
	Coeff.	Odd ratio	Coeff.	Odd ratio	Coeff.	Odd ratio
Environmental self-actualization	0.184*** (0.058)	1.202	0.196*** (0.063)	1.216	0.007 (0.169)	1.007
Market self-actualization	0.217 (0.144)	1.243	0.284* (0.159)	1.328	−0.236 (0.389)	0.790
Personal self-actualization	0.275** (0.130)	1.317	0.255* (0.141)	1.290	0.394 (0.338)	1.482
Gender	−0.409** (0.170)	0.664	−0.355** (0.184)	0.701	−0.224 (0.520)	0.780
Age	−0.014 (0.009)	0.986	−0.007 (0.010)	0.993	−0.027 (0.024)	0.973
Education	0.049** (0.023)	1.050	0.060** (0.025)	1.062	0.199 (0.061)	1.020
Familiarity with farm work	−0.158 (0.126)	0.854	−0.103 (0.140)	0.902	−0.342 (0.232)	0.710
Ability of information acquisition	0.268 (0.184)	1.307	0.238 (0.199)	1.268	0.357 (0.537)	1.428
Ln (family income)	0.036 (0.052)	1.037	0.043 (0.054)	1.044	−0.100 (0.165)	0.904
Ln (family income from rice)	−0.002 (0.018)	1.003	−0.012 (0.021)	0.988	−0.101 (0.139)	1.106
Dependency ratio	−0.077 (0.074)	0.926	−0.127 (0.079)	0.881	0.368 (0.286)	1.445
Constant	0.222 (1.152)	1.249	−0.633 (1.245)	0.531	3.018 (3.355)	20.457
Number of farmers	960		770		190	
Wald value	45.09***		42.02***		8.42	
R^2	0.038		0.040		0.038	

*, **, and *** indicate significance at the 10 %, 5 %, and 1 % levels, respectively, with the standard errors in parentheses.

smallholders and the full sample of farmers, women were more likely to intentionally apply low-toxicity or low-residue pesticides, which should be related to their more delicate emotions, more emphasis on life and health. Smallholders with longer years of education were more inclined towards green production, because education encourages them to better understand green prodction and have the ability to practice it.

4.5. Robustness check

To perform a robustness check, the logistic regression model was replaced with probit model for regression analysis. Table 8 shows that the signs and statistical significance of each independent variable align with the estimation results shown in Table 7.

Table 8 also presents the logistic regression results according to another smallholder standard. Owing to the limited land resources and large population in the survey area, each family had a limited area of contracted land. Therefore, farmers who farmed only on contracted land were classified as smallholders. Apart from personal self-actualization and gender no longer significant, the significance of other influencing factors was consistent (Table 8). One possible reason for this is that the scope of smallholders was underestimated, because many farmers cultivate small-scale land from their relatives or friends. Although they cultivate more than their contracted land, their behavior is consistent with that of farmers with the purpose of self-feeding. In conclusion, the empirical results are robust.

5. Discussion

A large amount of literature has concerned with the serious agricultural pollution caused by farmers' production behaviors. This study focused on current Chinese smallholders, who differ from smallholders in other countries, and also from those in China 20 years ago. According to mainstream literature, farmers with small farms face difficulties in their livelihoods. Our findings indicate that

Table 8
The result of robustness check.

	Probit (smallholder standard: self-feeding purpose)	Logistic (smallholders standard: farming on contracted land only)
Environmental self-actualization	0.122*** (0.039)	0.141* (0.078)
Market self-actualization	0.172* (0.096)	0.435** (0.185)
Personal self-actualization	0.158* (0.086)	-0.276 (0.181)
Gender	−0.216** (0.112)	−0.331 (0.221)
Age	−0.004 (0.006)	−0.000 (0.012)
Education	0.036** (0.015)	0.052* (0.029)
Familiarity with farm work	−0.065 (0.083)	−0.209 (0.141)
Ability of information acquisition	0.139 (0.119)	0.187 (0.230)
Ln (family income)	0.025 (0.034)	0.082 (0.073)
Ln (family income from rice sales)	−0.007 (0.012)	−0.028 (0.032)
Dependency ratio	−0.077 (0.050)	−0.140 (0.120)
Constant	0.364 (0.744)	0.281-0 (1.961)
Wald value	42.43***	31.03***
Number of farmers	770	551
R^2	0.043	0.042

*, **, and *** indicate significance at the 10 %, 5 %, and 1 % levels, respectively, with the standard errors in parentheses.

although small-scale land brings in little cash income, most Chinese smallholders' family incomes are mainly not from land. Therefore, current Chinese smallholders farm for self-actualization rather than profit. Based on this, a green production behavior model based on psychological motives was proposed (Fig. 1) in contrast to the profit maximization or risk minimization models.

From the first-hand survey data, only 5.10 % of the farmers had rice-planting area exceeding 2 ha. According to Hazell et al. [46], using 2 ha as the standard for smallholders, most Chinese farmers are smallholders. Of all the family members of the sampled farmers, approximately one-third had no income, one-third were responsible for agriculture, and one-third were migrant workers. This fully conforms to the livelihood mode of 'half-working and half-farming' as described by He [34]. This finding is also consistent with one of the key answers to the 'the puzzle of East and Southeast Asia's persistent smallholder' by Rigg et al. [35]. Although small-scale land can only generate little cash income, rural living cost is low and the families have off-farm incomes. Therefore, current Chinese smallholders have undergone differentiation, which aligns with Zhang's [30] concept of 'life-oriented smallholders'. Therefore, this study uses a new standard to define smallholders based on whether their production purpose is self-feeding or selling. According to this standard, about 80 % of sampled farmers are classified as smallholders. The *t*-test showed that smallholders perform poorly on almost all indicators compared with non-smallholders significantly. These survey results also confirm the aging and weakness of agricultural labour resources, which is consistent with Lu's [17] findings.

The logistic regression results revealed a significant positive correlation between smallholders' green production behavior and their self-actualization in all three aspects (environmental, market, and personal). Compared with high-toxicity pesticides, low-toxicity or low-residue green pesticides are less effective in killing pests, which means choosing green pesticides poses a risk of yield reduction. Smallholders, whose production purpose is self-feeding, are willing to exchange the risk cost of reducing production for psychological and spiritual benefits of self-actualization in environmental dimension. Additionally, smallholders have only a small amount, or even no rice for sale.Because of the absence of market transactions for the rice products, smallholders still believe their green products are valuable as long as they perceive the market having a high-quality and high-price mechanism. Although smallholders' green production does not achieve market value, it realizes smallholders' self-actualization in market dimension. Furthermore, smallholders produce agricultural products mainly for their family consumption. Therefore, when they believe that green production is beneficial to their health, they would naturally carry out green production. In other words, green production can realize smallholders' self-actualization in personal dimension.

In the non-smallholder group, none of the influencing factors in the green production behavior model were statistically significant. This suggests that there are different mechanisms of green behavior between farmers with the production purposes of self-feeding and selling. Environmental awareness, market value recognition, and personal health perception are not significant concerns for profit-oriented farmers' green production behavior. Interestingly, profit-oriented farmers do not show a significant positive effect on market self-actualization, despite the expectation that they would be more eager to gain market recognition. This may be because the Chinese agricultural product market is still a lemon market, which does not reflect the high price of green production rice [37,38]. The interview survey also revealed that the difference in acquisition prices was mainly due to the variety of rice rather than its green production status. Additionally, cash income from rice sales was not a significant factor. A possible reason for this is that, based on the current acquisition price of rice, the profits from rice production are minimal, whereas profits mainly come from subsidies or cash crops through crop rotation with rice.

Based on the views that land is no longer the 'lifeblood' of Chinese farmers and the core mode of today's Chinese rural household is half-working and half-farming [34], this study proposes that the self-actualization significantly affects current Chinese smallholders' green production behaviors.

6. Conclusions

The objective of this study is to explore the role of self-actualization in Chinese smallholders' green production behavior. The study was conducted in 13 municipal administrative regions in Guangdong Province, China, covering all major rice production areas.

The results showed that 94.90 % of the farmers' rice-planting area was less than 2 ha, while 80.21 % of the farmers reported that their production purpose was family self-feeding. Pearson's chi-square test indicated that there were significant differences in green production behavior considering planting areas. Combining the data of family income sources and living standards, the present study found that production purpose was a more suitable standard for defining current Chinese smallholders. Applying this new standard, the *t*-test showed that non-smallholders had significant advantages in most characteristics. However, the logistic regression results demonstrated that all three aspects of self-actualization (environmental, market, and personal) had a significantly positive impact on the green production behavior of smallholders, but without significant influence among non-smallholders.

Targeted policies should be implemented to meet the needs of Chinese smallholders. First, information about the agricultural ecological environment should be disseminated, particularly by linking green production practices to local environmental and personal health. This would increase smallholders' environmental awareness and meet their self-actualization needs for better environment and personal health. Additionally, the high-price green agricultural market should be built, promoting green production practices among smallholders by meeting their need for market value recognition.

This study has some limitations, which should be addressed by future research. The data used in this paper is based on the principle of randomness. On the one hand, it better represents the actual situation of Chinese farmers (with smallholders accounting for the majority), but on the other hand, the sample size of non-smallholder is relatively small. Further research should expand the total sample size to conduct more in-depth analysis of non-smallholders, then do comparison with smallholders. Additionally, despite the fact that the scope of our survey is limited in Guangdong Province, these results may provide useful information that might help to understand the green production behaviors of farmers who are not profit-oriented.

Funding

This work was supported by the Key-Area Research and Development Program of Guangdong Province, China (2021B0202030002); Guangdong Provincial Special Project of Rural Revitalization Strategy (China) (Document No. [2021] 12); the Innovation Team Construction Project of Modern Agricultural Industry Technology System of Guangdong Province, China (2022KJ105, 2023KJ105); National Social Sciences Fund of China (20BGL183); Philosophy and Social Science Planning Project of Guangzhou, China (2023GZGJ05); and Philosophy and Social Science Planning Project of Guangdong Province, China (GD23CYJ07).

Data availability

All data included in this study are available upon request from the corresponding author.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Economic and Management School, South China Agriculture University (Ethics Approval Reference 510051) in Jan of 2021. Informed consent was obtained from all the participants.

Consent for publication

This is not applicable.

CRediT authorship contribution statement

Hui Li: Writing – original draft, Investigation, Funding acquisition, Conceptualization. **Yaoming Liang:** Writing – original draft, Methodology, Formal analysis. **Lingling Shi:** Writing – review & editing, Methodology, Formal analysis. **Jiaen Zhang:** Writing – review & editing, Supervision, Funding acquisition. **Jiaen Zhang:** Conceptualization. **Fengbo Chen:** Supervision, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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frontiers | Frontiers in Environmental Science

TYPE Original Research
PUBLISHED 13 July 2023
DOI 10.3389/fenvs.2023.1150838

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OPEN ACCESS

EDITED BY
Diogo Guedes Vidal,
University of Coimbra, Portugal

REVIEWED BY
Shamsheer Ul Haq,
University of Education Lahore, Pakistan
Xin Huangfu,
Zhejiang University, China

*CORRESPONDENCE
Hua Li,
fatmartin@scau.edu.cn

RECEIVED 25 January 2023
ACCEPTED 22 June 2023
PUBLISHED 13 July 2023

CITATION
Li H, Huang D, Li H, Ma Q and Li J (2023), Villagers' attitudes and behaviors toward rural solid waste management under environmental authoritarianism in China. *Front. Environ. Sci.* 11:1150838. doi: 10.3389/fenvs.2023.1150838

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Villagers' attitudes and behaviors toward rural solid waste management under environmental authoritarianism in China

Hui Li[1,2,3], Diejun Huang[4], Hua Li[3]*, Qiuzhuo Ma[5] and Juan Li[6]

[1]College of Nature Resources and Environment, South China Agricultural University, Guangzhou, China, [2]College of Public Administration, South China Agricultural University, Guangzhou, China, [3]College of Economics and Management, South China Agricultural University, Guangzhou, China, [4]School of Culture Tourism and Geography, Guangdong University of Finance and Economics, Guangzhou, China, [5]Business School, Guangdong University of Foreign Studies, Guangzhou, China, [6]Graduate Institute for Taiwan Studies, Xiamen University, Xiamen, China

Rapid urbanization and industrialization in China, combined with a rural-urban dual structure, have resulted in significant challenges for rural solid waste management (RSWM). Through the issuance of regulations and guidelines, and the allocation of substantial funds, the Chinese government has achieved remarkable success in implementing a top-down, linear, and authoritarian waste system, with the national village-level coverage rate of the rural waste management system growing from zero to over 90% in less than 20 years. This paper provides insights into the factors that influence villagers' responses (attitudes and behaviors) to authoritarian environmental policy measures. Using primary data from Meizhou County in Guangdong Province (the poorest county in China's richest province), the study finds that villagers' attitudes are significantly affected by their satisfaction with the government's RSWM and their environmental concern, while villagers' behaviors are significantly influenced by their approval level of the local environment, the availability of solid waste collection (SWC) facilities, and their environmental concern. Thus, villagers' SWC behaviors are mainly influenced by practical convenience and internal motivation. In general, government-relevant factors do not directly impact villagers' SWC behaviors but significantly moderate villagers' behaviors. Surprisingly, the variable of villagers' education level is a significantly negative factor in affecting both RSWM attitudes and behaviors, implying that future RSWM policy measures should take consider democracy more and value villagers' participation.

KEYWORDS

rural solid waste management, villagers' attitudes and behaviors, rural China, authoritarian environmental governance, democracy environmental governance

1 Introduction

Solid waste management (SWM) is a global issue, particularly in fast-developing regions, where waste management cannot keep up with the pace of development (World Bank, 2018). China is a dual-structured country, with rural regions lagging behind urban regions generally. Rural China is facing more severe waste problems due to the expanding

economy (Liao et al., 2018). Traditionally, rural household waste was consumed and recycled by nature (Han et al., 2018). However, due to the increasing quantity and changing composition of waste, waste in rural areas have exceeded nature's capacity to handle, resulting in the phenomenon of "junk-sieged villages".

According to the garbage industry report data, the total annual quantity of rural solid waste (RSW) reached 227 million tons in 2017 (Qianzhan Institution, 2019). The Vice Minister of the Department of Agriculture and Rural Affairs reported that almost a quarter of RSW was not collected or processed (Xin Hua News Agency, 2020), which poses a significant theat to villagers' daily life and harms their bodies directly and indirectly (Han et al., 2018). Even worse, RSW pollutes agricultural land, water, and air, which resulting in contaminated agriculture products that affect public health. The effectiveness and efficiency of RSWM in China affects more than 600 million rural population living on about 9 million square kilometers of land. Acknowledging the seriousness of the RSW problem, the Chinese government has made great effects to solve it since around 2005. This includes issuing a series of laws and regulations, a large number of investments, and promotions on environment protection (Wang et al., 2017).

Due to the public goods nature of environmental protection, the government plays an important role in its management in most countries. Environmental authoritarianism is potentially a superior basis for public policy (Gilley, 2012), and has made some success in East Asia including Japan and China (Beenson, 2014). In the historical context of China's authoritarian rule, the Chinese-style logic of governance is embedded into the environmental governance, making it a top-down linear path (Zang and Lv, 2017). A nationwide panel data (in 2005, 2008, and 2012) indicates that rural solid waste collection (RSWC) facilities and services have rapidly increased from 3% to about 50% (Wang et al., 2016). Another national survey in 2016 announced that RSWC services cover more than 80% of villages across the country (Wang et al., 2017). In September 2020, in the third session of the 13th People Congress, the Ministry of Agriculture and Rural Affairs claimed that over 90% of villages have been covered by the RSW collection, transfer, and treatment system. Beeson (2018) pointed out that there is no sign of disappearing in China's particular variety of authoritarian rule, and the growing environmental problems are a possible reason for the durability of authoritarianism.

Considering the mismanagement, ineffectiveness, and injustice of authoritarian environmental governance, researchers put forward the idea of "participatory governance" in developed countries 50 years ago (Heibronner, 1974; Dryzek, 1987). Li and Reuveny (2006) analyzed data from more than 100 countries from 1961 to 2000 and found that participation can reduce environmental degradation. A Chinese case study in Shandong Province revealed that the current RSWM has unintended consequences, such as the erosion of rural environmental responsibility, social differentiation, power reconstruction, and environmental injustice (Sun, 2019). Empirical studies on environmental authoritarianism are rare, particularly in rural areas.

The main objective of this study is to identify the key determinants of villagers' attitudes towards RSWM and their RSWC behaviors under China's environmental authoritarianism. To achieve this goal, a survey is designed to collect primary data on villagers' RSWM attitudes and RSWC behaviors. A multi-variable analysis of the villagers' RSWM attitudes and RSWC behaviors is conducted. Finally, policy recommendations based on the empirical findings are provided.

2 Relevant research and background

This section provides background information for this paper, including a literature review, an overview of RSW in China, the current situation of RSWM, and the development of related regulations.

2.1 Related research

Studies on RSWM in China can be divided into two categories. The first category focuses on the provision of RSWM services at the village level (Wang et al., 2016; Pan et al., 2017; Cao et al., 2018), while the second category is related to individual attitudes and behaviors toward RSWM (Zeng et al., 2016; Han et al., 2018; Ma et al., 2020).

Studies on RSWM service supply are more about the facilities, policies, villager officers, and their villagers. According to a panel survey of 101 villages' RSWC conducted by Wang et al. (2016), there has been an overall significant increase in RSWC facilities, but richer villages tend to have more facilities. However, as noted by Pan et al. (2017) and Wang et al. (2017), RSWC service is not equally provided due to the uneven economic development, and some RSWC services are not practical but merely for "showcasing" (Pan et al., 2017). Additionally, villages with more educated villagers tend to discharge less waste (Huang et al., 2013). However, there is no significant correlation is shown between villagers' educational level and the RSWC service (Cao et al., 2018).

Individual-level studies have identified significant factors influencing attitude and behaviors towards RSWM including government regulations (Ma et al., 2018) and efforts (Wan et al., 2015); social factors, such as education level (Han et al., 2019) and culture (Han et al., 2018); economic factors, such as income (Han et al., 2019) and consumption (Han et al., 2018); and psychology factors, such as local identity (Pei, 2019) and attitude in the environment (Ma et al., 2018). A study of 14 developing countries found that education, training, and demonstration projects play a positive role in improving people's awareness of environmental protection. Different traditions and cultures, living habits, geography, and climate in different places lead to diverse environmental behaviors (Han et al., 2018). Ma's (2020) survey of 689 villagers in Shanxi Province in China revealed that the policy instruments not only directly affect pro-environmental behaviors but also indirectly affect perceived value.

The literature on RSWM in China is extensive. However, few studies have addressed its typical authoritarian governance, despite it being one of the eight major research clusters in environmental governance research (Ohno, 2019). Available literature on China's environmental authoritarianism mainly focuses on legislation (Gilley, 2012; Beeson, 2017; Wang and Jiang, 2020) and policy (Liu et al., 2019), but is rare on public response. Researchers outside China have made significant contributoins to the field. For example, String et al. (2006) examined three case studies to address the

potential of adoption management to make environmental management more democratic. Wallington and Lawrence (2008) studied a natural resource management experiment in Australia to discuss the responsibility of environment governance from federal and state governments to community-based bodies. Newig and Fritsch (2009) used 47 existing case studies as empirical data and found out that involved actors' preferences determine the environmental outcomes, but there is no correlation between government efficiency and decision-making scale. Hidayat and Stoecker (2018) analyzed a survey of city-wide residents in the US and found that community-based organizations could have a positive impact on civic environmentalism, environmental justice, and sustainability.

2.2 RSW in China

China's economy experienced rapid growth since 2000, but its development is still mainly in urban regions. Rural migrant workers have become an important economic engine, and income from these workers, which is often transferred to their parents and children in rural areas, has led to a significant increase in rural consumption of industrial products (Wang et al., 2014). In traditional self-sufficient rural economy, waste can be reused and recycled within villages, and returned to nature (Sun, 2019). However, the variety, component, and amount of waste are becoming similar between rural and urban areas. In 2010, the annual quantity of waste from rural regions (234 million tons) exceeded that from urban regions for the first time (Wang et al., 2016).

2.3 The development of RSWM in China

Although rural waste has increased dramatically since 2000, the environmental governance in China showed little concern about rural regions. Before 2010, there was no standardized nor systematic SWM in rural regions (He, 2012).

In 2002, the 5th National Conference on Environmental Protection clearly proposed the idea that "environmental protection is one of the most important governmental functions." In 2005, the National People's Congress issued the Law of *the Prevention and Control of Environmental Pollution by Solid Waste*, which brought RSWM under public scrutiny for the first time. In 2006, the Patriotic Health Campaign Committee Office and the Ministry of Health issued the "Notice on the Investigation of the Current Situation of Rural Drinking Water and Environmental Sanitation.", which is a nationwide environmental sanitation investigation that covered both urban and rural regions for the first time. In 2010, the Ministry of Environmental Protection issued the "Notice on Rural Life Pollution Control Technology Policy," which directly prohibited villagers from littering, piling up, or burning RSW. In 2015, the Ministry of Housing and Urban-rural Development collaborated with nine other ministries to issue the *Guidance on Rural Solid Waste Governance*. In January 2018, the General Office of the Communist Party of China Central Committee and the General Office of the State Council issued and distributed the *Three-Year Action Plan for the Improvement of Rural Human Settlements*.

Since 2010, RSWM special funds have been set up in three-level (national, provincial, and municipal) financial sections, and county-level governments include RSWM fees into the budget. Before that, the national public budget for community sanitation did not differentiate between urban and rural regions. The *12th Five Year Plan* proposed to build "clean and tidy villages" and to provide accompanying government investments, such as the Rural Environmental Protection Special Fund. Since 2010, the national public financial expenditure for environmental protection and community sanitation has been increasing every year. For example, in 2019 it accounted for about 4% of the total expenditure. Compared to 2018, the public expenditure for urban and rural communities together grew 16.1%.

After a series of RSWM pilot programs, the "village collection, township transfer, county treatment" united model (Figure 1) was promoted throughout China. This model is based on the "Guidance for Construction and Investment of Rural Domestic Waste Classification, Collection, Transportation and Treatment Projects" (2013) and the "Guidance on Improving Rural Human Settlements" (2014). In the RSWM framework, RSWC is the first step and the foundation of subsequent steps of RSW transfer and treatment (Cao et al., 2018). The completion rate and quality of RSWC depend on individual villagers.

3 Theoretical model and hypotheses

Environmental authoritarianism is a model of top-down governance to address pro-environmental issues, with limited community participation (Wang and Jiang, 2020). According to Beeson (2010), the combination of environmental crisis and authoritarian traditions has led to the prevalence of environmental authoritarianism in East Asia, particularly in China.

3.1 Environmental attitudes and behaviors under China's environmental authoritarianism

The theory of reasoned action posits that attitude is a key determinant of behavior(Ajzen, 1991). Our model is to identify factors affecting attitudes and behaviors towards RSWM among villagers, and to determine whether government-related factors have mediating effects under China's environmental authoritarianism.

There are two thoughts in environmental behaviors. One suggests that individuals make active choices based on personal attitude, knowledge, and demographic characteristics; while the other posits that external factors such as social norms and facilities play a more significant role. As a matter of fact, both internal and external factors can play a role in shaping individual environmental behaviors. Based on the literature and field survey, factors included in the model are promotion, social norms, environmental identity, facilities, environmental concern, satisfaction to government's RSWM jobs, gender, age, education, and family size. The following hypotheses are proposed:

FIGURE 1
The management framework of RSWM in China.

Hypothesis 1a. (H1a). If a villager has a higher level of satisfaction with the government's RSWM jobs, he or she will be more likely to fully support RSWM.

Hypothesis 1b. (H1b). If a villager has a higher level of satisfaction with the government's RSWM jobs, he or she will be more likely to strictly follow the government's requirements to clear waste.

Hypothesis 2a. (H2a). If a villager has a higher perception that the government's promotion makes him or her more concerned about RSW, he or she will be more likely to fully support RSWM.

Hypothesis 2b. (H2b). If a villager perceives that the government's promotion makes him or her more concerned about RSW, he or she will be more likely to strictly follow the government's requirements to clear waste.

Hypothesis 3a. (H3a). If a villager has a higher perception that all neighbors follow the government's requirements to clear waste, he or she will be more likely to fully support RSWM.

Hypothesis 3b. (H3b). If a villager has a higher perception that all neighbors follow the government's requirements to clear waste, he or she will be more likely to strictly follow the government's requirements to clear waste.

Hypothesis 4a. (H4a). If a villager has a higher level of satisfaction with the local environment and has no plan to move to another place, he or she will be more likely to fully support RSWM.

Hypothesis 4b. (H4b). If a villager has a higher level of satisfaction with the local environment and has no plan to move to another place, he or she will be more likely to strictly follow the government's requirements to clear waste.

Hypothesis 5a. (H5a). If a villager has a higher perception that there are reasonable waste collection facilities in the village, he or she will be more likely to fully support RSWM.

Hypothesis 5b. (H5b). If a villager has a higher perception that there are reasonable waste collection facilities in the village, he or she will be more likely to strictly follow the government's requirements to clear waste.

Hypothesis 6a. (H6a). If a villager has a higher perception that environmental protection is not only the government's responsibility but everyone's, he or she will be more likely to fully support RSWM.

Hypothesis 6b. (H6b). If a villager has a higher perception that environmental protection is not only the government's responsibility but everyone's, he or she will be more likely to strictly follow the government's requirements to clear waste.

Hypothesis 7. (H7). If a villager reported he or she fully supports RSWM, he or she is more likely to strictly follow the government's requirements to clear waste.

Drawing upon them, a theoretical framework is formulated (Figure 2).

3.2 Mediating role of government-relevant factors

ABC theory of emotion is widely applied including pro-environmental research (Guagnano et al., 1995). By certain antecedents, an individual's belief (attitude) might adjust, and then relevant consequences appear (behavior). As to China's environmental authoritarianism of RSWM, the government has designed, invested, and built up a complete RSWM system for villagers. Government-relevant factors might not only directly affect villagers' attitudes and behaviors respectively, but act as a catalyst to affect the relationship between villagers' attitudes and behaviors. Therefore, the following hypotheses are proposed:

Hypothesis 8. (H8). Villagers' satisfaction with the government's RSWM jobs positively moderates the positive impact of villagers' RSWM attitudes to RSWC behaviors.

Hypothesis 9. (H9). Villagers' perception of the government's promotion positively moderates the positive impact of villagers' RSWM attitudes to RSWC behaviors.

Hypothesis 10. (H10). Villagers' perception that "environment protection is not only government's responsibility, but everyone's" positively moderates the positive impact of villagers' RSWM attitudes to RSWC behaviors.

Drawing upon this, a theoretical framework is formulated (Figure 3).

4 Data collection

4.1 Study area

The data for this study were collected through a questionnaire survey of rural households in Meizhou County, Guangdong

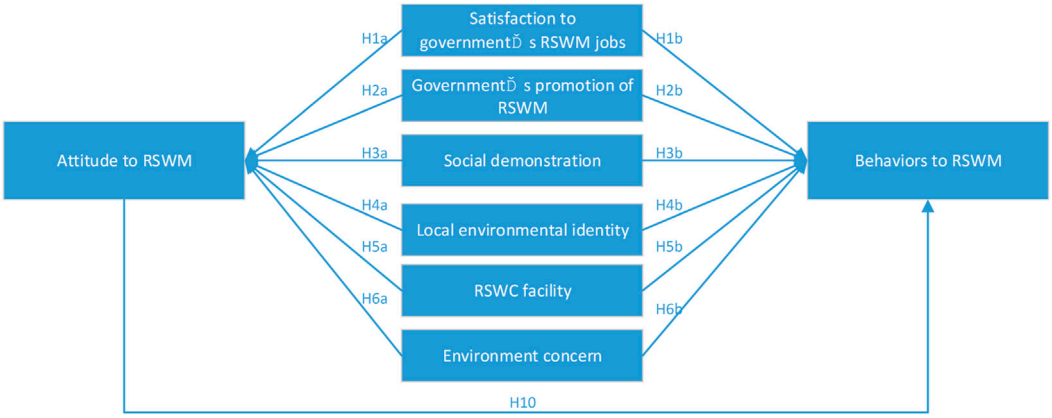

FIGURE 2
The theoretical framework of villagers' attitudes and behaviors to RSWM.

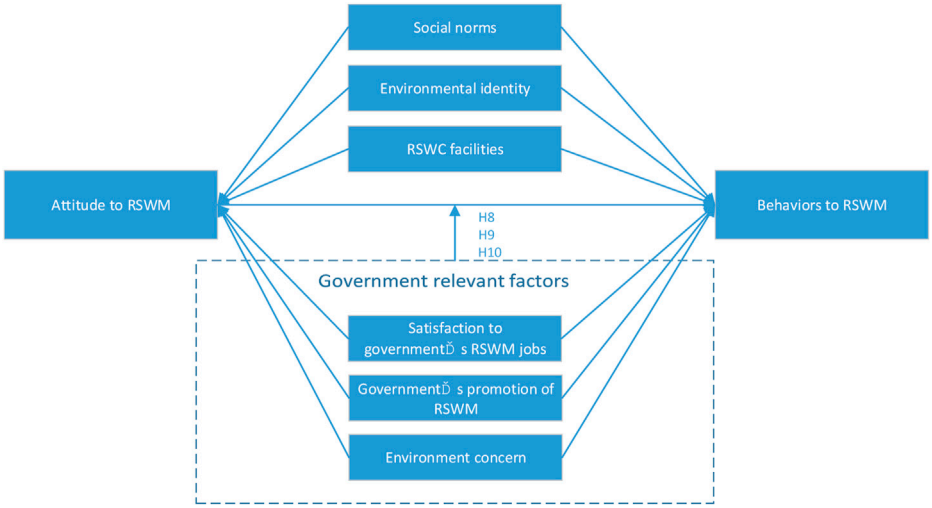

FIGURE 3
The theoretical framework of mediating role of government-relevant factors.

Province in February 2020 (Figure 4). The survey was conducted in Meizhou County because it is the most representative area of environmental authoritarianism. All eight towns in Meizhou County were planned for investment, but due to COVID-19, one town (Wuhua Town) was not completed. Two villages were randomly selected from each of the seven towns, and twenty-five farmers were randomly selected from each selected village. Of the 350 rural households surveyed, 46 questionnaires were invalid due to missing key information. The final sample includes 304 households, yielding an effective survey rate of 86.86%. Meizhou County has a permanent population of 3,876,900, of which 1,846,200 live in rural areas.

In 2015, the Provincial People's Congress of Guangdong Province issued *the Regulations of Guangdong Province Urban-Rural Solid Waste Management*, which defined and clarified standards for village cleaning, rural waste handling requirements, and waste classification specifications. In 2018, the Department of Housing and Urban-Rural Development of Guangdong Province issued and distributed *Guidelines for Rural Solid Waste Governance* to regulate the practical operation of villagers' waste management by local governments and villages. The Guangdong Province government promoted the "one county one landfill, one town one station, one village one point" policy for RSWM construction. According to data presented by the Department of Housing and Urban-Rural Development of Guangdong Province in 2018, Guangdong had constructed waste landfills in 66 counties out of 69 counties, waste treatment stations in all 1,139 towns, and waste collection points in all 198,000 villages. Additionally, about 180,000 village cleaners were on duty, and the government had provided 2.67 billion RMB in special financial funding for rural waste management (including solid waste and liquid waste)

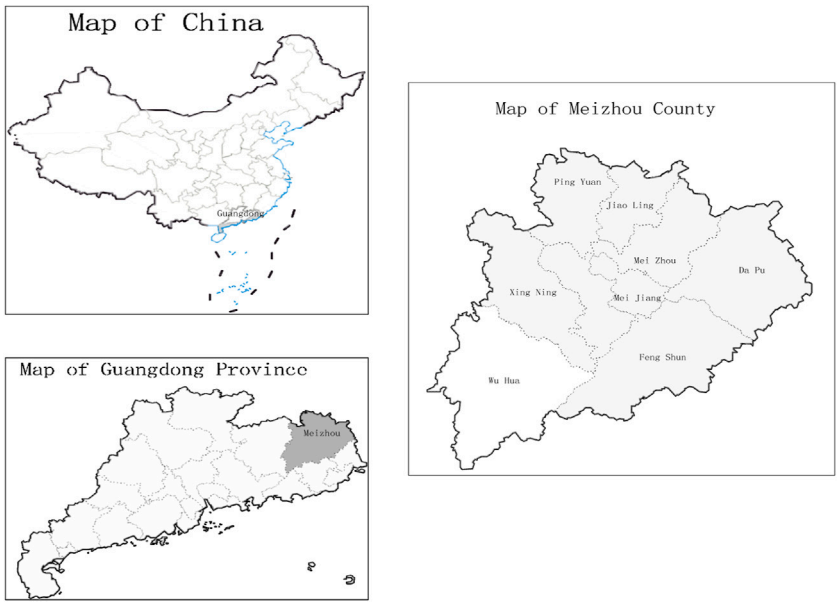

FIGURE 4
Study area.

TABLE 1 Demographic characteristics of the respondents.

Variable	Category	Frequency	Percentage (%)
Gender	Male	166	54.61
	Female	138	45.39
Age	<20	38	12.50
	20–30	77	25.33
	31–40	37	12.17
	41–50	47	15.46
	51–60	44	14.47
	>60	61	20.07
Education	Primary school or below	52	17.11
	Junior middle school	93	30.59
	Senior middle school	59	19.41
	College or above	99	32.57
Family size	<4	48	15.12
	4	81	26.64
	5	81	26.64
	>5	94	30.92

from 2012–2017. In 2019, during an on-site promotion meeting held by the Guangdong provincial housing and urban-rural system to implement a revitalization strategy and improving the rural living environment, it was announced that the goal was to processed 100% of RSW by the end of 2020.

Meizhou County was selected as the case study sample due to its unique position as the poorest county in China's richest province, Guangdong. In 2020, Guangdong's GDP reached 1.61 trillion USD, the highest GDP in China for 32 years, while Meizhou County's GDP was 17.56 billion USD, less than 1.1% of Guangdong's GDP. Additionally, Meizhou County has the lowest *per capita* GDP at 4,535 USD. Therefore, Meizhou County is an ideal area to study the impact of RSWM funding from Guangdong provincial finance in a typical environmental authoritarianism setting.

4.2 Descriptive characteristics

Table 1 presents descriptive statistics for the characteristics of the survey respondents.

Table 1 shows that 54.61% (n = 166) respondents are male. The largest age group of respondents is between 20 and 30 years old (25.33%), followed by the over-60-years-old group (20.07%), the 41-to-50-years-old group (15.46%), the 51-to-60-years-old group (14.47%), the younger-than-20-years-old group (12.17%), and the 31-to-40-years-old group (12.17%, n = 37). The high percentage of young people in rural China during the survey period is a seasonal phenomenon that occurs every February due to schools' winter vacation and the Spring Festival public holiday. Of the respondents, 32.57% have a college or higher education level, while a similar percentage (30.59%) have junior middle school education. 19.41% have a senior middle school education, and 17.11% only have primary education or less. The same percentage of respondents (26.64%) have 4 or 5 family members, while over 30.92% have a larger family with more than 5 members, and 15.12% have a smaller family with less than 4 members.

TABLE 2 Variables' settings and descriptions.

Variable name	Variable definition and assignment	Mean	Standard deviation	Expected sign
Attitude to RSWM	Do you fully support RSWM? 1 = yes; 0 = no	0.793	0.406	
Behaviors to RSWM	Do you strictly follow government's requirements to clear waste? 1 = yes; 0 = no	0.645	0.479	
Satisfaction to government's RSWM jobs	I am pretty satisfied with the government's work in RSWM. 1 = total not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	4.000	1.169	+
Government's promotions of RSWM	The government's promotion of RSWM makes me more concerned about the RSW issue. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	4.217	1.046	+
Social norms	All neighbors follow governments' requirements to clear waste. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	3.924	1.119	+
Local environment identity	I am satisfied with the local environment and will not move to other places. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	4.069	0.656	+
RSWC facilities	There are reasonable waste collection facilities in my village. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	3.895	1.156	+
Environmental concern	Environmental protection is not only the government's responsibility but everyone's. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	4.694	0.656	+
Gender	Gender 1 = male; 2 = female	1.454	0.499	-
Age	Age 1 < 20; 2 = 20–30; 3 = 31–40; 4 = 41–50; 5 = 51–60; 6 > 61 years old	3.543	1.734	-
Education	Years of formal education	10.680	3.774	+
Family size	Family member 1 < 4; 2 = 4; 3 = 5; 4 > family members	3.697	1.126	-

5 Empirical analysis

This section analyzes the survey data introduced above to empirically understand the association between villagers' attitudes towards RSWM and their RSWC behaviors. Additionally, the analysis exams the impact of villagers' satisfaction with the government's RSWM jobs, RSWC social norms, local environment identity, RSWC facility situation, environmental concern, personal characteristics, and family characteristics on the aforementioned factors.

5.1 Variables

Table 2 presents the variables used in the empirical analysis, with the detail of variable settings and basic statistics results. Based on previous RSWM literature and an understanding from field survey, the study predicts the direction of impact on villages' RSWM attitudes and RSWC behaviors. As our study focuses on government-relevant issues. Half independent variables pertain to the governments.

5.2 Empirical model

This study employs logit regression to model the association between the villager's RSWM attitudes and behaviors, and a series of independent variables. Logit regression is commonly used when the dependent variable is binary. In this study, villagers' attitude towards RSWM are measured by whether they fully support RSWM or not, while their RSWC behaviors are measured by whether they strictly follow the government's RSWC rules to clear waste or not. The answer to these two options corresponds to the different situations and attributes of each responding villager. Each villager's RSWM attitude and behavior are represented by a dummy variable, as shown below:

$$D_i = \begin{cases} 1\, if\ a\ villager\ fully\ supports\ RSWM \\ 0\, if\ a\ villager\ does\ not\ fully\ support\ RSWM \end{cases} \quad (1)$$

$$D_i = \begin{cases} 1\, if\ a\ villager\ strictly\ follows\ RSWC\ rules \\ 0\, if\ a\ villager\ does\ not\ strictly\ follow\ RSWC\ rules \end{cases} \quad (2)$$

This study constructs a binary model based on theories and practices to quantify the factors influence villagers' RSWM attitudes and RSWC behaviors.

$$\mathrm{In}\left(\frac{P_i}{1-P_i}\right) = \alpha + \sum_{n=1}^{n} \beta_n x_{ni} \quad (3)$$

here the dependent variable p_i represents the probability of fully support RSWM or strictly follow RSWC rules. The intercept parameter is denoted by α, while β represents a vector of regression coefficients. Additionally, x_{ni} represents a vector of n independent variables (such as age or local environment identity).

6 Result and discussion

6.1 Factors influencing RSWM attitudes and RSWC behaviors

This study conducted a logit analysis using Stata 12 to assess the factors associated with the villagers' RSWM attitudes and RSWC behaviors. The result of the analysis are presented in Table 3.

TABLE 3 Logit regression fitted model coefficients.

Variables	Logit model to RSWM attitude	Logit model to RSWC behavior
	Coef. (Std. Err.)	Coef. (Std. Err.)
Satisfaction to government's RSWM jobs	0.465*** (0.160)	−0.125 (0.164)
Government's promotions of RSWM	−0.022 (0.179)	0.228 (0.162)
Social norms	0.009 (0.179)	−0.077 (0.166)
local environment identity	0.079 (0.175)	0.282* (0.162)
RSWC facilities	0.258 (0.166)	0.467*** (0.152)
Environmental concern	0.585** (0.235)	1.263*** (0.279)
Gender	0.342 (0.334)	0.105 (0.299)
Age	0.008 (0.127)	0.237** (0.117)
Education	−0.132** (0.057)	−0.087* (0.052)
Family size	0.057 (0.150)	−0.269* (0.146)
RSWM attitude	—	1.487*** (0.298)
_cons	−3.501** (1.619)	−7.329*** (1.723)

Note: *, **, *** represent significant differences at the 10%, 5%, and 1% levels, respectively; the values in parentheses are standard deviation.

The estimated coefficients of the logit model reveal that three of the ten selected variables are statistically significant for RSWM attitudes; while six of the ten are significant for RSWC behaviors. The RSWM attitude significantly influences RSWC behaviors at the 1% level. Among the three significant influencing factors, positive factors for villagers' RSWM attitudes include being satisfied with the government's RSWM jobs and the environmental concern. Contrary to the predictions, the education variable has a negative effect on villagers' RSWM attitudes. Regarding villagers' RSWC behaviors, positive factors include local environment identity, RSWC facilities, environmental concern, and age, while negative factors are education level and family size. The variables of age and education are opposite to predictions. In summary, this study supports H1a, H6a, H4b, H5b, H6b, and H7.

The coefficient of the variable "satisfaction to government's RSWM jobs" is positively and significantly associated with villagers' RSWM attitudes at the 1% level. This finding is consistent with previous literature both in urban (Wan et al., 2015) and rural areas (Ma et al., 2020). A study in a rapidly urbanizing area in Thailand also found that increased government spending on SWM (such as on-time waste collection), improves individuals' waste clearing performance (Yukaling et al., 2018). Conversely, a in Lebanon found that insufficient government funding and effects are serious obstacles to waste management and could even lead to a trash crisis (Ahad et al., 2020). In Ma et al.'s (2020) study, the government's RSWM policy instruments not only directly affect behaviors but also indirectly affect them through individuals' perceived value. The study explain that in rural China, villagers' consideration of RSWM does not depend on personal feelings about the environment, but rather on governmental policy. This is an example of the ideal state of authoritarian management (Gilley, 2012). However, in our study, "satisfaction with government's RSWM jobs" is not statistically significant for villagers' RSWC behaviors. This is a drawback of authoritarian, as insufficient public participation may make it more difficult to implement practical action. Other empirical studies also reveal a gap between intention and behavior in waste management (Zhang et al., 2020; Zhou et al., 2023) and another possible reason is the obstacles to follow RSWC rules at the execution level, such as convenient facilities.

As for the local environment identity, the variable "being satisfied with the local environment and not planning to move to another place" has a positive and significant impact on villagers' RSWC behaviors at the 10% level. This supports the finding from Candelo et al. (2017) that individuals with higher levels of local identity contribute more to local public goods. However, in contrast to the findings of Hernandez, et al. (2010) and Pei (2019), our study finds no significant effect of villagers' local environmental identity on their RSWM attitudes. One possible reason for this discrepancy is the gap between pro-environmental intention and support for detailed RSWM, which may be explained by a lack of participation.

Reasonable RSWC facilities has a positive effect on villagers' RSWC behaviors at the 1% level. When villagers perceive that they have reasonable RSWC facilities, they are more likely to follow waste disposal rules accurately. It is generally understood that better RSWC facilities make it more convenient for villagers to complete RSWC tasks. Researchers have explained that sufficient bins, more funding, and more services demonstrate the government's strong political determination, which can increase people's willingness to follow RSWC rules (Yuka et al., 2018; Ma et al., 2020). However, our study find no significant relationship between reasonable facilities and villagers' RSWM attitudes. One possible explanation is that RSWC facilities are provided free of charge by the government, but are not sought after or demanded by villagers. Therefore, the sufficiency of RSWC facilities is not related to their environmental attitudes.

The variable of environmental concern has a positive and significant effect on both villagers' RSWM attitudes (at the 5% level) and RSWC behaviors (at the 1% level). In our survey, the environment concern variable refers to villagers' subjective judgment of their responsibility to the environment beyond the idea that pro-environmental action are solely the responsibility of the government. We find that villagers who are aware of their personal responsibility to the environment, in addition to governments' responsibility, were more likely to fully support RSWM and accurately follow RSWC rules. Public awareness is an important factor that influences environmental behaviors (Dhokhikah et al., 2015). Individuals feel proud when their behaviors align with their moral concern, and guilty when they do not (Onwezen et al., 2013).

The variable of age has a statistically significant effect on RSWC behaviors at the 1% level. Wang et al. (2018) found out that young people are more likely to participate in pro-environmental behaviors because they are more receptive to pro-environmental information. In contrast, a survey of RSWM across 12 provinces in China found out that older respondents are more likely to pay for RSWM, possible because they are more involved in RSWC works and more concerned about RSWM quality (Zeng et al., 2016). However, our study finds no significant correlation between age and RSWM attitude. One possible explanation is that although the older generation in rural China has less education and updated information, they strongly trust the government, and are more willing to follow governments guidelines than to act on their environmental attitudes. A similar explanation to pro-environmental behaviors is found in a Vietnamese case study (Nguyen et al., 2019), which shares cultural roots and political history with China.

The education variable has a negative statistically significant effect on RSWM attitudes at the 5% level and a negative effect on RSWC behaviors at the 10% level, which is opposite to expectation. We find that villagers who have received more formal education are less likely to fully support RSWM and strictly follow RSWC rules. This contradicts most literature, which suggests that people with higher education levels are more positive toward pro-environment behaviors. The common explanation is that education can improve an individual's environmental awareness (Song et al., 2016; Triguero et al., 2016). However, a survey in Guilin (Ma et al., 2018) and another in Suzhou (Zhang et al., 2014) also found that there is a significantly negative relationship between an individual's education level and pro-environmental intention. One possible explanation for the negative effect of education on pro-environmental is that while education can improve an individual's environmental awareness, it can also expose them to a bigger picture of environmental issues, leading to less trust in governments and traditional bureaucratic system. This is particularly relevant in China, which is currently undergoing a rural-urban dual structure that creates significant differences in social culture and economic opportunities between rural and urban areas. Specifically, villagers who receive middle school education are more likely to leave villages from towns, while those who receive higher education tend to move to cities. In rural China, educated villagers are more independent in decision-making, while others are more likely to rely on government guidance.

The variable of family size has a significantly negative effect on RSWC behaviors at the 10% level. This means that families with more members are less likely to strictly follow government RSWC rules. This finding is consistent with previous studies (Kang et al., 2018) and can be explained by the fact that larger families generate more waste (Han et al., 2018), which creates higher pressure in waste collection tasks. However, family size does not significantly affect RSWM attitudes. One possible reason for this is that the environmental attitudes are more personal and have less to do with family size.

A positive and significant coefficient at the 1% level when RSWM attitude was set as an independent variable and RSWC as a dependent variable. This suggests that villagers who fully support RSWM in attitude are more likely to strictly follow RSWC rules in behavior. This finding is consistent with previous researches on RSWM in China (Zhang et al., 2015; Ma et al., 2018), and can be explained by the theory of planned behavior (TPB), which posits that an individual's behavior is primarily determined by their behavioral intention (Ajzen and Fishbein, 2005). TPB theory is widely applied to pro-environmental behaviors research, and most indicate that attitude plays the most significant role in the predicting intention, which in turn positively affects behavior.

6.2 Moderating effect of government-relevant factors

To further assess the government-relevant factors associated with the villagers' RSWC behaviors, we set variables of satisfaction with government RSWM jobs, government promotions of RSWM, and environmental concern as moderators. Table 4 presents the logit analysis results with interactive items of moderators and variables of villagers' RSWM attitudes. Model 1 is the logit regression of 10 independent variables and villagers' RSWC behaviors. In Model 2, we added interactive items of the variable of satisfaction with the government's RSWM jobs and the RSWM attitude to Model 1. In Model 3, we added interactive items of the variable of government promotions of RSWM and the RSWM attitude to Model 1. In Model 4, we added interactive items of the variable of environmental concern and the RSWM attitude to Model 1.

All three moderators have significantly positive moderating effects on the relationship between villagers' RSWM attitudes and RSWC behaviors. The finding supports H8, H9, and H10.

The interactive item of RSWM attitudes and satisfaction with the government's RSWM jobs has a significantly positive effect on villagers' RSWC behaviors at the 10% level. Specifically, villagers who are more satisfied with the government's RSWM are more likely to exhibit a positive RSWM attitude towards practical RSWC behaviors, that is, strictly following the government's rules for waste disposal. Additionally, the interactive item of RSWM attitudes and the government's promotions of RSWM also has a significantly positive effect on villagers' RSWC behaviors at the 10% level. Villagers who agree more strongly that the government's promotions make them more concerned about RSW issues are more likely to exhibit a positive RSWM attitude in personal practice. Finally, the interactive item of RSWM attitudes and environmental concern has a significantly positive effect on villagers' RSWC behaviors at the 5% level. Villagers who agree more strongly that "environmental protection is not only

TABLE 4 Logit regression fitted model coefficients of moderating effect.

Variables	Model 1	Model 2	Model 3	Model 4
Satisfaction to government's RSWM jobs	−0.125 (0.164)	−0.282 (0.186)	−0.150 (0.163)	−0.163 (0.164)
Government's promotions of RSWM	0.228 (0.162)	0.226 (0.163)	0.092 (0.178)	0.227 (0.164)
Social norms	−0.077 (0.166)	−0.094 (0.168)	−0.090 (0.167)	−0.086 (0.168)
local environment identity	0.282* (0.162)	0.279* (0.162)	0.268* (0.161)	0.271* (0.161)
RSWC facilities	0.467*** (0.152)	0.449*** (0.153)	0.459*** (0.153)	0.454*** (0.153)
Environmental concern	1.263*** (0.279)	1.211*** (0.279)	1.225*** (0.279)	1.093*** (0.288)
Gender	0.105 (0.299)	0.080 (0.301)	0.080 (0.301)	0.081 (0.301)
Age	0.237** (0.117)	0.236** (0.118)	0.243* (0.118)	0.242** (0.119)
Education	−0.087* (0.052)	−0.082* (0.053)	−0.074 (0.053)	−0.071 (0.053)
Family size	−0.269* (0.146)	−0.274* (0.147)	−0.287* (0.148)	−0.288* (0.148)
RSWM attitude * satisfaction to government's RSWM jobs		0.172* (0.097)		
RSWM attitude * government's promotions of RSWM			0.155* (0.087)	
RSWM attitude * environmental concern				0.156** (0.076)
_cons	−7.329*** (1.723)	−6.958 (1.732)	−6.913 (1.730)	−6.897 (1.738)

Note: *, **, *** represent significant differences at the 10%, 5%, and 1% levels, respectively; the values in parentheses are standard deviation.

government's responsibility but everyone's" are more likely to exhibit a positive RSWM attitude towards RSWC behaviors.

7 Conclusion and limitation

Our study in Meizhou County, the poorest county in the richest province (Guangdong) in China, provides insight into the RSWM attitudes and behaviors among villagers in the context of authoritarian environmental governance with significant investment and new policies. The survey results shed light on the factors that influence Chinese villagers' approach to environment protection, which is a typical example of a public good led by governments in the top-down linear path.

The study finds that almost 80% of villagers fully support RSWM, and their positive attitude towards RSWM is a relatively persistent and stable psychological construct that is only influenced by a few external factors. Governments' RSWM promotions, neighbors' RSWC behaviors, the satisfaction of the local environment, and RSWC facilities have no statistical relevance to villagers' RSWM attitudes. Only three factors significantly affect villagers' RSWM attitudes, two of which are positively related to governments, including satisfaction with government RSWM jobs and the belief that environmental protection is not only government's responsibility but everyone's. Additionally, the study finds a high positive correlation between RSWM attitudes and RSWC behaviors. In summary, the government is a key positive factor influencing villagers' RSWM attitudes in China, leading to high participation in RSWC. The study suggests that governments should focus on making villagers satisfied with their RSWM jobs and promoting the idea that the responsibility of RSWM belong to everyone, not just the government.

Regarding RSWC behaviors, almost 65% of villagers claim to strictly follow RSWC rules, and have more statistically significant influencing factors compared to RSWM attitudes. Interestingly, satisfaction with governments' RSWM jobs does not significantly affect villagers' RSWC behaviors, but factors including local environment identity, RSWC facilities, environmental concern about responsibility, age, education, and family size do. Therefore, villagers' RSWC behaviors are not influenced by external factors, including satisfaction of government RSWM jobs, promotions, neighbors' behaviors, but rather by personal ideas and characteristics. The study suggests that there should be less investment in RSWM promotions and more in RSWC facilities.

All three government-relevant variables have a significantly positive moderating effect on the relationship between RSWM attitudes and RSWC behaviors. In rural China, although government-relevant factors do not directly affect villagers' RSWC behaviors, they indirectly affect their RSWC behaviors by shaping their RSWM attitudes. Specifically, the study finds that the efficiency of government RSWM jobs leads to proper RSWC behaviors among villagers.

The survey finds that, contrary to common understanding, education has a negative impact on both RSWM attitudes and RSWC behaviors among Chinese villagers. Additionally, there is a significant gap in socioeconomic and social psychology between rural and urban areas in China. Less-educated villagers, who are typically older, tend to a strongly trust in the government, while educated villagers who leave rural regions and have studying and living experiences in urban regions, have broader horizons and their own insights. The study suggests that the current government RSWM policy is effective for a large percentage of villagers, particularly the older generation who are regulated residents in rural China. However, as time passes, governments should update their RSWM policy measures to take the new generation into greater consideration. Participatory governance can be one of the optimization directions.

This study limited by its used of data from only one county. While Meizhou is an appropriate sample, further studies should include more sample areas for comparative analysis. Additionally, this survey relied on self-reports rather than direct observation to measure respondents' behaviors. These limitations will be addressed in future studies.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

Conceptualization, HIL; methodology, HAL; formal analysis, HIL and HAL; investigation, HIL and DH; resources, QM and JL; data curation, DH and JL; writing—original draft preparation, HIL and DH; writing—review and editing, JL; supervision, HAL; All authors contributed to the article and approved the submitted version.

Funding

This study was funded by Social Sciences Foundation of Guangdong (GD23CYJ05; GD23CYJ07); Social Sciences Foundation of Guangzhou (2023GZGJ04; 2023GZGJ05); and Nature Sciences Funding of Guangdong (2019A1515012149). MOE Youth Foundation Project of Humanities and Social Sciences (18YJC790079).

Acknowledgments

We are thankful to Prof. Li Jihong and Student Captain He Yiting, Jiaying University, and Student Captain Deng Yongshi, South China Agriculture University for the field survey and to Xin Chen, Carnegie Mellon University for the help with language polishing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Factors Influencing the Technology Adoption Behaviours of Litchi Farmers in China

Hui Li [1], Diejun Huang [2,*], Qiuzhuo Ma [3], Wene Qi [1] and Hua Li [1]

[1] College of Economics and Management, South China Agricultural University, Guangzhou 510642, China; smarthuili@scau.edu.cn (H.L.); qiwene@scau.edu.cn (W.Q.); fatmartin@scau.edu.cn (H.L.)
[2] Institute of Geography and Tourism, Guangdong University of Finance & Economics, Guangzhou 510320, China
[3] Business School, Guangdong University of Foreign Studies, Guangzhou 510420, China; 201810036@oamail.gdufs.edu.cn
* Correspondence: diejunhuang@gdufe.edu.cn

Received: 1 December 2019; Accepted: 26 December 2019; Published: 29 December 2019

Abstract: Litchi is a traditional tree crop grown in Southern China. Sustainable development of the litchi industry is reliant on technology adoption by farmers. The top grafting technique allows for the introduction of new, quality litchi varieties. The fact that these new varieties ripen earlier or later than the traditional ones helps stabilize litchi prices. Selling new litchi varieties can increase farmers' incomes through higher prices of quality varieties and stabilizing prices by staggering the harvest periods. However, the rate of adoption of top grafting among farmers is low, and up till now, more than half of the litchi trees in China are still traditional litchi varieties. This study explores the factors that influence top grafting adoption by litchi farmers. Using primary data gathered by the China Agriculture Research System of Litchi and Longan (CARSLL) from 567 litchi farming households, a binary logit choice model is employed to determine the factors that influence adoption of litchi top grafting among litchi farmers. The results show that farmers owning larger litchi orchards are more likely to adopt top grafting compared to ones owning smaller orchards. Litchi information accumulation, including experience and training, significantly influences farmers' technology adoption levels. Moreover, a positive attitude toward technology also significantly influences technology adoption behaviours.

Keywords: technology adoption; farmer behaviour; binary logit choice model; litchi; top grafting technique; China P.R.

1. Introduction

Litchi (lychee) is a tropical fruit native to Southern China. Artificial cultivation of the fruit dates to more than 2000 years ago. According to the China Agriculture Research System of Litchi and Longan (CARSLL), currently, mainland China produces more than half of the world's litchi supply, accounting for over 60% of global litchi production. Litchi's attractive appearance and unique flavour lend it high commercial value. However, all litchis are extremely perishable. Their shelf-lives are only two to four days in ordinary temperatures [1]. It means fresh litchi can only be sold to a relatively small geographic scope. What is more, the harvest period for each litchi variety in a region is extremely concentrated. Therefore, litchi farmers are eager to sell their harvest quickly because mature litchi will perish within a few days, losing all commercial value. Following economic principles, a large quantity of undifferentiated product supplied in a small market at the same time can only result in low prices. In general, litchi bumper harvests cannot correspondingly reward litchi farmers. CARSLL reported that suitable weather in 2018 led to the total litchi production in mainland China increasing

by almost 50% over 2017. However, unfortunately, litchi farmers' total income was even lower than in 2017 because of the collapsed price. Litchi farmers are in the dilemma between quantity and price.

Mixing varieties is a shortcut that helps farmers escape from this dilemma, because the harvest periods are staggered. In addition, new litchi varieties can be sold at much higher prices than traditional varieties in the market. According to CARSLL, the average orchard price of Nuomici (a late maturing, high-quality litchi variety) over the last three years (2016–2018) was three times higher than Heiye (a traditional litchi variety). Furthermore, it is fundamentally practical to adopt the variety changing technique, considering the large amount of traditional litchi varieties in the market. As it is seen in CARSLL, in 2017, two of the three most cultivated litchi varieties were traditional ones (Heiye and Huaizhi), accounting for 45.7% of all litchi orchards in mainland China.

The most popular technique for changing the cultivated litchi variety is called top grafting, which is assessed as the first priority litchi cultivation technique by Delphi method [2]. Compared to other variety control technologies (such as hybridization), top grafting has the advantage of resource saving, thanks to its short recovery period and the low uptake cost. Qin and He conducted an economic benefit evaluation of litchi top grafting in China in a 20 ha orchard, called Xü Qizhi Orchard. Based on the orchard's average sales data from 2000–2004 and 2008–2014, the value of Xü Qizhi Orchard's yield increased 5.71 times after the top grafting technique was applied to change the varieties [3].

As different litchi varieties are ready for harvest at different times, it lengthens the period in which litchi can be supplied to the market within a region. By increasing the varieties cultivated in an orchard, a smoother supply is achieved. A stable litchi supply can lead to a relatively stable high price, and higher quality litchi varieties can also garner higher prices. Therefore, the top grafting technique could greatly increase the incomes of litchi farmers and lead to a sustainable development of the industry.

Even though the top grafting technique can significantly improve litchi farmers' incomes and increase the sustainability of the industry, the accumulated uptake rate for these technologies is not very high (from CARSLL). Increasing the rate at which farmers adopt new techniques has become an even more urgent and important issue than technology innovation in most counties [4]. The aim of this study is to determine the factors that influence the adoption of litchi grafting by litchi farmers, and correspondingly, to find out the ways to improve the adoption rate of litchi grafting so as to sustainably develop the litchi industry.

Previous studies on agriculture technology adoption in China focused mostly on top-down promotion, but relatively less focus on farmer adoption behaviours. Furthermore, the majority of the literature on agriculture technology adoption behaviours worldwide have focused on grain crops (beginning with Bryce's very early research on corn in the U.S. [5]), but the studies specifically focusing on tree crops are rare. Litchi is a typical commercial tree crop, and it has specific characteristics that lead to unique farmer behaviours. For instance, tree crops must be grown for several years before they are ready to harvest. In addition, tree crops generally have a higher, but more fluctuating, market price.

Today's China is an interesting place to study farmer technology adoption behaviours. Firstly, some farming households in China, just as in other developing countries, rely on agriculture for their livelihoods. For these households, agricultural growth can be linked directly to poverty reduction. However, they cannot bear the risks involved in trying new technology [6]. Moreover, for some farming households, just as in other developed countries, most of the younger generation now work in cities, leaving older family members to deal with the land. These older farmers may lack knowledge of and ability to apply new techniques [7]. In comparison, young people who have a proper education and the initiative to work in agriculture are called the New Farmers [8], and one of the characteristics of these New Farmers is their eagerness to adopt new technologies. Lastly, Chinese consumers, and the government, are beginning to put more and more emphasis on high-quality edible agricultural products.

The aim of this study is to provide knowledge on the adoption of litchi top grafting by litchi farmers through identifying the internal and external factors that influence the uptake. The results of

this study can help policy makers understand potential drivers of and barriers to the adoption of top grafting by litchi farmers.

2. Methodology and Data

2.1. Theoretical Model of Technology Adoption

According to the theory of behavioural economics, farmers facing the decision of whether to adopt a new agricultural technique are assumed to be rational and to pursue maximum self-interest. However, Simon put forward the bounded rationality theory that leads the decision making closer to the real world. The theory of bounded rationality is based on the idea that individuals do not have complete information and have cognitive limits, and thus, individuals are seeking for a 'good enough' decision, which Simon called a satisfactory decision [9].

A farmer's decision to adopt a new technology is affected by the information gained as well as his or her cognitive level and attitude about technology. Based on Rogers' innovation diffusion theory, the 5-step process by which a farmer adopts a new technology is as follows: the farmer gains adoption knowledge, forms an attitude about the technology, makes a decision, implements it, and confirms it [10]. Information on the agriculture technology is diffuse, both formally (such as training) and informally (such as from neighbours). A farmer's gaining of information is affected by his or her ability to access information, such as his or her social capital. A farmer's cognitive level is affected by personal and family characteristics. Additionally, adoption behaviour is both a function of dynamic technology diffusion and a psychological process from cognition to decision, which is affected by many factors. The theory model for a litchi farmer's technology adoption is formulated as follows.

$$\begin{aligned} D_i &= f(I_i, C_i, A_i) \\ I_i &= f(B_i, E_i) \\ C_i &= f(P_i, F_i) \\ D_i &= f(B_i, E_i, P_i, F_i, A_i) = \beta_0 + \beta_1 B_i + \beta_2 E_i + \beta_3 P_i + \beta_4 F_i + \beta_5 A_i + \varepsilon \end{aligned} \quad (1)$$

In the formulas, D stands for a farmer's decision regarding technology adoption. I represents the farmer's information gain. C stands for the farmer's cognition level. A represents the farmer's attitude about the technology. B represents the farmer's ability to access information. E represents the farmer's accumulated experience with litchi farming. P represents the farmer's personal characteristics, and F stands for the farmer's family characteristics. ε is the disturbance term that refers to the uncertainty factors. β_0, β_1, β_2, β_3, β_4, and β_5 are the impact coefficients, and i is the sample number.

2.2. Variable Design

From the theories and literature, the factors influencing farmer technology adoption behaviour could include personal characteristics, family characteristics, technology information accessibility, technology information accumulation, and technology attitude.

As to the personal characteristics, the number of years of formal education and the age have been found to be significant predictors of technology adoption in many studies. These are the most common indicators in innovation adoption research, and it has been found that younger and more educated farmers are more likely to adopt new technologies [11,12].

In terms of family characteristics, many studies show that technology adopters tend to have more land and earn a higher income percentage from that land. This indicates the ability to deal with the farm and a stronger motivation to adopt new techniques [4,13]. However, some studies have found that larger farm sizes and a higher percentage of family income coming from the farm have a negative or insignificant effect on technology adoption. This is normally explained by their risk tolerance level [14].

In terms of technology information accessibility, better access to market and technology information have a positive effect on the technology adoption level [14,15]. Having a relative or friend working

in the market may make it easier for farmers to update price information and to sell out products, and it is particularly important for perishable commercial products. Another information source could be the mass media. Considering that the litchi technology information is a very specific topic, little information on the subject is spread through TV and radio. However, smart mobile phones are widely used in China, so litchi-related information can be gained through search engines. The WeChat application, which is a social app with 10 billion users, is chosen as a variable to represent the ability to access Internet information.

For technology information accumulation, attending a specific training is a direct approach to gaining technology knowledge and reducing subjective uncertainty [16,17]. Years of farming experience is another way to accumulate knowledge, which is to learn by working and gaining information from informal mechanisms, such as other farmers [18]. Farmer experience is normally positively related to technology adoption. However, some studies show that less experienced farmers are more open to new technology, and, hence, are more likely to embrace new techniques [19].

The attitude about technology seems to be a behavioural factor behind technology adoption [20]. When a farmer has a high level of trust in technology, he or she is more likely to adopt new techniques. On the other hand, a low level of trust in technology is a key limitation to technology adoption.

Regional specific contextual factors, such as non-agricultural opportunities, natural agricultural resources, and policy support, will affect farmers' technology-related decisions in each locality [13]. Accordingly, regional factors will influence technology adoption.

2.3. Empirical Model

There are only two choices—to use or not use—in most farmers' technology adoption decisions. Our field survey is carried out in 2018 by the CARSLL team. In the questionnaires, responding farmers are asked whether they had used the top grafting technique. The answer to the two options corresponds to the different situation and attributes of each responding farmer. The dependent variable of the technology adoption function is a discrete variable, so a binary discrete choice model is chosen. The binary logit choice model is popular in technology adoption research [21]. Therefore, each farmer's decision regarding adoption of the top grafting technique is represented by a dummy variable as below:

$$D_i = \begin{cases} 1 \; if \; a \; farmer \; adopts \; top \; grafting \\ 0 \; if \; a \; farmer \; does \; not \; adopt \; top \; grafting \end{cases} \quad (2)$$

To quantify the factors influencing farmer decisions on whether to adopt the top grafting technique, the following binary model is constructed based on theories and practices:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \alpha + \sum_{n=1}^{n} \beta_n x_{ni} \quad (3)$$

where dependent variable p_i stands for the probability of technology adoption, α stands for the intercept parameter, β stands for the vector of regression coefficients, and x_{ni} stands for a vector of n independent variables (such as age and farm size).

2.4. Data Collection

2.4.1. Study Area

Litchi is a subtropical to tropical perennial fruit tree that needs an annual average temperature of over 25 °C, over 1200 mm of precipitation, over 1700 h of sunshine, and a short period of low temperatures (about 10 °C) to hasten blossoming. Therefore, the regions for litchi cultivation are limited. According to CARSLL, worldwide, there are 32 countries and regions in which litchi are

commercially cultivated, and the main areas of production are China, India, South Africa, Australia, Mauritius, and Madagascar.

The CARSLL data indicates that there are six provinces in China in which litchi are harvested, and the top two are Guangdong (province) and Guangxi (province). In 2018, the two provinces produced 1,581,600 tonnes and 986,300 tonnes of litchi, respectively, accounting for 52.23% and 32.57% of litchi production in mainland China. Therefore, Guangdong and Guangxi were selected as the study area (Figure 1) to discuss what factors influence a litchi farmer's technology adoption in China.

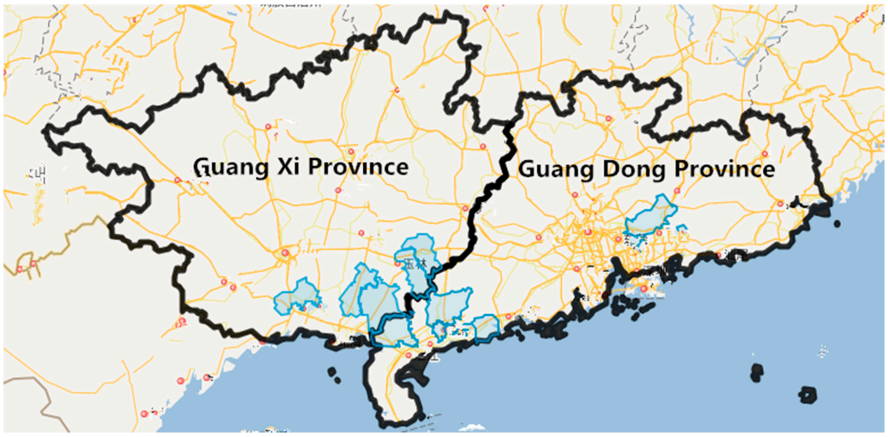

Figure 1. Study area.

2.4.2. Sampling Method

A farming household survey was conducted by the CARSLL team in July and August of 2018. The sampling method is probability proportionate to size.

First, all 16 Guangdong litchi technology demonstration counties (accounting for 73.74% of all Guangdong litchi planting areas in 2017) were divided by litchi planting size into five groups: large scale, large and medium scale, medium scale, medium and small scale, and small scale. One random sample was picked in each group, resulting in five survey counties. The same sampling method was applied in all 15 Guangxi litchi technology demonstration counties (accounting for 70.06% of all Guangxi litchi planting areas in 2017), so five counties in Guangxi were selected as survey counties. This resulted in a total of 10 survey counties.

Next, all towns in the 10 counties were divided by litchi planting size into three groups: large scale, medium scale, and small scale. One town was randomly sampled in the large-scale and medium-scale groups, respectively, in each country, resulting in 20 survey towns.

After that, all villages in the sample towns were divided by litchi planting size into three groups: large scale, medium scale, and small scale. One village was randomly sampled in the large-scale and medium-scale groups, respectively, in each town, resulting in 40 survey villages. Finally, 25 farmers were randomly sampled from among all the litchi farmers in each survey village, and they were selected as the survey interviewees. This resulted in 1000 farming household survey samples.

To ensure the accuracy and integrity of the survey, all questions in the questionnaire were asked through face-to-face interviews. Similar to the situation in most other rural area in China today, most young and middle-aged farmers were working in towns or cities, leaving old farmers to deal with agriculture, and thus a large number of random sampling samples were not in the village in the survey period. The total number of completed questionnaires was 584, so the response rate was 58.4%.

2.4.3. Respondent Profile

Through a data quality audit, the effective rate of the survey was found to be 97.09%. There were 251 questionnaires from Guangdong and 316 from Guangxi. As such, Guangxi accounted for 55.73% of the effective survey samples. Table 1 illustrates the demographic characteristics of the survey samples.

As seen in Table 1, the average age of the respondents was 58.01 years old. Nearly 90% of the farmers were over 45 years old, and 47.90% were over 60 years old. Most of the farmers had a middle school education, accounting for 61.90%, and very few had a higher education (1.77%). 36.33% farmers only had a primary education, and most of them had not even completed that. In total, 39.51% respondents had not received even one training. However, 66.84% of them had more than 20 years of litchi planting experience, and only 11.99% respondents had less than 10 years of experience. The average experience in litchi planting was 22 years. Among the sample, almost two thirds did not use WeChat (63.67%), and 73.02% did not have a relative or friend working in litchi distribution. As to the litchi income as a percentage of total family income, in the largest group (37.57%), litchi income accounted for less than 25% of their total income. However, in the second largest group (31.75%), it accounted for more than 75% of total income. The average litchi orchard size per household was 1.09 ha. However, more than half the farmers (57.32%) had less than 0.7 ha of litchi; 28.21% had 0.7–2 ha, and 6.87% had 2–3.4 ha, with 7.58% farmers having more than 3.4 ha. The largest litchi cultivation area was 23 ha. In terms of attitude about new litchi techniques, a little more than half of the respondents claimed they would apply it when positive results appear, whereas 23.63% claimed that they would use it immediately, and 25.04% would use it when most farmers have adopted it. In all the survey samples, 217 farmers (38.27%) had applied the top grafting technique to their litchi trees, while the other 350 (61.73%) had not.

Table 1. Basic sample characters.

Variables	Value	N = 567	
		Frequency	Percentage (%)
Age	<45	58	10.23
	≥45 and <60	24	42.68
	≥60	267	47.90
Education level	≤6 primary school or below	206	36.33
	>6 and ≤12 middle school	351	61.90
	≥12 college or above	10	1.77
Litchi orchard size	<0.7 ha	325	57.32
	≥0.7 ha and <2 ha	160	28.21
	≥2 ha and <3.4 ha	39	6.87
	≥3.4 ha	43	7.58
Percentage of family income from litchi	<25%	213	37.57
	≥25 and <50%	98	17.28
	≥50 and <75%	76	13.40
	≥75%	180	31.75
Relatives or friends selling litchi	1 have	153	26.98
	0 none	414	73.02
Application of WeChat	1 yes	206	36.33
	0 no	361	63.67
Litchi training experience	1 had	343	60.49
	0 none	224	39.51
Experience of litchi planting	<10 years	68	11.99
	≥10 and <20 years	120	21.17
	≥20 years	379	66.84
Attitude towards new technique	1 apply immediately	134	23.63
	2 apply when good results appear	291	51.32
	3 apply when all others applied	142	25.04
Region	1 Guangdong	251	44.27
	0 Guangxi	316	55.73
Application of top grafting technique	1 had applied	217	38.27
	2 not apply	350	61.73

Table 2 presents the survey variable settings and the basic statistics results. Based on the previous literature on farmer behaviour toward agriculture technology adoption, the direction of impact on litchi farmers' decision making in regard to top grafting is predicted.

Table 2. Variable settings and descriptions.

Variable	Variable Definition and Assignment	Average	Standard Deviation	Sign
	Personal Characteristics			
Age	Years of age	58.01	10.72	−
Education level	Years of formal education	8.20	3.10	+
	Family characteristics			
Litchi orchard size	ha of total litchi orchard	1.09	40.96	+
Proportion of litchi income in total family income	Percentage of total family income from litchi in 2018	46.90	36.58	+
	Ability to access information			
Relatives or friends selling litchi	No = 0, Yes = 1	0.26	0.44	+
Application of WeChat	No = 0, Yes = 1	0.36	0.48	−
	Accumulation of information			
Litchi training	No = 0, Yes = 1	0.60	0.48	+
Years of litchi planting	Years of planting litchi	21.60	9.85	+
	Attitude towards technology			
Attitude towards new technology	apply immediately = 1, apply when good results appear = 2, apply when most others applied = 3	2.08	0.38	−
	Region			
Region	Guangxi = 0, Guangdong = 1	0.44	0.49	−
	Dependent variable			
Application of top grafting technique	No = 0, Yes = 1	0.38	0.48	

2.5. Data Analysis

2.5.1. Top Grafting Application by Different Types of Farmers

Among all 567 survey samples, 217 had applied the top grafting technique, accounting for 38.27%. According to the different types of farmers and top grafting application, a cross-linked table is generated (Table 3).

Table 3. Top grafting technique adoption behaviours of different types of farmers.

Types of Farmers		Number	Number of Farmers Applied Top Grafting	Percentage of Farmers Apply Top Grafting Tech (%)
Age	<45	58	18	31.03
	≥45 and <60	242	97	40.08
	≥60	267	102	38.20
Education level	≤6	206	65	31.55
	>6 and ≤12	351	148	42.16
	>12	10	4	40.00
Litchi orchard size	<0.7 ha	325	107	32.92
	≥0.7 ha and <2 ha	160	66	41.25
	≥2 ha and <3.4 ha	39	20	51.28
	≥3.4 ha	43	24	55.81
Percentage of litchi income in family total	<25%	213	73	34.27
	≥25% and <50%	98	41	41.83
	≥50% and <75%	76	37	48.68
	≥75%	180	66	36.66
Relatives or friends selling litchi	Yes	153	66	43.14
	No	414	151	36.47
Application of WeChat	Apply	206	80	38.83
	Not apply	361	134	37.11
Litchi training	Had	343	153	44.60
	None	224	64	28.57
Experience of litchi planting	<10	68	21	30.88
	≥10 and <20	120	35	29.16
	≥20	379	161	42.48
Attitude towards new technique	Apply immediately	134	69	51.49
	Apply when good results appear	291	98	33.67
	Apply when all others applied	142	50	35.21
Region	Guangdong	251	59	23.50
	Guangxi	316	158	50.00

The younger age group (<45 years old) had the lowest percentage (31.03%) of applying the top grafting technique. The two other age groups had similar percentages, about 40%. This did not conform to the expectation that younger farmers were more willing to apply the top grafting technique. One possible reason could be that the new generation owns better quality varieties of litchi trees that do not require the top grafting technique. As for the education level, 65 out of the 351 farmers with less than a primary school education (18.52%) had applied the top grafting technique, which was much lower than the average technology adoption level, 38.27%. The other two groups had a similar adoption level; though, the farmers with a college level education had a slightly lower adoption level. One possible reason was that the sample size was too small, as there were only 10 samples. Another possible reason was that their litchi trees might be the better quality varieties.

According to the family characteristics, the group owning larger litchi orchards had a higher top grafting technique application rate. More than half of the farmers had the total litchi orchard size of less than 0.7 ha, but they had the lowest technique adoption rate at 32.92%. The figure for the 0.7–2 ha group was 41.25% and that of the 2–3.4 ha group was 51.28%. The group with more than 3.4 ha was 55.81%. The rate shows a trend that larger farmers are more willing to apply the top grafting technique. Another indicator of family characteristics was the percentage of litchi income in family total income.

The biggest group, whose litchi income was less than 25% of total family income, had the lowest top grafting technique uptake rate. When the percentage of litchi income goes from 25% to 50%, and then to 75%, the technique uptake rate goes from 34.27% to 41.83%, and then to 48.68%. However, when litchi income accounted for more than 75% of total family income, the top grafting uptake rate dropped to 36.66%. The possible reasons for this upside-down U shape curve in the adoption rate are as follows. When litchi income only takes a low percentage of the family income, there is low motivation to adopt new technology. When a higher percentage of a family's income comes from litchi cultivation, there is stronger motivation for farmers to try new techniques to raise their litchi income. However, when litchi income accounts for more than 75% of the total family income, the family has few other income sources besides litchi. This group of farmers are more cautious to try new technology.

Concerning the ability to access information, 26.98% of the farmers had a relative or friend selling litchi, and 36.33% were using WeChat. Farmers who had a relative or friend selling litchi enjoyed a higher percentage of top grafting technique uptake at 43.14%, while the uptake percentage for the others was 36.47%. A person with a job selling litchi is able to gain direct information on the local litchi market. Those that know more about the litchi market are more likely to change from traditional varieties to higher quality varieties. The top grafting rates were very slightly different between the WeChat App group (38.83%) and the non-WeChat group (37.11%). This is possibly because there is still little litchi information available on the Internet.

In terms of information accumulation, 44.60% of farmers who received litchi training had applied the top grafting technique. Correspondingly, 28.57% of farmers who never had litchi training had adopted the technique. The data shows the positive effect of training in technology adoption. Compared with formal training, the number of years of litchi planting experience also showed a positive effect on technology adoption. Farmers with less than 10 years litchi planting experience and 10–20 years of experience had similar top grafting adoption rates—30.88% and 29.16%, respectively. However, 42.48% of farmers with more than 20 years of experience had adopted the top grafting technique.

Attitude to technology is a socio-psychological factor that effects technology adoption behaviour. The farmers, who claimed that they would apply a new technology once they learn it, had the highest top grafting rate among all types of farmers at 51.49%. The application rate of the other groups, including those who claimed they would apply the new technique when it shows good results and those who would apply it only after most others had applied it, were 33.67% and 35.21%, respectively. New technique application requires certain costs and has unpredictable risks. Therefore, the more positive is the farmers' attitude to new techniques, the more possible it would be for them to uptake the top grafting technique.

Different regions have specific external environments that affect farmers. Half of the farmers in Guangxi had adopted the top grafting technique, but the figure in Guangdong was only 23.5%. Comparing the economic development of these two provinces, Guangdong is the number one province in terms of GDP, while Guangxi was number 18 out of all 31 provinces in China. Farmers in Guangdong have, comparatively, more opportunities other than litchi cultivation. On the other hand, Guangxi is an agricultural province, and the fruit industry there has rapidly grown over the past decade. Guangxi and Guangdong are at the same latitude, but in Guangxi, more resources are brought to the agricultural industry, especially for fruits. Data from the Ministry of Agriculture of China showed that, in 2016, the fruit production in Guangxi was 15 million tonnes, and that figure grew to 18 million in 2018.

2.5.2. Factors Influencing a Litchi Farmer's Application of the Top Grafting Technique

A logit analysis was conducted using Stata 12, and the result is shown in Table 4. Based on the field survey samples, the factors positively affecting the application of the top grafting technique include education level, litchi orchard size, and relatives or friends selling litchi. The factors negatively affecting the top grafting technique application include age, percentage of litchi income to family total income, WeChat use, attitude to new technology, and region.

The estimation results of the proportion of litchi income in family total income was the reverse of our expectation. In terms of the different litchi income percentage groups, the rate of adoption of the technique first rose and then fell. The group with a very high percentage (75%) of litchi income in total income did not apply the top grafting technique, and a possible reason is that these families rely so heavily on litchi income that they are unable to bear any risk. Financial support is a must for technology adoption; thus, farmers who are struggling financially would have difficulty with any innovation adoption [21–23].

Table 4. Impact of top grafting technique adoption by litchi farmers.

Variable	Logit Model coef. (Std. Err.)	Marginal Effect coef. (Std. Err.)
Age	−0.13005 (0.01103)	−0.00036 (0.00228)
Education level	0.06888 (0.03348)	0.00522 (0.00680)
Litchi orchard size	0.00954 *** (0.00268)	0.00202 *** (0.00066)
Percentage of litchi income to family total income	−0.00007 (0.21017)	−0.00011 (0.00055)
Relatives or friends selling litchi	0.12748 (0.24202)	0.02295 (0.04266)
Application of WeChat	−0.03830 (0.00981)	−0.01743 (0.04951)
Litchi training	0.52518 ** (0.18600)	0.11205 *** (0.04132)
Experience of litchi planting	0.03553 *** (0.20554)	0.00678 *** (0.00203)
Attitude towards new technology	−0.25101 * (0.00338)	−0.04339 (0.02793)
region	−1.19719 *** (0.20192)	−0.24389 *** (0.03634)
_cons	−0.86060 (0.91944)	– –

*, **, *** represent significant difference at the 10%, 5%, and 1% levels, respectively; the values in parentheses are standard deviation.

3. Results

The results from the estimated coefficients and marginal effects of the logit model showed that five of the 10 selected variables were significant at the 10% level.

The coefficient of the litchi orchard size variable was positive and statistically significant at the 1% level for farmers adoption of top grafting. Similar results have been found in literature [4,24]; farmers with larger sized farms are more likely to adopt new technology. The reasons for this may be as follows: first of all, the larger farm size itself means more resources. Farmers who own and manage more resources have a higher ability to learn and apply new technologies. Second, a large litchi orchard size could bring in comparatively more income, which can cover the additional operating costs for technology adoption [22]. Third, larger sized farms are more likely to have higher incomes, which motivates farmers to adopt new technology to further improve outcomes.

As to information accumulation, both the litchi training variable and the variable of litchi planting experience had a positive and significant impact on the adoption of the top grafting technique. The litchi training variable showed a 5% significance sign in the adoption equation. This is consistent

with the previous research findings, which have shown that training is an effective tool to improve knowledge, especially in reducing subjective uncertainty about the technology [18,25]. Experience in litchi planting significantly affected top grafting adoption behaviour at the 1% significance level. This is consistent with the notion that farmers with more experience in agriculture are more likely to adopt innovation [26].

The attitude toward technology significantly influenced litchi farmers' adoption of top grafting techniques. The coefficient for technology attitude was negative and significant at the 10% level, suggesting that the litchi farmers who were more eager to apply new technology were more likely to apply the top grafting technique. This result supports the possibility that the attitude toward technology leads to a practical technique uptake [14,27].

The regional factor significantly and negatively affects a litchi farmer's adoption of the top grafting technique at the 1% level. This means that litchi farmers from Guangxi are significantly more likely to apply the top grafting technique than the farmers from Guangdong. The map (Figure 1) shows that the two provinces are adjoined and fall along the same latitude. Both Guangdong and Guangxi are the regions where litchi was originally cultivated, and are still producing the largest percentage of litchi in the world. The difference between the two provinces was that the fruit industry, including litchi, is a more important industry in Guangxi than Guangdong. Guangxi had the second largest fruit production among all 31 Chinese provinces in 2018. A possible reason for this was that the Guangxi government and farmers were more focused on the agriculture industry and paid more attention in technology promotion and adoption.

4. Discussion and Conclusions

The large-scale survey on litchi farmers' adoption of technology provides a detailed understanding of common barriers to adoption between adopters and non-adopters. The results of the survey provide political insight and suggest that potential interventions should be encouraged.

In the literature, the main barriers to agriculture technology adoption are cost and risk. This was confirmed in the survey, as larger litchi orchard farmers are more likely to adopt the top grafting technique. Litchi is a kind of tree crop that is perennial for several decades. Smaller sized litchi farms are more likely to belong to, or to have even been passed down from an older generation. These farmers of small sized litchi orchards have no plan to invest in litchi cultivation; they just want to maintain it without incurring any risk. Therefore, as to policy making, litchi technology promotion should target on larger farms that are both willing and able to adopt new technology.

The study results also support the notion that an agriculture extension service is the key to better technology adoption [28]. Most litchi training in China is organized by extension services that show farmers how to apply the technique effectively and reduce uncertainty about the performance. In the survey samples, the average experience of growing litchi was over 20 years, and this group had the highest percentage of farmers accessing extension services. It suggests, in policy making, that agriculture extension services should be promoted to improve litchi technology adoption.

The theory of planned behaviour is built on the assumption that an individual's behaviours are derived from his or her intention, which is primarily determined by attitude [29]. This is also supported by the study, which finds that litchi farmers with a positive attitude toward technology are more likely to adopt new technologies in practice. In terms of policy making, to build up litchi farmers' positive attitude toward technology is a long-term task, which is mainly about promotion and education.

Author Contributions: Conceptualization, H.L. (Hui Li) and W.Q.; methodology, Q.M., H.L. (Hui Li), and W.Q.; software, Q.M.; validation, H.L. (Hui Li), D.H., and H.L. (Hua Li); formal analysis, H.L. (Hui Li) and Q.M.; investigation, W.Q., D.H. and X.W.; resources, H.L. (Hui Li) and W.Q.; data curation, D.H.; writing—original draft preparation, H.L. and D.H.; writing—review and editing, H.L. (Hua Li), Q.M., and D.H.; supervision, project acquisition, and administration: H.L. (Hui Li) and D.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by MOE (Ministry of Education in China) Youth Foundation Project of Humanities and Social Sciences (18YJC790079); the earmarked fund for the China Agriculture Research System (CARS-33-18); Natural Science Foundation of Guangdong Province (2018A030310687;2019A1515012149); the Key Project of the National Natural Science Foundation of China (71633002); and Philosophy and Social Science Planning Project of Guangdong Province (GD19CYJ14).

Conflicts of Interest: The authors declare no conflict of interest.

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ECOLOGICAL ECONOMY

第39卷 第12期 2023年12月

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2023年第12期

（第39卷 总第396期 2023年12月）

生态经济

第39卷 第12期 总第396期 2023年12月

生态经济
SHENGTAI JINGJI
〔月刊，1985年创刊〕
第39卷 第12期 总第396期 2023年12月

ISSN 1671-4407
CN 53-1193/F

主　　管　云南出版集团有限责任公司
主　　办　云南教育出版社有限责任公司
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期刊基本参数：
CN 53-1193/F*1985*M*16*230*ZH*P*￥30.00*2500*31*2023-12

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市场感知、农药认知与农户绿色施药行为
——基于广东省 13 市稻农的调研数据

李慧[1, 2, 3]，石玲玲[2]，陈风波[3]，章家恩[1]
（1. 华南农业大学 资源环境学院，广东 广州 510642；
2. 华南农业大学 公共管理学院，广东 广州 510642；
3. 华南农业大学 经济管理学院，广东 广州 510642）

摘要：绿色施药是农业生产绿色转型的重要组成部分，对我国的食品安全和生态安全有着重大影响。论文利用广东省13市1 106户稻农生产行为数据，通过对农户农药选择、农药施用、农药废弃物处置三个环节综合测量其绿色施药行为，运用有序Probit模型进行分析，发现：市场感知和农药认知对农户绿色施药行为均有显著影响，其中农药认知在感知优质优价影响农户绿色施药行为过程中发挥部分中介作用；农户感知优质优价对三个绿色施药环节的影响均显著，而农药认知对选择绿色农药和集中处置农药废弃物的影响显著，但对超标准量施用农药的影响不显著。因此，推动农户绿色施药应着力推动优质优价的农产品市场建设，同时进一步传播农药相关的知识和信息。
关键词：优质优价；市场感知；农药认知；农药施用；绿色生产

Market Perception, Pesticide Perception, and Application Behavior of Green Pesticides: Based on Survey Data of Rice Farmers in 13 Cities of Guangdong

LI Hui[1, 2, 3], SHI Lingling[2], CHEN Fengbo[3], ZHANG Jiaen[1]
(1. College of Nature Resources and Environment, South China Agriculture University, Guangzhou Guangdong 510642, China;
2. College of Public Administration, South China Agriculture University, Guangzhou Guangdong 510642, China;
3. College of Economics and Management, South China Agriculture University, Guangzhou Guangdong 510642, China)

Abstract: Green pesticide application is an important part of the green transformation of agricultural production in China, which has a significant impact of food safety and ecological security. By using 1 106 rice farmers' survey data in 13 cities of Guangdong Province, green pesticide application behaviors is measured by three links of pesticide choice, pesticide application, and properly pesticide waste disposal. Based on the analysis of Ordered Probit model, the study shows that both market perception and pesticide perception are significantly influencing factors to green pesticide behavior, which pesticide perception is a partial mediating effect of pesticide perception between market perception and green pesticide behavior; Farmers' perception of high quality high price has a significant influence on all the three green application links, while pesticide perception also has significantly impact on pesticide choice and properly pesticide waste disposal except on pesticide application. Therefore, in order to promote green pesticide application by farmers, it is necessary to build a high quality high price agriculture product market, and further publicize pesticide related knowledge and information.
Key words: high quality high price; market perception; pesticide perception; pesticide application; green production

2017 年，中共中央办公厅、国务院办公厅印发指导绿色发展的纲领性文件《关于创新体制机制推进农业绿色发展的意见》，明确指出要把农业绿色发展摆在生态文明建设全局的突出位置。2022 年中央一号文件再次提出要继续推进农业农村绿色发展，农业绿色发展既是“三农”自身发展倒逼下的客观要求[1]，也是人民日益增长的美好生活需要[2]。中国最基本的农情是“大国小农”，农业生产绿色转型成败的关键是农户的响应和执行[3]。

农药对农业生产有巨大贡献，但我国农户形成了大量、超量施用化学农药防治虫害的习惯[3-5]。农药在防控病虫害的同时，也对食品质量和生态平衡造成负面影响。农药一头连接生产保量，另一头连接市场保质。开

基金项目：国家社会科学基金一般项目“要素市场形成背景下农户行为可分性检验——对中国南方稻农跟踪数据研究”（20BGL183）；教育部人文社科青年项目“农业社会化服务改善我国小农发展空间的研究”（18YJC790079）；广东省现代农业产业技术体系创新团队建设项目（2021KJ105）；广东省哲学社会科学规划项目“农户绿色生产自我实现机制研究：基于合约匹配视角”（GD23CYJ07）
第一作者简介：李慧，博士研究生，讲师，研究方向为生态经济、农户行为、农产品运销。
通讯作者简介：章家恩，博士，教授，研究方向为生态、土壤。E-mail: jeanzh@scau.edu.cn

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展农户农药施用行为决策机理的研究，能够为农业转型升级提供政策建议，具有重要意义。

学者已对农户农药施用行为进行了丰富的讨论，提出和验证了各种影响因素，主要包括：第一，农户的个体特征、家庭特征、资源禀赋和经营特征[6-8]。第二，农户的认知和态度，如对农药的认知、对环境的认知、对市场的认知和对风险的态度等[1, 4, 6]。第三，农户的外部环境，如合作社[4]、社会化服务[9]、环境规制[2, 4, 6]、补贴政策[10]、市场价格[1, 4, 11]等。当前主流文献把农户的个人和家庭特征作为控制变量，较新的研究集中在发展较快的外部因素[4, 9, 12]及农户的认知对生产绿色转型的影响[5-6, 13]。此外，在我国消费升级的带动下，市场因素受到了更多的关注，王常伟等[4]发现销售价格是蔬菜种植农药施用量的重要影响因素；刘勇等[11]研究了稻农施药行为，结论是当稻米商品率低于75%时，农户规范施用农药随商品率提高而升高，而当稻米商品率突破75%时则相反。黄炎忠等[12]通过研究市场信任对稻农施药行为的影响，发现超过半数农民不信任市场，而市场信任对生物农药施用行为有显著的积极影响。综上所述，尽管当前该领域已有较好的研究基础，但仍有一些值得深入和拓展的方向：一是大量文献对农药施用行为的测量仅为施药单个环节；二是现有文献关于市场因素对农药施用行为影响机理的探讨尚不多见。

鉴于此，本研究借鉴麻丽平等[5]的研究，选取农药施用前、中、后三个环节对农户施药行为进行综合测量，具体包括农药的选择、农药的施用和农药废弃物的处置。在此基础上，本研究进一步引入“农药认知”变量，利用有序Probit模型探讨感知优质优价和农药认知对绿色施药行为的影响，并验证农药认知在感知优质优价影响农户绿色施药行为过程中的中介作用，以期对现有文献作有益的补充，为我国农业绿色转型相关政策的制定提供参考。

1 理论分析与研究假说

1.1 感知优质优价对农户绿色施药行为的影响

绿色施药行为具有典型的外部性，即绿色施药的成本和风险由农户承担，而由此带来环境改善的成果被他人分享，农户难以得到回报[14]。随着我国消费升级，市场对绿色食品的需求不断增加，绿色溢价能部分弥补外部性成本，激励农户绿色行为。舒尔茨指出，理性小农在特定情境下将调整资源，实现利益最大化。也就是，当农户感知到优质优价信号，将调整生产决策，通过提高产品质量以获取更高的收益。规范施用农药是食品安全的基础[5]，是绿色产品的基本要求。王常伟等[4]通过damage-abatement生产函数推导得出：若市场能够区分农药施用导致的产品差异，农药施用超量带来的产品价格下降越大，农户越倾向于少施用农药。基于此，本研究提出假设H1：感知优质优价正向影响农户绿色施药行为。

1.2 农药认知对农户绿色施药行为的影响

农药认知是农户对农药和农药施用结果的认知和识别[5]，是农药施用行为决策的基础。AJEN[15]提出的计划行为理论的核心观点为认知影响行为，因此分析个人决策行为应考虑认知因素。具体而言，农户对农药的认知是绿色施药行为的重要影响因素[5]。农户对农药有正确的认知，才可能开展绿色施药。基于此，本研究提出假设H2：农药认知正向影响农户绿色施药行为。

1.3 农药认知在感知优质优价影响农户绿色施药行为过程中的中介效应

当理性农户接收到优质优价信号，会产生开展绿色施药的意愿，同时还会产生提高农药认知的意愿。此外，对市场信号敏感的农户，通常具有更强的学习能力和信息获取能力。因此，感知到优质优价市场信号的农户，有意愿且有能力去提高农药认知。进一步，随着农户农药认知的提高，就更有能力开展绿色施药。基于此，本研究提出假设H3：感知优质优价能够激励农户提升农药认知，进而正向影响农户绿色施药行为。

2 数据来源与研究方法

2.1 数据来源

本研究所使用的数据来源于广东省水稻流通与产业经济岗位研究团队于2021年7—8月对广东省稻农生产行为的入户调查。大规模调研前，团队于5月开展预调研以确定调研村落名单，具体分布如下：汕头潮阳区、揭阳揭东区、阳江阳西县、茂名高州市和信宜市、湛江雷州市和遂溪县、云浮罗定市、梅州兴宁市和蕉岭县、清远连山县、韶关始兴县和南雄市、河源龙川县、惠州龙门县、肇庆高要区和怀集县、江门台山市和恩平市。调研覆盖广东省21个市级行政区中13个水稻种植面积较大的地市，抽样方式为：首先，根据水稻种植面积对广东省各个地级市进行排序，选取排名靠前的13个，然后，每个地级市选取1～2个水稻种植面积较大的县（县级市、区或县），再然后对每个县随机抽取2个行政村，再在每个村随机抽取30户农户为样本，最终完成1 124份问卷，其中有效问卷1 106份，样本有效率为98.40%。

2.2 研究方法

2.2.1 变量选择

（1）被解释变量的选取。借鉴麻丽平等[5]研究，把

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农户农药施用行为分为三个环节，包括施用前的“农药选择”、施用时的“按标准施用”和施用后的“废弃物处置”。问卷题项和赋值具体见表 1，可得出样本农户农药施用综合得分，具体分为四级，即 0 分、1 分、2 分、3 分。

表1 变量定义及描述性统计

变量类型	变量名称	定义与赋值说明	均值	标差
被解释变量	绿色施药行为	考虑施药前、施药中、施药后行为，三种行为赋值加总	1.94	0.84
	农药选择	是否有意选择低毒低残留的农药？ 1= 是，0= 否	0.67	0.47
	农药施用	按说明书标准，是否超标施用农药？ 1= 否，0= 是	0.74	0.44
	农药废弃物处置	是否集中处理农药包装？ 1= 是，0= 否	0.53	0.50
核心解释变量	市场感知	是否认为当前稻谷销售能体现优质优价？ 1= 是；2= 不确定；3= 否	1.73	0.82
中介变量	农药认知	除草剂的使用是否影响当地生态环境？ 1= 是；2= 不确定；3= 否	2.11	0.91
控制变量	性别	1= 男；2= 女	1.28	0.45
	年龄	周岁	59.42	9.57
	受教育程度	受教育年限 / 年	6.96	3.37
	健康状态	1= 好；2= 一般；3= 差	1.29	0.55
	市场距离	住处离集市的距离 / 千米	3.64	4.15
	水稻种植面积	2020 年种植水稻面积 / 亩	7.42	16.44

（2）核心解释变量的选取。通过问卷题项“您是否认为当前稻谷销售能体现优质优价？”测量农户的市场感知，若选项为“是”，赋值为 1；若选项为“不确定”，赋值为 2；若选项为“否”，赋值为 3。

（3）中介变量的选取。通过问卷题项“您认为除草剂的使用是否影响当地生态环境？”测量农户的农药认知，若选项为“是”，赋值为 1；若选项为“不确定”，赋值为 2；若选项为“否”，赋值为 3。

（4）控制变量的选取。借鉴现有文献，选取农户家庭特征、农业生产决策者个人特征、种植特征为控制变量。各变量定义及描述性统计分析详见表 1。

2.2.2 模型构建

为检验农户感知优质优价和农药认知对绿色施药行为的影响，农户农药施用行为（被解释变量）全过程三个环节的累计得分为“0，1，2，3”，是具有递进顺序的变量，适用有序 Probit 模型进行实证检验，函数形式如下：

$$y^*=\alpha+\beta_1 market+\beta_2 pesticide+\sum_{n=1}\beta_3 Dni+e \quad (1)$$

式中：y^* 表示被解释变量，*market* 表示感知优质优价，*pesticide* 表示农药认知，*Dni* 表示农户个人特征、家庭特征和耕作特征等控制变量；α 表示常数项，e 表示误差项，模型如下：

$$y^*=\begin{cases}0, \text{若} y^*<r_0\\ 1, \text{若} r_0<y^*<r_1\\ 2, \text{若} r_1<y^*<r_2\\ 3, \text{若} r_2<y^*\end{cases} \quad (2)$$

式中：r_0、r_1、r_2 为待估参数，表示农户绿色施药行为的未知分割点。

由于系数只反映变量的影响方向，而不能反映影响程度。本研究将进一步计算变量的边际效用，以考察变量的影响程度。

3 结果与分析

3.1 感知优质优价对农户绿色施药行为的差异分析

为探讨感知优质优价对农户绿色施药行为影响的差异，本研究对不同市场感知的绿色施药行为进行交叉项检验。表 2 显示，认同稻谷市场优质优价的农户中，71.63% 的农户有意选择低毒农药，77.30% 的农户施用农药量低于或等于农药说明书标准，56.91% 的农户集中处置农药包装。同样的行为在感知稻谷市场不是优质优价的农户中的比例分别是 66.29%，72.73% 和 48.86%。本研究运用 Stata12 对相关数据进行卡方检验，结果均在 1% 统计水平上显著。由此说明，感知优质优价对农户绿色施药行为存在统计意义的显著差异。

3.2 感知优质优价和农药认知对农户绿色施药行为的实证分析

为验证感知优质优价和农药认知对农户绿色施药行为的影响，本研究运用 Stata12 就农户感知优质优价对其绿色施药行为的影响进行有序 Probit 回归分析，具体结果参见表 3。在进行实证检验前，先对变量进行了多重共线性检验，各变量的方差膨胀因子（VIF）最大值为 1.46，最小值为 1.01，平均值为 1.16。所有变量 VIF 远小于 10，说明各变量间不存在严重的多重共线性。

感知优质优价对农户绿色施药行为的影响在 1% 统计水平上显著，表明感知优质优价能够促进农户绿色施

表2 不同市场感知农户绿色施药行为的差异分

变量名称	是否有意选择低毒农药				是否超标施用农药				是否集中处理农药包装			
	是		否		是		否		是		否	
	频数 / 人	百分比	频数 / 人	百分比	频数 / 人	百分比	频数 / 人	百分比	频数 / 人	百分比	频数 / 人	百分比
优质优价	404	71.63%	160	28.37%	128	22.70%	436	77.30%	321	56.91%	243	43.09%
不一定优质优价	166	59.71%	112	40.29%	90	32.37%	188	67.63%	140	50.36%	138	49.64%
不是优质优价	175	66.29%	89	33.71%	72	27.27%	192	72.73%	129	48.86%	135	51.14%
Person 检验 χ^2	6.996 1***				8.518 6***				1.1e+03***			

注：上角标 *、** 和 *** 分别表示 10%、5% 和 1% 的显著性水平。表 3 ～表 6 同。

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表3 感知优质优价对农户绿色施药行为的回归结果（*N*=1 106）

变量名称	系数	标准误	边际效应			
			Y=0	*Y*=1	*Y*=2	*Y*=3
市场感知	−0.131***	0.040	0.012	0.032	−0.001	−0.043
农药认知	−0.070*	0.036	0.006	0.017	−0.000	−0.023
性别	−0.740	0.080	0.007	0.018	−0.000	−0.024
年龄	−0.007*	0.004	0.001	0.002	−0.000	−0.002
受教育程度	0.029***	0.010	−0.003	−0.007	0.000	0.010
健康状态	−0.176***	0.061	0.016	0.043	−0.001	−0.058
距市场距离	−0.002	0.008	0.000	0.001	−0.000	−0.001
水稻种植面积	0.002	0.002	−0.000	−0.000	0.000	0.001
R^2	0.019 7					

药行为。究其原因，当下中国的市场经济发育较为充分，农户通过销售所生产的产品获得收入，通过感知市场价格行情变化来调整自己的生产行为。一方面，从市场激励的角度来看，绿色施药是绿色产品的关键指标，实施绿色施药能够提升产品价值，获得溢价。因此，当农户感知到优质优价后，会主动调整施药决策为绿色施药。另一方面，从市场规制的角度来看，农药残留超标的检测结果会阻碍产品销售，甚至带来罚款，负面经历或报道能够规范农户施药行为[16]。H1 得到验证。

农药认知对农户绿色施药行为的影响在 10% 统计水平上显著，表明更好的农药认知能够促进农户绿色施药行为。究其原因，农药认知是农户对农药本身及施用结果的理解和判断，农户对农药的正确认知是其选择绿色农药、不超量施用农药及正确处置农药包装的前提，是开展绿色农药施用行为的基础[5]。因此，当农户对农药有正确认知时，更可能开展绿色生产。H2 得到验证。

部分个人与家庭变量对农户绿色施药行为有显著影响。水稻生产决策者的年龄对绿色农药施用的影响在 10% 统计水平上显著。绿色生产是市场的新要求，年龄大的农户信息接收量相对少，对新信息的接受度相对低，更习惯于传统的生产方式，开展绿色施药行为可能性也就相对低。受教育程度对绿色施药行为的影响在 1% 统计水平上显著。当农户接受更多的教育，一方面能够较好地接收市场信息，从而更有意愿开展绿色生产；另一方面能够更准确地了解、理解农药的知识和使用方法，从而更有能力开展绿色施药。身体健康程度对绿色施药行为在 1% 统计水平上显著，健康程度越高的农户，越倾向于开展绿色施药。一方面，不当施用农药会对人体健康产生直接的负面影响；另一方面，健康人群普遍更注重食品质量、生产安全和环境保护，也更可能关注绿色生产，更倾向于绿色施药。

3.3 农药认知在感知优质优价对农户绿色施药行为影响过程中发挥中介作用

根据上述分析，当农户更多地感知到优质优价信号，会更倾向于开展绿色施药，但在行动上，开展绿色施药行为需要以正确的农药认知为前提。基于此，本研究采用有序 Probit 逐步回归检验“感知优质优价—农药认知—绿色农药施用行为”机制，具体结果如表 4 所示。三步检验的结果均通过统计学显著性检验，农药认知在“市场感知—绿色施药行为”过程中发挥部分中介作用，也就说明农户对农药认知的提升能够强化其感知优质优价对绿色农药施用行为的激励作用。H3 得到验证。

表4 农药认知在感知优质优价对农户绿色施药行为影响过程中的中介作用（*N*=1 106）

变量名称	第一步		第二步		第三步	
	被解释变量：绿色施药行为		被解释变量：农药认知		被解释变量：绿色施药行为	
	有序 Probit		有序 Probit		有序 Probit	
	系数	标准误	系数	标准误	系数	标准误
感知优质优价	−0.126***	0.040	−0.083*	0.043	−0.131***	0.040
农药认知	—	—	—	—	−0.070*	0.036
控制变量	已控制		已控制		已控制	
R^2	0.018 3		0.005 7		0.019 7	

3.4 稳健性检验

为检验实证结果的稳健性，本研究采用有序 Logit 估计感知优质优价和农药认知对农户绿色农药施用行为的影响。表 5 中有序 Logit 的检验结果与有序 Probit 的结果基本一致，农药认知对农户绿色施药行为影响的显著性水平从 10% 上升到 5%，说明分析结果是稳健的。

表5 有序Logit稳健性检验结果

变量	系数	标准误
市场感知	−0.225***	0.068
农药认知	−0.129**	0.061
控制变量	已控制	
R^2	0.019 2	

3.5 进一步分析

本研究测量农户绿色农药施用行为由农药选择、农药施用和废弃物处置三个部分组成。在不同环节，农户的绿色行为存在差异，感知优质优价和农药认知对其影响也存在差异。基于此，本研究采用 Probit 模型进一步分析感知优质优价和农药认知分别对绿色农药施用三个环节的影响，实证结果见表 6。

感知优质优价对绿色施药行为三个环节的影响都是显著的，其中对农药废弃物处置的影响在 5% 统计水平上显著，对农药选择和农药施用的影响均在 10% 统计水平上显著。这说明，当农户能够感知到市场是优质优价时，将会在施药各个环节开展绿色生产。

农药认知对绿色施药行为三个环节的影响显著性各异。其中，农药认知对农药选择在 1% 统计水平上显著，

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表6 感知优质优价和农药认知对农户不同绿色施药环节的回归分析结果（*N*=1 106）

变量名称	农药选择		农药施用		农药废弃物处置	
	Probit		Probit		Probit	
	系数	标准误	系数	标准误	系数	标准误
市场感知	−0.089*	0.049	−0.084*	0.050	−0.103**	0.047
农药认知	−0.122***	0.044	0.059	0.045	−0.081*	0.042
控制变量	已控制		已控制		已控制	
R^2	0.048 6		0.014 1		0.018 3	

说明农户对农药有更高的认知水平，更可能选择绿色农药。然而，农药认知对能否超过说明书标准施用农药的影响不显著，可能的原因是农户施用农药量更多是根据现场作物虫害情况，依靠经验施用农药，并有部分农户认为说明书的施用标准偏低。农药认知对农药废弃物处置的影响在 10% 统计水平上显著，说明农户对农药有更高的认知水平，将更可能妥善地处置农药废弃物。

4 讨论

以往的绿色施药行为研究更多关注农药减量 [4, 9] 和是否采用绿色农药 [12, 15]，本研究的贡献在于把绿色施药行为分解为施药前的农药选择、农药施用及施药后的农药废弃物处置三个环节，并进行量化测量，这能够更细致、全面地反映农户绿色施药行为。此外，本研究实证检验感知优质优价对农户绿色生产行为的积极影响，与预期相符，与王常伟等 [4] 通过 damage-abatement 模型推导的结果一致，再次证明感知优质优价对农户绿色施药行为具有显著的积极影响，此结论在我国消费升级的背景下具有重要的现实意义。本研究还实证了农药认知在感知优质优价影响绿色施药行为过程中发挥部分中介作用，与预期相符，与桑贤策等 [13] 的研究结论有相似之处，检验了农药认知对感知优质优价激励农户开展绿色施药行为的作用机制，进一步厘清农户绿色施药行为的决策机理，是对现有研究结果的有益补充。

5 结论与启示

本研究基于广东省 13 个市 1 106 户样本农户的调研数据，运用有序 Probit 模型探讨感知优质优价对农户绿色施药行为的影响，主要得到以下两点结论。

（1）感知优质优价和农药认知均为农户绿色施药行为的显著影响因素，其中农药认知在感知优质优价对农户绿色施药行为影响过程中发挥部分中介作用。年龄、教育年限和身体健康程度也对农户绿色施药行为有显著影响。

（2）感知优质优价显著影响绿色施药全部三个环节，而农药认知显著影响绿色施药三个环节中的农药选择和废弃物处置，但对农药施用本身的影响不显著。

基于上述结论，得到如下政策启示：第一，要把绿色施药作为核准绿色农产品的基础要求，并积极推动绿色农产品市场的发展，兑现绿色优价；第二，要把优质优价的信号传达到农户。第三，应进一步通过科技培训、科普宣传等多种途径，以各种形式让农户接触、了解农药的科学知识和施用的相关技术，提升农户对绿色施药的认知，从而使农户具有更强的绿色生产能力。

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生态经济

ECOLOGICAL ECONOMY

第39卷 12期 总第396期 2023年12月

全国中文核心期刊

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中国标准连续出版物号：
ISSN 1671-4407
CN 53-1193/F
微信号：shengtjj
邮发代号：64-54
定价：30.00元

ISSN 1002-4433

世界农业

WORLD AGRICULTURE

2011 12

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中国农业

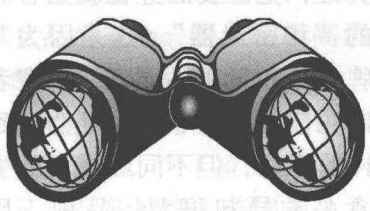
英国超市生鲜食品经营研究

李 慧 田金梅 张光辉

摘要：随着超市营业网点的增多和业务范围的扩大，超市日益成为中国居民日常消费品的主要购买场所，但生鲜食品的销售并未出现大幅增长。英国超市经营生鲜食品由来已久，在生鲜食品的管理和销售方面积累了相当成熟的经验。本文通过收集数据及实地考察，总结了英国超市生鲜食品经营的发展历程与现状，为中国超市扩大生鲜食品经营提供借鉴。

关键词：英国；超市；生鲜食品；经营

近年来，中国食品安全问题层出不穷，传统的农贸市场已不能满足消费者对食品安全的强烈诉求，而超市凭借一站式购物环境、丰富的商品种类、食品代加工服务等优势，吸引了越来越多的消费者将超市作为购买食品的首选场所[1-2]。生鲜食品的概念由外资超市引入中国，发达国家生鲜食品销售额一般占超市营业额的10%，但中国这一比例仅为1%[3]。除了传统消费习惯的影响外，超市生鲜食品经营乏力也是一个重要的原因。近几年中国政府采用补贴方式推动超市的生鲜食品经营，取得了一定的成效[4-5]。笔者在收集数据及实地考察的基础上，介绍了英国超市生鲜食品经营的发展历程，总结其生鲜食品的经营和管理经验，分析消费者的购买行为，并以Morrisons超市为典型案例进一步剖析英国超市生鲜食品经营的成功之道。



环球瞭望

一、英国超市生鲜食品经营的发展历程

英国超市经营生鲜食品已有超过50年历史，市场占有率和销售额不断增长，进入20世纪90年代，更是获得了绝对的市场优势。1969年，英国超市生鲜食品销售额占生鲜零售市场的比例仅为8%，经过20多年的发展，1995年这一比例达到72%，2005年更是达到90%以上（图1），几乎垄断了英国的生鲜食品市场，并一直保持至今[6]。市场份额的持续上升，与英国超市的不断扩张有着密切的关系。传统商铺1995年的食品零售市场份额不到1973年的1/3，而五大超市的市场占有率却从28.7%上升到了66.0%，各类超市约占英国食品零售市场份额的90%（表1）。传统商铺在食品市场逐渐被超市取代，过去主要从商铺购买生鲜食品的消费者

基金项目：国家社会科学基金项目（08BJY080）；广东省自然科学基金项目（10451064201005388）

作者简介：李慧（1982—），女，广东茂名人，硕士，讲师，从事农产品供应链管理与农产品营销研究

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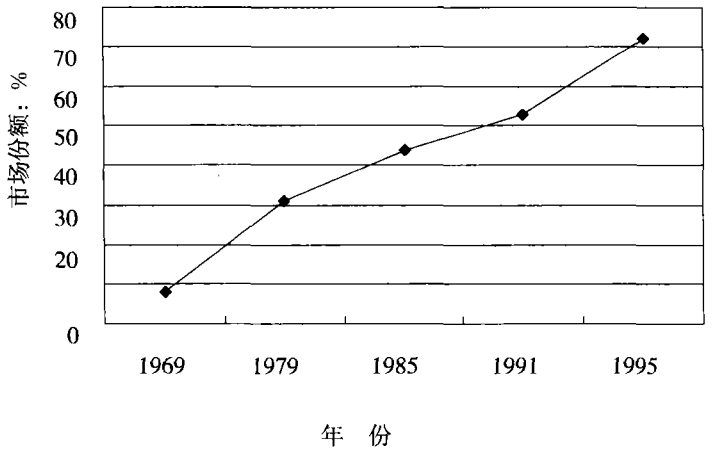

图 1　英国超市生鲜食品销售市场份额变化

数据来源：英国生鲜水果与蔬菜信息局（FFVIB），1996

表 1　英国不同类型食品零售商市场份额变化

单位：%

食品零售商	1973 年	1982 年	1987 年	1995 年
五大超市	28.7	46.4	52.7	66.0
其他超市	21.4	18.9	20.2	17.9
传统商铺	32.9	21.7	16.1	9.4
消费合作社	17.0	13.0	11.0	6.7

注：消费合作社是英国的商业营利组织，其零售业以超市形式实现

数据来源：Taylor Nelson AGB有限公司，2006

自然向超市转移，而超市的市场份额又逐步集中于英国最大的 5 家超市，市场垄断化程度日益加深。这一过程大致可以分为两个阶段。

1.竞争阶段（1970—1990） 20 世纪 70 年代，英国超市和传统商铺为争夺零售市场份额展开了激烈的竞争。超市以连锁经营为主要形式，依靠雄厚的经济实力不断增加分店数量，几乎在英国每一个社区都设立了便利超市。超市还不断丰富经营形式，衍生出大卖场、生鲜超市、折扣店、量贩店、会员店、便利店等类型多样、满足不同消费群体需要的小型超市。同时，随着经营实体不断扩大，规模效益的优势逐渐显现，超市通过与供应商签订合同，利用大批量采购获得折扣，确保超市商品“物美价廉”，这是分散经营的传统商铺无法做到的。通过丰富商品种类、增设分店、运用促销手段等方式，超市的市场份额不断提高[7]。起初超市主要销售日用品和食品，随着杂货店、水果铺、面包店等传统商铺的倒闭，超市将这些业务也纳入自己的经营范围，生鲜食品经营应运而生。这既是消费者追求便利的要求，也是超市实现扩张的手段。

2.垄断阶段（1990 至今） 20 世纪 90 年代初，超市已经建立起在食品零售市场的垄断地位，因此经营重点转向打造特色、保持优势。价格不再是主要的竞争手段，便利程度、店面环境和特色产品成为超市能否吸引消费者的关键，生鲜食品经营就是各超市的“秘密武器”。这是因为对品牌食品和日用品而言，消费者可以在任何一个零售商处购买到同样的产品，但不同经销商的生鲜食品差异却很大，品种、质量、包装都各有特色。经过超市加工的食品，如糕点、沙拉、半成熟制品等，都是消费者选择超

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市的重要依据，是超市的特色所在。生鲜食品为超市带来稳定的顾客，不仅能从生鲜食品销售中获得利润，还提高了超市的整体销售额。

二、英国超市生鲜食品的经营和管理

英国超市非常重视生鲜食品的经营，从销售品种、柜台布置、人员配置等多方面入手，力求使生鲜食品销售成为自身特色，并形成超市新的利润增长点。生鲜食品保质期短，损耗大，对温度、湿度、环境的要求较高，因此英国超市普遍开辟了专门的柜台陈列生鲜食品，这些柜台配置了特殊的控温设备，能根据食品种类、材质的不同调控温度，如热带水果的温度一般都设置为原产地的温度，而水产品柜台基本都铺了一层薄冰，从而延长生鲜食品的保鲜期。对于自行加工的食品，超市非常重视加工环境和操作人员的卫生状况，要求熟食加工区域必须保持干净、整洁，加工者必须持有健康证明，并且要严格遵守操作规范，加工设备也要定期消毒。为了使顾客对超市的加工食品更加放心，加工区通常设计为半开放式，顾客可以在操作间外看到整个加工过程，从而确保食品的安全、卫生，提高消费者的购买信心。

生鲜食品的新鲜度对销售有着重要影响，为了减少流通环节，保证产品新鲜度，英国超市不再依赖于传统的批发市场，实力雄厚的大型超市都建立了自己的配送中心，通过与农户直接签订订单，建立起从产地到超市的一站式采购系统。这种采购模式有利于超市监控产品质量，超市可以根据市场销售情况，自行制定生鲜食品特别是果蔬的采购标准，包括品种、大小、色泽、采摘时间等，执行严格的质量分级制度，实现生鲜食品供应的规格化、标准化。同时这种模式还能大幅降低物流成本，即使是必须经过供货商流转的冷冻食品，超市也尽量将供货商控制在2个以内，从而在价格上有更多的让利空间，提高产品的竞争力。

为了进一步加强生鲜食品的销售，2000年，所有英国超市都将生鲜食品柜台移到了入口处，柜台面积较20世纪80年代平均扩大了1倍[7]。生鲜食品柜台位置的移动对其销售额有很大的促进，研究显示，柜台位置移至入口处后，生鲜食品销售额增长了约50%。但这也要求超市销售人员具备管理大批量生鲜食品的经验和能力，超市大部分蔬菜水果在销售前都必须清洗，每天还有专门的管理人员对没有售出的生鲜食品进行检查，以避免产品出现变质、过期等问题。生鲜食品的包装也很有讲究，超市自有的食品包装简单，贴有统一的标签，其他生鲜食品分为散装自称、袋装全只和袋装切件3种规格[8]。不同包装的同类产品价格相差甚远，有的差价达到5倍，可以兼顾不同层次的消费者的需求。

随着电子商务的普及，英国大型超市纷纷开通网上购物系统，将产品放到虚拟的网络出售，生鲜食品也加入了网络销售的队伍。消费者可以在网上订购生鲜食品，超市将会在规定时间内送货上门。网络销售模式推动了小型特色食品超市的发展，这类超市主要经营一些高档、新鲜的天然食品和本地食品，生鲜食品的比例比大型超市高出很多。其中比较有名的Whole Foods Market，在伦敦有5个门店，主要以连锁形式经营。

三、英国超市生鲜食品的消费者

英国超市经历了与传统商铺的竞争阶段，超市生鲜食品的购买群体也发生了很大的变化。根据英国皇家出版局（HMSO）的调查报告（表2），过去超市的市场份额相对较低时，高收入者偏好到超市购买生鲜食品，特别是新鲜的水果、蔬菜，而低收入者则恰好相反，不仅很少到超市购物，而且几乎不购买超市的生鲜食品。

在超市与传统商铺竞争阶段，超市的蔬菜、水果、鲜肉和水产品等初级生鲜食品的价格优势并不明显，因此对低收入者吸引力有限，而超市良好的购物环境和生鲜食品质量是吸引高收入者的主要原因。低收入者通常没有私人交通工具，因此多在居住地附近购买食品[9]。传统商铺店面小，经营灵活，通常设立在社区，吸引了许多在社区居住的居民，特别是低收入者前来购买食品。购买习惯也对食品购买地点的选择有一定的影响，特别是年长者，对社区店铺有独特的感情，是传统商铺忠实的顾客。如今，超市在英国生鲜食品市

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表 2　1994—1995 年不同收入消费者在英国超市购买食品的比例

单位：%

	高收入者	低收入者	中等收入者	总　体
生鲜肉类	74	55	65	65
生鲜水果蔬菜	83	53	66	67
其他食品	79	62	70	70

场的占有率超过 90%，也就是说，收入水平的高低不再是影响消费者选择的决定性因素，绝大多数消费者都选择在超市购买生鲜食品。

四、英国最新鲜的超市——Morrisons

Morrisons 是英国第四大超市，成立于 1899 年，在全国有超过 360 家分店。Morrisons 最显著的特点是“新鲜”，其生鲜食品销售额占销售总额的 45%，除了大型超市都有的食品和杂货外，超过 270 家 Morrisons 设有咖啡厅，向消费者供应热食和点心。Morrisons 的生鲜食品能够成为特色，得益于其横向联合的供应链，对各个环节的统一管理与监督确保了食品的安全和新鲜。Morrisons 的供应链遍布全国，销售的所有新鲜水果和蔬菜都是从供应商处散装购买，运到自己的控温仓库或包装工厂进行包装，然后根据需求配送到各个店面或地区仓库。Morrisons 旗下的全资子公司 Farmers Boy，成立于 1980 年，是 Morrisons 的生鲜食品生产企业，负责生产比萨饼、熟肉、香肠、馅饼，以及奶酪和咸肉的包装。Morrisons还在布拉德福德（Bradford）拥有加工仓库，在塔里夫（Turriff）设立了肉制品加工厂，在韦克菲尔德（Wakefield）建立起配送中心，在荷兰也建有生鲜产品包装工厂。这些子公司构成了 Morrisons 强大的供应体系，使其能将生鲜食品作为长期的经营策略，在英国众多超市中脱颖而出。

五、小　结

从历史来看，英国超市是在与传统店铺争夺零售市场份额的过程中成长起来的，而生鲜食品经营的引入与扩大是这个过程后期战略性的一步。生鲜食品管理难度大，但利润高，能吸引新的顾客群体，因此扩大生鲜食品经营规模是超市进一步发展的必经阶段。超市的集中采购和自有品牌使生鲜食品的成本下降，其形式也日趋多样化，满足了不同层次的消费者的需求。传统生鲜食品店铺在竞争中逐渐处于劣势，市场份额不断减少。如今英国超市在生鲜食品销售中占有绝对优势，超市成为居民购买生鲜食品的最主要场所（Planet Retail）。

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作者单位：华南农业大学经济管理学院

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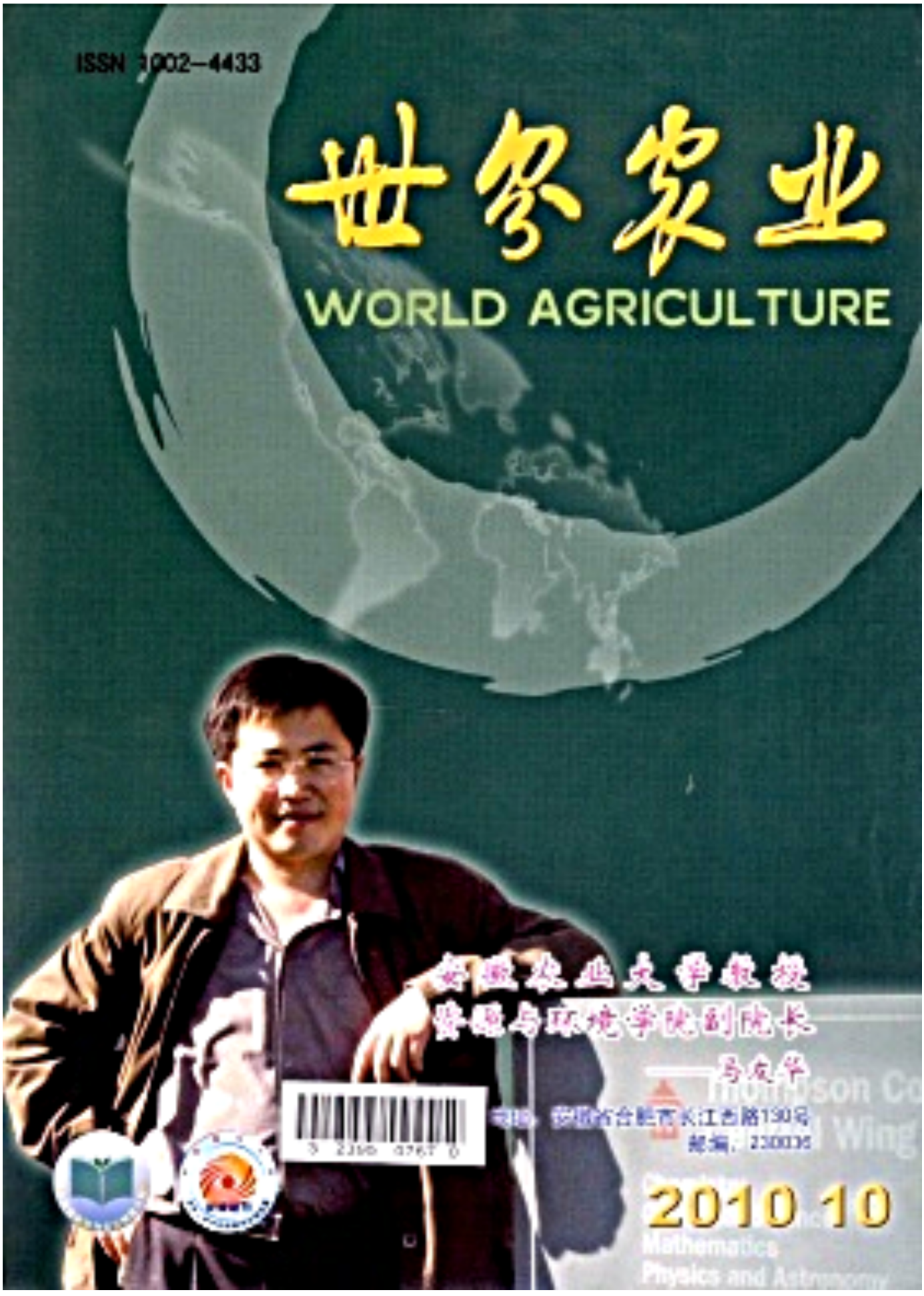
ISSN 1002-4433
世界农业
WORLD AGRICULTURE
安徽农业大学教授
资源与环境学院副院长
2010 10

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英国食品供应链管理特点及对中国的启示

李 慧 张光辉

摘要：在分析英国食品供应链发展背景和基本要素的基础上，展现供应链各环节相互关系，并通过中英两国食品供应链的对比，展望中国食品供应链的发展方向。

关键词：英国；食品供应链；特点；启示

英国是全球第六大经济体，食品供应链管理是英国农业发展的重要特征，代表着现代农业的发展趋势。笔者结合国内外文献及实地考察，对英国食品供应链管理特点进行简要介绍，以期为中国相关研究提供借鉴。

一、英国农业概况

英国国土面积 24.4 万 km^2，耕地面积占 1/4，典型的温带海洋性气候为农业生产带来丰沛降水。地势东南低西北高，东南部多为平原，土壤肥沃，是英国粮食主产区，北部多山区和丘陵，雨量充足，草木茂盛，主要发展畜牧业。英国统计局 2009 年资料显示，在 6 061 万全国总人口中，约有 32.11 万人从事农业相关活动，占全国受雇佣人口的 14.5%，直接从事农业生产的人口约为 5.41 万，占全国受雇佣人口的 2.4%。集约式生产和供应链式管理是英国农业的 2 个显著特点[1]。农业集约化表现为农场数目减少，个体规模扩大，农业机械化、专业化程度高。农业人均产值高，仅占 1%的农业人口提供了全国 60%的农产品。而供应链式管理主要依靠合约联结生产到消费的各个环节，是英国农业领域目前普遍采用的经营模式。

二、英国食品供应链分析

食品供应链是由农业、食品加工业和物流配送业等相关企业构成的食品生产与供应的系统，主要围绕食品生产、食品供应、食品物流、食品需求 4 个领域组织实施。食品供应链管理目标是根据最终消费者的要求，合理安排从原材料到产品生产、加工、销售及物流的整个过程。最终消费品在食品供应链中要经过生产者、加工厂和零售商 3 个主要环节，其中原料生产又可进行多重细分，在生产者和零售商之间可能还会经历多次的加工和物流过程。随着经济全球化、一体化的发展，政府给予农业的保护措施减少，市场竞争加剧，农业机械化程度进一步提高[2]以及消费者对食品质量的要求不断提升[3]，横向紧密联合的食品供应链管理成为现实的必然选择。其流程见图 1。

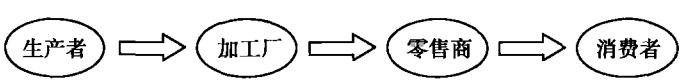

图1 食品供应链

1. 生产者：通过食品供应链获取信息和稳定收入 在英国，农场是农产品的主要生产者，合约生产则是基本的生产方式。通过签订固定合约，农场主能够准确获取市场供求信息、取得技术支持，收入也相对稳定，使得农业生产处于有序运行状态。但这种高度集中的生产方式容易导致产品单一化，面向顾客

基金项目：国家社会科学基金项目(08BJY080)；广东省普通高等人文社科重点研究基地重大项目(07JDXM63001)

作者简介：李慧(1982—)，女，硕士，讲师，研究方向：农产品供应链管理与农产品营销

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群体狭小，且产品偏离市场真实价格，从而导致生产者在市场竞争中处于不利地位。而一些生产能力超过合约规定限度的农场，则有可能跳出既定的食品供应链，独立向市场销售产品，从而获得更多的顾客和更丰厚的收入。

2. 加工厂：通过食品供应链增加产品附加值　合约生产包括加工企业和上游生产者及下游零售商的合约。通过合约将食品供应链中的各个企业联系起来，大大降低了交易成本，减轻了生产者的风险，并使销售计划具有可调节性。食品加工通常包括初级产品加工和包装加工，加工厂在食品供应链中主要起联结作用，有时还承担食品分类和配送的任务，包括订单管理、配送计划和运作等。总的来说，英国的食品加工厂通常与零售商联合，对初级农产品进行深加工以增加其附加值，同时进行简单的食品分类和配送，加快产品的流通速度。

3. 零售商：通过食品供应链降低成本　英国食品市场供应充足，行业中心由生产者向消费者转移，最接近消费者的零售商的地位也因此提高。超市向上联结着众多农场和加工厂，为了跟踪食品质量与安全，大型超市设立了统一的食品标准和证书，如欧盟良好农业操作规范(EUREP-GAP)。这是几个大型欧洲食品零售商设立的关于食品安全和环境保护的标准，旨在减少农药的使用，以降低对环境的污染，并指导食品生产、加工企业进行技术和管理革新。超市向下联系最终消费者，通过对产品销售情况和顾客购买行为的分析，超市能清楚地获知消费者的偏好，以便对产品结构作出调整。同类产品在销量上的差异，体现出消费者对不同供应商的选择，为超市挑选长期合作的供应商提供参考。消费者的需求是食品供应链发展的重要目标和推动力，因此英国超市普遍重视消费者信息的收集。

大部分英国家庭都在超市中购买食品，以特易购(TESCO)为首的5大超市的零售额占英国日用品销售总额的70%，其中食品的比重相当大。超市巨大的市场份额决定了其在食品供应链中的领导地位，从而可以对上游企业提出诸如价格优惠、附加服务等要求，甚至将部分上游企业纳入旗下，减少中转环节以进一步降低成本，同时，超市注重将消费者购买信息反馈至食品生产者和加工者，从而提供适量的、符合消费者需求的产品。超市在食品销售方面的垄断地位日益凸现，而食品生产者和加工者在市场中逐渐处于从属地位[4]。

4. 消费者：通过食品供应链保证食品安全　近几年频繁发生的食品安全事故引起社会恐慌，政府、企业、消费者都高度重视食品安全。消费者期望获得安全、高质、营养、新鲜的食品，要求实行“从农场到餐桌”的食品安全监管体系，即可以沿着供应链追溯到最初生产者，从食品供应的各个环节进行安全监控[4]。消费者对食品安全的重视，是催生食品供应链管理的重要因素，整个食品供应链都紧紧围绕如何满足消费者需求而展开。同时，最终消费者对产品的喜好和选择，促使食品供应链其他环节作出相应的改进。

高效的食品供应链管理包括6大基本因素，即生产规模、战略合作、生产灵活性、供应连续性、质量管理和供应链内部沟通[5]。英国农业集约式的生产方式促进了农业规模化、产业化发展，合约生产成为食品生产者、加工者、零售商合作的基础。由于食品供应链环节众多，充满复杂性，信息流通就显得格外重要[5]。消费者的偏好将食品供应链的各个环节联结起来，而各环节之间的联合程度以及信息的交流是供应链成败的关键。在英国的食品供应链中，大型超市正是掌握了生产者的产品信息和消费者的购买信息，同时将这些信息资源准确而迅速地传递，从而确立了在供应链中的领导地位。与此相反，为数众多的中小型农场和加工厂则处于弱势地位。大型超市以低于平均市场价4%的价格进货，这部分差额多由农场负担。而多数情况下，“食品出货后再定价”成为超市下订单的前提，从而将经营风险转移到农场和加工厂。而上文提到的EUREP-GAP标准，所有费用几乎都由生产者承担，而且检验费用对不同规模的企业是一致的，加重了中小型农场的负担。

为改变英国食品供应链的不合理结构，Berdegue曾于2001年提出“小农场经济组织”方案[6]，即在供应链中处于弱势地位的生产者组成合作组织，使组织内部实现更高程度的专业化，形成规模效益；通过联合提高组织的议价空间，在与超市的抗衡中获得合理的产品收益，并在不同的供应链中实现有效的计划调配。

三、英国食品供应链对中国的启示

英国食品供应链的发展无疑领

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先于中国,其经验值得借鉴。通过对两国食品供应链各个环节的对比,从中探寻中国食品供应链的现状及不足,并展望未来的发展方向。

1. 生产 英国农场机械化程度高,农场规模较大,虽然直接从事农业生产的总人数不多,但生产水平高,人均产量居世界前列。而中国农业生产集约化程度低,绝大部分农户处于零散状态,食品供应链上的各个要素缺乏联合。因此应加快农业产业化进程,扶持优势企业做大做强,形成一批有影响力的龙头企业,再通过"龙头企业+农户"的方式,充分发挥龙头企业在资金、技术、管理方面的优势,组织农户集中、定向生产,实现农户与市场的对接[7]。

2. 加工 英国食品加工厂与上下游企业以合约的方式联系紧密,使产品、信息在供应链中连续地、灵活地流动,在增加产品附加值、优化储存和配送方面发挥了重要的作用。而中国多数食品加工厂仍为手工作坊,相对独立运行,在经营中不断地寻找合作企业,没有固定的合作对象,并且仅对农业产品进行初步加工,缺少对产品的深度开发,产品增值有限。对此国家应出台相关政策,鼓励在食品原料产地建立食品加工企业,引进国外先进装备和技术,对初级产品进行多方面的开发,以促进农民增收,并提高中国食品加工行业的整体竞争力。

3. 销售 20世纪80年代,英国超市开始改变传统的零售方式,如今已在食品零售业中占有绝对的优势。超市作为英国食品供应链的领导者,协调供应链的各个环节,将产品信息传递给消费者,又将消费者信息传递给生产者和加工者,并制定相关标准以减低成本和经营风险。目前中国并未推行合约生产方式,农户与市场脱节,既不能及时获取市场信息以调整种植品种,农作物收获后又面临销路不畅的困境,"增产不增收"降低了农户的生产积极性。随着城市化进程加快,超市在中国发展迅速,在食品零售中的市场份额越来越大。但在人口众多的农村,农户将产品在集市上直接出售的情况仍比较常见,缺乏统一的采购和调度。在这方面,应借鉴英国的经验,大力发展以超市为主导的食品供应链模式,由超市统一采购、配送降低运输成本,并通过消费者的购买行为促进农业企业的优胜劣汰。同时,政府应大力促进农业企业与农户的合作,出台优惠政策鼓励有实力的企业与农户签订生产合同,解决农户的销售难问题。

4. 售后 由于英国在食品供应链中实现了严格的追溯制度,一旦发生食品质量问题,消费者可以根据产品的条形码找到各个环节的生产者,进而追究相关企业的责任。近年来,中国食品质量事故频发,但消费者往往处于被动的局面,很难获得产品的详细信息,追究违规企业的责任也是困难重重。究其原因,一是中国现行的食品安全标准混乱,国家标准、地方标准、行业标准存在交叉和矛盾,且普遍低于西方发达国家的标准[8];二是监管不到位,目前食品质量问题由多个部门并行管理,主体不明确造成职责不清,部门之间缺乏协调和联动,且处罚力度较轻,难以对违法企业形成威慑。因此,应尽快建立食品供应可追溯系统,敦促相关企业严格遵守,考虑到实施该系统会增加企业的生产成本,政府可提供一定的资金补贴;同时对现有食品监管部门进行合并,或建立独立的监管机构,按照责权一致的原则对食品安全进行全程监管。

作者单位:华南农业大学

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ISSN 1004-874X
CN 44-1267/S

广东农业科学

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ISSN 1004-874X

广东省农业科学院
华南农业大学

2009 6
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广东花卉拍卖实施回顾及启示

李 慧，彭思喜
（华南农业大学经济管理学院，广东 广州 510642）

摘 要：分析了广东花卉产业流通现状，及与先进的花卉拍卖制度的矛盾，得出广东现有两个大型花卉拍卖中心难以运行的原因。通过分析广州缤纷盆花拍卖实施的成功案例，并根据花卉拍卖实施条件分析广州缤纷盆花拍卖的具体实施状况，由此得出广东花卉拍卖流通方式的实施应该是从低到高不断完善的过程，要特别注意与本地市场状况相适应。

关键词：花卉；拍卖交易；本地市场
中图分类号：F724.59 文献标识码：A 文章编号：1004-874X(2009)06-0285-03

花卉产业被称为朝阳产业，全球生产量和消费量多年来都以高于全球经济增长速度增长，而主要的增长贡献来自于发展中国家。从 2008 年 3 月举行的全国花卉产业发展情况交流会获悉，截止 2007 年底，中国花卉种植面积超过 57.3 万 hm^2，2007 年产值近 480 亿元，种植面积及产量均居世界第一。随着我国经济的持续增长，人们生活水平的提高，花卉消费增长明显。

1 广东花卉产业流通现状

广东是中国花卉主要生产基地，在种养花卉习惯和经济发展双重因素下，本地消费旺盛。广州芳村历史以来就是珠江三角洲花卉产品的集散地，改革开放后成为中国花卉进出口的窗口，拥有广州花卉博览园、岭南花卉批发市场及一批各种形式的花卉批发贸易企业，花卉集散地的地位更加明确。

广东本地生产量最大的是盆花，辐射全国，乃至全球，销售量逐年递增，流通总量巨大，但其流通方式仍是传统的对手交易，交易成本较高，影响流通效率；供求信息不透明，价格变动剧烈，容易导致市场混乱。政府及部分龙头企业都意识到流通问题是广东花卉产业发展的瓶颈，也是未来进一步大发展的机遇所在，焦点聚集到先进的花卉流通模式——拍卖。

拍卖项目投资购买了当前世界最先进的花卉拍卖设备，希望提高花卉交易效率，推动产业发展。但是，无论是广州市政府投资在芳村广州花博园的广州花卉拍卖中心，还是陈村花卉世界有限公司投资在顺德陈村花卉世界的广东顺德陈村花卉拍卖中心，都遇到越来越少采购商到中心竞拍的情况，花卉产品供应协议也就无法维持，导致巨额投资的拍卖中心只在年宵花或展销会时偶尔拍卖新特花卉，拍卖中心没有发挥预期的作用。

2 广东花卉产业与先进拍卖模式的矛盾

广东两个花卉拍卖中心的拍卖设备是世界最先进的，拍卖模式本身无论是在传统花卉生产国家（如荷兰），还是在新兴花卉生产国家（如韩国）都行之有效，为什么不能在广东这个有着巨大流通量的花卉集散地运行呢。花卉拍卖模式的实施所需要的主要条件包括：（1）有一定的花卉供销规模；（2）花卉产品标准化；（3）花卉拍卖所需要的专用设施。以下分析拍卖模式运行的条件与广东花卉产业流通现状的矛盾。

广东是中国花卉的生产和销售地，总体供销规模不成为拍卖运行的障碍。这是花卉拍卖模式生产的基础，但是，中国绝大多数花卉生产者生产规模小，实力弱，一方面不愿意承担进入拍卖市场所需的销售上的附加成本，另一方面技术能力弱，难以实施质量控制，产品达不到拍卖市场在质量上的统一要求。

销售渠道方面，虽然广东市场的销售总量大，但销售地域分布广泛，而地区平均或人均的消费仍然很低。此外，信息的不透明导致市场的不稳定，与之相适应的是小企业、小批量、高频率的采购。批发采购商甚至到田头采购，把单次采购成本减到最低，这迫使大的生产商也进行零散销售。

广东花卉供销的总量可达到拍卖模式需求的要求，但零散的个体生产及与之相适应的零散采购，与拍卖模式要求的大生产、大流通不相符合。而在零散

收稿日期：2009-02-13
基金项目：华南农业大学校长基金项目“拍卖模式在花卉产业的应用——广州花博园花卉拍卖市场可行性的理论与实证研究”（2007S002）
作者简介：李慧（1982-），女，硕士，讲师，E-mail:smarthuili@scau.edu.cn

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的、高频的交易中，花卉产品质量控制非常困难，标准化难以实现，而这又是花卉实行拍卖的基本条件。虽然广东拥有花卉拍卖先进的专用设备，但没有符合以上两个条件，花卉拍卖难以实施。

3 广州缤纷公司的拍卖模式

广东花卉产业的蓬勃发展，引发了两个拍卖中心的启动，但都没有能正常运行。而缤纷园艺有限公司下属的广州缤纷盆花卖场（以下简称广缤）内部却有一个成功的拍卖市场，1 周拍卖 6 d，自 2006 年 9 月开拍以来，从没有断市。

3.1 缤纷公司现状

缤纷园艺有限公司 1979 年成立于中国香港，1985 年在中国大陆成立独资企业，根据不同气候特点在广东、云南、海南、福建建立生产基地，共有 30 多个项目场、4 个卖场，其中广缤以“缤纷盆栽”为品牌的盆花卖场，每年销售来自各个项目场的超过 2 000 万盆盆花，供应整个中国市场。广缤采用“限时，限量，公开，售完”的拍卖定价机制，以优质的产品，稳定的供货，完善的服务，形成高效的流转。

3.2 广缤拍卖具体实施流程

花卉拍卖一般使用“减价拍卖法”（荷兰式拍卖），其竞价过程是下浮的；广缤的花卉拍卖以“低估价拍卖”，即“竞价上行”，更符合大家对拍卖的习惯认识。

每天晚上 19：30 后，缤纷公司自有的汽车按预定的周计划把盆花从项目场运到广缤，晚上到场的主要原因是避开入城的交通高峰。每车盆花到货后，立即进行统计清点；由质量检查部门根据《缤纷盆栽等级标准》确定产品等级，贴标签；然后理货，上拍卖货架车，等待第 2 天早晨的拍卖。次日上午 8：00 整，广缤的盆花采购商凭会员卡取得拍卖号胶版及当天拍卖盆花的顺序清单，进场自由查看待拍的盆花。8：30 拍卖正式开始，由一名工作人员推出整齐装满盆花的货架车，另一名工作人员以麦克风主持拍卖，清晰宣布所展示盆花的名称，品种、数量、规格、质量、底价及每次出价上浮幅度，采购商根据产品及各自需求进行应拍，直到无人出更高的价格，主持人宣布成交，再次清楚宣布成交价格，推货架车的工作人员当即在货架的标签记上产品竞得者编号，竞得的价格；与此同时，在拍卖场边上的另一名工作人员在联网的电脑上即时输入相关信息。推货架车的工作人员把已成交的盆花推到拍卖场后端，竞得货品会员的相应卡位，等候包装运输。主持人以相同的程序，对下一批盆花进行拍卖。如果盆花无人应价，将以起拍价在卖场货架出售。

广缤经过多年对拍卖模式的思考，对国外，特别是荷兰拍卖体系的研究学习，经过 2 个月的试运行，2006 年 9 月广缤拍卖正式实施，又经过近 1 年的实践探索，对拍卖品种调整，拍卖数量调整，会员制度调整，拍卖底价设置的调整，切实地努力适应本地市场的实际情况，拍卖模式才逐渐固定下来。从另一个角度说，广缤现行的拍卖模式是与广东的盆花市场情况相适应的。

3.3 广缤拍卖实施条件

3.3.1 花卉拍卖需要的产销规模 花卉拍卖实施的条件除了一定的交易规模外，日本专家指出“只有当花卉生产十分集中，并且产销距离较大，建立花卉拍卖市场才有必要，也才有维持生存和发展的可能。”也就是说，花卉拍卖应设立在集中的花卉生产地，以最大限度减少花卉产品的物理和生物耗损，并保证市场的充足供应量。产销距离较大，指的是拍卖市场有较大的销售半径，以保证拍卖的需求量，拍卖市场的承销商应该是掌握一定市场份额的一级批发商。

由于广缤的货源绝大多数是来自自有的生产基地，在花卉供应的数量和质量上都有很好的控制力。全国 30 多个项目场和 4 个卖场的所有数据都由表格通过网络每天归总，详细的供货计划提早 7 d 完成，并分发各分公司，成品由公司车辆统一按计划调配。缤纷是由市场情况决定销售计划，反推生产计划，因此在无意外的情况下，货物供应是有保证的。同时，由于生产和销售都是预先的计划，成本控制成为可能，运输工具及仓储使用可以达到最优。

广缤的采购商遍布全国，西至陕西西安，北至辽宁大连都有广缤的长期会员，经常到拍卖现场竞拍。这些会员大多是地区的一级批发商，要货量是地区需求量总量，出于远距离运输成本的考虑，会批量入货，也只有实力强的批发商才能承受远距离亲自采购，到广州的广缤实地看货拍卖，而这又保证了广缤的定单总量及每票的定单量。

总体言之，缤纷作为全国最大的盆花生产商，能保证广缤拍卖的产品货源，统一的生产销售计划是拍卖货源的保证。广缤的销售半径达全中国，大量有实力的一级批发商保证了广缤的销售量，符合拍卖模式的要求。

3.3.2 花卉拍卖需要的标准化产品 花卉拍卖实施的条件需要比一般农产品要求更高的标准化。花卉产品是鲜活品，且品种多，质量评定困难，其标准化

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需要细致,详尽的条例规定及严格的执行。

缤纷有限公司在拍卖市场启动前两年,2004 年就着手《缤纷盆栽等级标准》的制定,这是在多年盆花培植生产经验的基础上编写的,每个品种都经历"小试–中试–生产–批量生产"的过程,跟踪记录生长情况,在批量生产前,确定此品种的等级标准,包括株高、杆粗、叶片数、花头尺寸、颜色等。每个品种有不同要求,如叶片数,多于或小于其标准叶片数都被评定为不合格,要求每一批花的整齐度。

每个盆花品种等级标准确定的时间长度是根据品种实验的状况而定,时间短(如仙人掌)的一两年,而时间长的达到 7 年(如蟹爪兰)。对于单个品种,等级标准确定后,每年仍然会根据生产情况做微调,而这些调整会越来越少,直至标准基本固定。总的来说,广缤每年都有新品种的等级标准加入到《缤纷盆栽等级标准》中,现已确立了超过 900 个品种的等级标准。不断的充实和调整使《缤纷盆栽等级标准》更完善,更科学,更精确。

采购商对广缤的产品质量是认可的,虽然他们不一定清楚《缤纷盆栽等级标准》的具体内容,但他们认可由此标准鉴定出来的盆花,一方面,明确不同的等级会有不同的标价,另一方面,采购商对产品质量提出质疑时,随时可以到广缤的质检部门,通过与《缤纷盆栽等级标准》的对照去解决问题。

总体言之,《缤纷盆栽等级标准》的制定是从基地实验,基地生产而来,其实施由广缤质检部检验,由采购商监督,整个过程得以在缤纷的体系内贯彻实施,保证了盆花的质量和标准度,这也是拍卖模式实施的基础。

3.3.3 花卉拍卖需要的专用设施及配套服务 花卉拍卖实施的条件需要特殊的软硬件设备。拍卖市场必须提供与交易直接相关的一系列服务,包括产品分类、分级、质检、包装、储藏、运输、结算等,一般还提供供求信息。

广缤的拍卖是在研究荷兰拍卖的基础上实施的,同时又充分考虑本地市场的实际情况,没有如其他的花卉拍卖项目,把大量资金投放在拍卖专用设备上(一口荷兰的拍卖钟就是几百万人民币的投资,仅相配套的软件又是上百万元)。

广缤学习荷兰拍卖的手推拍卖货架车,自行定制的货架车经过简易的架板装拆就可以批量装载不同高度的盆花,其 360 度旋转的车轮一个人就可轻松向任意方向推动,展示待拍的产品,在非拍卖时间作为盆花场内搬运工具灵活方便。

广缤用最传统的,易于理解接受的升价人工喊叫拍卖法,培训企业内部员工作为拍卖主持人进行拍卖,额外成本非常低,也便于员工及竞拍者理解和接受。

广缤做好拍卖前后的配套服务,包括质检部门负责的拍卖前的盆花分类、分级,严格根据《缤纷盆栽等级标准》完成;而拍卖后的结算、包装、储藏、运输是由专门的员工团队负责,是业内公认做得最好的。

广缤的信息系统与生产基地、总部、银行等相关单位以互联网对接,所有花卉从生产到销售都是在数据计划控制下完成。盆花进入广缤时,质检部门通过计算机确认数量和质量,拍卖现场通过计算机确认最新的拍卖价格及销售量,财务通过计算机开单结算,办公室通过计算机的综合数据进行总体生产销售计划。采购商可以从会员部的信息栏获取最近一周详细的到货信息,某产品的需求状况可以从拍卖价格的变化中反映,以上信息还可以在网上随时查询。另外,广缤接受电话,传真,电子邮件的查询及定货,并开始尝试网上拍卖。所有信息,场内即时共享,网上及时更新,准确清晰。

广缤提供规格化的包装服务,免费提供瓦楞纸箱及相关的稳固配件,提高运输货物安全性。广缤的包装部有 40 多名员工,瓦楞纸箱就有 30 多个规格。气温高的时候,打透气孔,加冰袋;气温低的时候,如发往长江以北的盆花,在纸箱内外加两层的毛毯。广缤根据花卉品种,发货目的地进行专业包装,力求货损率最小化。

广缤根据需求,帮助自行取货的采购商装车,或发货到指定地点,或直接联系快递公司发货。

总体言之,广缤为采购商提供符合本地实际需要的服务,通过各种措施,保证盆花的质量,交易信息的畅通,及包装的安全,也由此保证了拍卖的效率。

3.4 广缤拍卖的效用

总的来说,广缤的拍卖是简单的现场展示,叫喊式拍卖,是拍卖的初级阶段。其中,广缤适度充分地运用了计算机跟踪、分享信息,灵活的手推货架车,明确的《缤纷盆栽等级标准》,顾客满意的包装物流服务。

广缤拍卖的实施,首先把采购商在同一时间聚集于拍卖场,价格确定的效率来自于规模效应,此明显优于对手议价,所以广缤明文规定"拍卖定价,不设议价";而这种公开市场竞争的方式获取的市场价格,是相对公平的,反映市场需求的,把拍卖的价格

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百色市右江河谷地区香蕉产业特色及发展措施

梁家铭，罗炫兆
（广西百色农业学校，广西 百色 533000）

摘 要：从种植历史、生产环境、土地资源、品种及栽培技术、风味和商品品质、产业规模及产业体系等方面对右江河谷地区香蕉产业特色进行论述，并从政府的规划引导、建设香蕉产业发展基础，新品种新技术推广、提高右江香蕉品质，重抓品牌建设、提高香蕉种植效益及强化政府服务引导、营造香蕉产业发展的良好环境等对百色市右江河谷各县区大力发展香蕉产业并使之成为右江河谷地区的一项特色产业的经验和措施进行了总结。

关键词：右江河谷地区；香蕉；产业特色；措施；
中图分类号：F326.13 文献标识码：A 文章编号：1004-874X(2009)06-0288-04

香蕉是热带、亚热带地区的重要水果，四季常青，周年开花结果，在国内外市场上是常年供应的鲜果，是人们喜爱的热带果品之一。香蕉具有速生快长、投产早、产量高、供应期长、效益好等优点，是农民进行产业结构调整、脱贫致富的好项目。经论证百色市右江河谷地区的气候、土地等条件十分适宜香蕉的发展，随着农业产业化的调整，以及国家西部大开发的热潮，围绕增加农民收入这个主题，百色市把发展香蕉生产作为调整产业结构来抓，并取得了初步成效，增加了农民收入，同时也积累了许多宝贵的经验，形成了产业特色。通过到右江河谷地区各县（区）香蕉生产情况进行调查，对右江河谷发展香蕉生产的产业特色和优势进行分析，对右江河谷地区香蕉产业的发展措施和经验进行总结，以期为百色市发展香蕉生产提供可持续发展的依据和建议。

收稿日期：2009-02-26

作者简介：梁家铭（1968-），男，讲师，E-mail:lzx_681@126.com

1 右江河谷地区香蕉产业特色

1.1 种植历史悠久

百色市右江河谷地区包括现右江流域河谷的百色

推广为批发价格的基准，使广缤整体价格体现公平，高效。

其次，拍卖除在短时间内确定价格外，还确认了交易，减少流通交易所耗费的时间，使产品在下游有更高的消费价值，销售价格也就更高。加上信息和包装等服务的配合，对比传统的田头交易，批发档口交易高效而低损。

再次，拍卖以市场的规则，出价高者得货品，公平公正，解决了争夺热门货物的问题，广缤获得了合理收入的同时，采购商认同分配规则的合理，不发生争端。

另外，拍卖模式的施行反过来推动缤纷从生产基地到卖场的产品质量把关。《缤纷盆栽等级标准》的制定到严格执行，推动着整个体系的产品质量，包装质量，服务质量的提高，计划能力，控制能力的提高，标准化程度的提高。

4 对广东花卉拍卖的启示

广东是中国花卉生产的重要产区，凭借着广东优越的地理自然气候，发达的经济实力，廉价的劳动力，花卉产业生产潜力还很大；完善的交通运输能力，全国不断增长的花卉产品需求，广东花卉产业发展潜力也很大。现在，广东花卉产业的瓶颈是销售流通环节，如何加快花卉产品流转，提高流通效率是广东花卉产业发展的关键。

拍卖是国际上行之有效的花卉快速流通模式，但这需要符合相应的实施条件，要与当地的产业发展，市场需求相适应。广东顺德陈村花卉拍卖中心和广州花卉拍卖中心都因广东的市场没有达到相应的条件而不能实施。而广缤拍卖的成功实施是给广东花卉产业，乃至中国花卉产业提供了成功范例。同时，进一步明确了在广东实施花卉拍卖模式所需要的条件及可实施的具体流程。

总之，花卉拍卖是解决花卉流通瓶颈的方法之一，是广东花卉产业发展的未来方向。但通过照搬先进设备是难以成功实施的，而应是不断完善，从低到高发展的过程，是与生产供给和市场需求相配合的过程，应当充分考虑广东市场条件和实际状况。

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广东农业科学

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广东农业科学
月刊　1965 年创刊
2024 年 1 月　第 51 卷 第 1 期

GUANGDONG AGRICULTURAL SCIENCES
Monthly, Started in 1965
Vol. 51 No. 1 Jan. 2024

主　管	Responsible Unit	Guangdong Academy of Agricultural Sciences
主　办	Sponsor Unit	Guangdong Academy of Agricultural Sciences South China Agricultural University
主　编	Chief Editor	LU Huazhong
编辑出版	Edited and Published by	Editorial Department of Guangdong Agricultural Sciences
地　址	Address	In Guangdong Academy of Agricultural Sciences, Wushan, Guangzhou, China (510640)
电　话	Telephone	+86 20 3831 9946，3831 9948，3831 9942
电子信箱	E-mail	gdnykx@vip.163.com
网　址	Website	http://gdnykx.cnjournals.org/ch/index.aspx
印　刷	Printed by	Guangzhou Caiyuan Color Printing Co., Ltd.
总 发 行	Domestic Distributor	Guangdong Newspapers and Periodicals Distribution Office
订 阅 处	Subscription	Domestic Post Office

ISSN 1004-874X
CN 44-1267/S

国内外公开发行
邮发代号：46-43
定　价：30.00 元

ISSN 1004-874X

https://doi.org/10.17221/331/2023-AGRICECON

Understanding cross-cultural chicken consumers' behaviour

Fallah Samuel Kassoh[1,2], Baichen Jiang[1], Achara Boonkong[1], Hui Li[1,3,4]*, Abdelrahman Ali[1,5], Tanapon Srisukwatanachai[1]*

[1]College of Economics and Management, South China Agricultural University, Guangzhou, P. R. China
[2]Sierra Leone Agricultural Research Institute, Freetown, Sierra Leone
[3]College of Public Administration, South China Agricultural University, Guangzhou, P. R. China
[4]College of Nature Resources and Environment, South China Agricultural University, Guangzhou, P. R. China
[5]Department of Agricultural Economics, Faculty of Agricultural, Fayoum University, Fayoum, Egypt

**Corresponding author: baichen_jiang@126.com; smarthuili@scau.edu.cn*

Citation: Kassoh F.S., Jiang B., Boonkong A., Li H., Ali A., Tanapon S. (2024): Understanding cross-cultural chicken consumers' behaviour. Agric. Econ. – Czech, 70: 73–90.

Abstract: Concerns for human health and food safety are gaining momentum in emerging and developing nations as well as in food research due to the reputations that products have established over time. Understanding cross-cultural consumers' purchasing behaviour for chicken meat (CM) could provide valuable insights into the global food sector since it is the most consumed meat worldwide. This study examines the effect of buying features (*BF*), culture factors, behavioural attitudes (*BA*), subjective norms (*SN*) and perceived behavioural control (*BC*) on CM actual purchase behaviour (*APB*) in China and Sierra Leone. Primary data were sourced from 588 Chinese and 410 Sierra Leonean participants. We adopt structural equation modelling (SEM) to verify the model and test the associations between the variables. The SEM results confirm that *BF*, *BA*, *SN* and *BC* stimulate customers' intent and actual purchase of CM in both nations. The findings indicate that cultural factors (CF) significantly moderates the association between the independent constructs (*BF*, *BA*, *SN* and *BC*) and *APB* in Sierra Leonean markets. This study provides significant insights for chicken industry stakeholders that can help them increase CM sales along the supply chain via a marketing strategy focused on cultural and psychological factors.

Keywords: buying features; behavioural attitudes; chicken meat; cultural factors; consumer behaviour

Meat consumption has increased tremendously over the past five decades, particularly in emerging and developing nations like China, and its consumption has surged 15-fold since 1961 (Giromini and Givens 2022). As demand for white meat (chicken) increased, consumer concerns about safety and quality also surged due to intensified production (Escobedo del Bosque et al. 2021). Chicken meat (CM) is more popular in many African and Asian dishes (Awono-Bessa et al. 2008; Asante-Addo and Weible 2019) due to the advan-

Supported by China's National Social Science Fund (20BGL296). The Wal-Mart Foundation: Improve Food Safety in China Pork Supply Chain (52514289). Social Sciences Foundation of Guangdong Province (GD23CYJ07) and Social Sciences Foundation of Guangzhou (2023GZGJ05).

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https://doi.org/10.17221/331/2023-AGRICECON

tages it has over other types of meat, including availability, affordability, being relatively less expensive and preventing cardiovascular diseases and cancer (Asante-Addo and Weible 2020; Boimah and Weible 2021; Lupoli et al. 2021). This study focuses on domestic and imported high-quality CM. Domestic chickens were raised in the two countries (China and Sierra Leone) selected for this study. Concerning imported chicken, China imports from countries like Brazil, the United States, Thailand, Russia and Argentina, while Sierra Leone sources chicken from the United States, Poland, Brazil and the Netherlands.

In addition, changing consumer behaviour (CB) from buying whole chicken to buying chicken cuts has been attributed to increased CM consumption (Escobedo del Bosque et al. 2021). The change in CB from purchasing whole chicken to purchasing chicken cuts has not been fully examined. Although chicken is the second largest animal protein consumed in Sierra Leone, the factors influencing consumer purchase behaviour remain unknown. Several studies have examined the influential factors of purchase behaviour for quality food in China (Kantono et al. 2021; Budhathoki et al. 2022; Wang et al. 2022a). However, previous research has not investigated consumer purchase behaviour in a cross-cultural context. Despite the rise in chicken consumption and rapid market expansion, the determinants that affect chicken purchase behaviour remain relatively unknown and are highly varied when compared across nations. For instance, markets in developing countries are in varying phases of development, making it crucial to advance research on the variations in consumer purchase behaviour for CM, particularly the variables that contribute to such variations. Therefore, this study explores the antecedents – particularly psychological factors and buying features (BF) – that influence customers' purchase behaviour of CM in two distinct markets.

Interestingly, numerous updated studies focused on purchase intention (PI) have explored the factors that influence CB towards quality meat such as country of origin (Asante-Addo and Weible 2020), environmental factors (Jiang and Kassoh 2022) and psychological factors (Kantor and Kantor 2021; Kung et al. 2021; Ling et al. 2021; Quevedo-Silva and Pereira 2022; Li et al. 2023). However, studies that examined the impact of psychological factors and BF on consumer purchase behaviour for CM are at a rudimentary stage and have largely focused on developed nations (Carfora et al. 2019; Ogorevc et al. 2020; Escobedo del Bosque et al. 2021; Roseira et al. 2022). In addition, few studies have examined meat purchase behaviour (de Araújo et al. 2022; Jiang and Kassoh 2022), leading to repeated recommendations for additional research to include actual purchase behaviour (APB) in a cross-cultural context (Roseira et al. 2022). Therefore, there is a quest to produce more research on the differences among consumers and the factors influencing their APB for chicken meat in two different nations. Despite several studies regarding the attributes that influence individuals' APB for quality food products, exactly how these elements influence customers seems to vary depending on the region, as indicated by the diverse findings, and most of these factors have been found to be inconsistent for predicting CB towards meat (Ahmad and Zhang 2020; Kumar et al. 2021; Munerah et al. 2021). Additionally, the empirical literature on CB has emphasised impulsive purchases rather than examining buyers' cognitive evaluation (Rodrigues et al. 2021; Song et al. 2022).

It has been generally acknowledged that culture has a significant effect on consumer APB (Afzal et al. 2019; Doanh et al. 2021; Jeong and Lee 2021; Zong et al. 2023), and additional research on chicken consumption would be helpful for the field (Roseira et al. 2022). Acknowledging the relevant role of culture in food purchase behaviour, Watanabe et al. (2019) emphasised the scarcity of research with respect to Hofstede's cultural elements in food acquisition behaviour in a cross-cultural context. However, few cross-cultural investigations have examined the impact of culture on PI, and many of these investigations have been concentrated in developed nations (Djekic et al. 2021; Peña-García et al. 2020; Roseira et al. 2022). Furthermore, many studies have suggested expanding the research beyond developed nations (Iguisi 2018; Liu et al. 2020). Studies have also suggested that cultural factors, particularly uncertainty avoidance (UA), might have a strong positive effect on customers' PI for CM (Jiang and Kassoh 2022), advocating the need for more cross-country research between emerging and developing nations.

To bridge this gap in the empirical literature, this study answers to the call for a deeper understanding of consumer shopping intention and behaviour regarding CM in a cross-cultural context, as suggested by Sreen et al. (2018), Ruangkanjanases et al. (2020), and Jiang and Kassoh (2022). This study compares Chinese and Sierra Leonean consumers' PI and behaviour towards CM, which varies based on UA and other cultural dimensions. The investigation expands the theory of planned behaviour (TPB) framework to evaluate the degree to which one of Hofstede's cultural dimensions (UA) moderates the impact of BF, behaviour at-

https://doi.org/10.17221/331/2023-AGRICECON

titudes (BA), subjective norms (SN) and perceived behavioural control (BC) on consumer intention and behaviour towards CM. Finally, the study examines the effect of BF, BA, SN and BC on the intention to purchase CM. Based on the research gap, this study seeks to answer the following research questions: How does UA influence chicken meat PI and APB among Chinese and Sierra Leonean consumers? Does UA significantly moderate selected independent constructs and APB? Are differences evident in the impact of SN, BF, BA and BC on APB between the study markets?

The rationale for selecting Chinese and Sierra Leonean consumers for this study is that broilers have an extremely significant and dominant role in food consumption demand in both countries, and both countries have similar preferences and behaviours towards meat consumption and some common cultural dimensions. Another significant reason for selecting these countries is the differences between them in perceived broiler quality and other cultural factors, particularly Hofstede's uncertainty avoidance cultural dimension. Chicken meat consumption has surged in emerging and developing countries, indicating the necessity to conduct research on the significant considerations that might influence PI and behaviour for CM. Second, both countries have different cultures with an extensive array of customers' preferences towards chicken. Despite the fact that the two nations are situated on different continents (Africa *vs.* Asia), which widens the potential cultural gap between them, we anticipate that the model will not be invariant given the pre-existing differences that have been previously established. This distinction may be significant because purchasing power appears to affect the choice of meat. Chinese and Sierra Leonean consumers have different profiles and preferences regarding food safety attitudes and behaviours. Exploring the dynamics that affect chicken APB in emerging and low-income developing nations could provide insights for stakeholders in chicken markets and a clearer comprehension of the chicken markets. The findings could also serve as the basis for advancing chicken trading in the meat industry to develop effective strategies for developing the chicken market in Sierra Leone and improve the existing market in China.

Theoretical framework

In nutritional psychology and food safety studies, the TPB has been the primary framework used to investigate food purchase behaviour (Nguyen et al. 2021; Jiang and Kassoh 2022; Mai et al. 2023); therefore, this study employs a TPB model to explore Chinese and Sierra Leonean consumers' CM APB. The TPB model is a modified variant of the theory of reasoned action (TRA) (Ajzen 1991) that predicts consumers' APB by incorporating perceived BC (PBC) into the TRA. The TPB model employs three major elements (SN, BA and PBC) to predict consumer PI and APB (Ajzen 1991). The TPB framework has been extensively used to explain consumer PI and behaviour in various contexts, including meat purchases. For example, Shen and Chen (2020) and Chang and Chen (2022) adopted the TPB framework, and their findings revealed that SN, PBC and BA strongly influence Taiwanese PI for meat. In the same vein, studies on purchases in China also indicated that a person's attitude, SN, PBC and BF significantly affect customers' APB (Song et al. 2017; Ruangkanjanases et al. 2020; Jiang and Wu 2022).

According to Ajzen (1991), the most significant element in predicting CB is PI. The association between behavioural intention and individual behaviour is used together to examine consumer buying behaviour. The TPB framework indicates that an individual's behavioural intentions are influenced by three main components of BA, SN and PBC. We extend the TPB model by integrating BF and cultural factors into the TPB construct to predict consumer PI and APB for CM in the sample markets. This study also incorporates UA into the conceptual model to examine this construct and effectively moderates the link between TPB's variables (BA, BF, SN and BC) and PI and APB regarding CM. The research paradigm is illustrated in Figure 1.

Hypotheses development

The link between purchase intention and actual purchase behaviour. One of the principal objectives of the TPB is to emphasise that individual behaviour is predominantly determined by intention, which holds true for customer purchases of CM. Intention is defined as a person's promptness to engage in the intended behaviour. Numerous CB studies, including those concerning meat purchases, have assumed the underlying premise that PI statistically influences APB (Jiang and Kassoh 2022; Roseira et al. 2022). A limited number of studies have focused on individual APB related to meat purchase; however, such studies have typically concluded that PI is a key predictor of meat APB (Shen and Chen 2020; Chang and Chen 2022). Consumers' PI positively influences APB (Carfora et al. 2019; Ogorevc et al. 2020; Jiang and Kassoh 2022; Roseira et al. 2022) and is a major indicator used by marketing managers to predict upcoming sales (Chang and

https://doi.org/10.17221/331/2023-AGRICECON

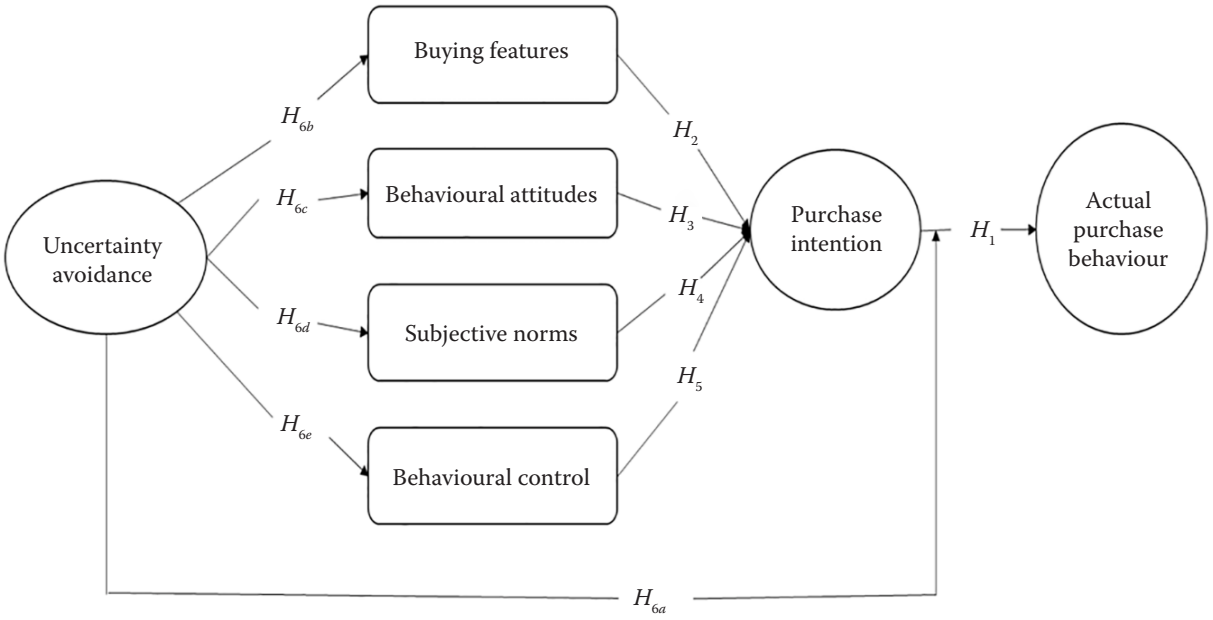

Figure 1. Conceptual model

Source: Authors's own elaboration

Chen 2022). Referencing the TPB model and previous empirical literature, we anticipated that the stronger consumer intention towards acquiring CM, the more likely the consumer will successfully acquire it. Therefore, we propose the following hypothesis:

H_1: Individual intention to purchase CM favourably influences actual purchase behaviour.

The relationship between buying features and purchase intention. Buying features include sensory, colour, appearance, taste and tenderness considerations that are influential factors of PI (Kung et al. 2021; Yang 2021). PI can be influenced by BFs such as product attributes, personal characteristics, health, safety and social factors, and related impulses positively affect CB. Therefore, we incorporate BF into the TPB model as an influential construct of chicken meat APB. The link between BF and PI has been examined from diverse perspectives, including cognitive and psychological perspectives, rational processes and the outcome of advertising food quality attributes on individual CB (Sreen et al. 2018; Afzal et al. 2019). For instance, production processing attributes and intrinsic and extrinsic factors positively influence individual shopping decisions (Cozzio et al. 2020; Kumar et al. 2021; Javeed et al. 2022). In the context of chicken meat, BF is a vital component in PI and APB; hence, this study proposes the following hypotheses:

H_{2a}: Buying features positively influence consumer purchase intention towards CM.

H_{2b}: Purchase intention positively mediates the link between buying features and actual CM purchase behaviour.

The link between behavioural attitude and purchase intention for CM. A positive BA towards CM is a primary premise that drives chicken meat PI (Ajzen 1991; Kamboj et al. 2023). According to the TPB, consumers' attitude is an essential component of behavioural intention, and a stronger BA indicates a stronger intention towards APB (Mai et al. 2023). Previous empirical research has demonstrated that BA positively influences PI and APB (Ruangkanjanases et al. 2020; Iqbal et al. 2021; Ling et al. 2021; Nguyen et al. 2021; Assefa et al. 2023). Hence, we propose the following hypotheses:

H_{3a}: Attitude strongly influences chicken purchase intentions.

H_{3b}: Individual intention to buy chicken positively mediates behavioural attitude and actual buying behaviour.

The association between subjective norms and purchase intention for CM. Since individual attitudes alone cannot elucidate PI, SNs are important antecedents of intention in the TPB that influence a person's decision to execute a behaviour (Jiang and Wu 2022). The concept of social pressure towards behavioural intention for quality food purchases refers to perceived social pressure from trusted individuals that influences others to perform a specific behaviour (Ajzen 1991; Ling et al. 2021; Nguyen et al. 2021). SN is a crucial fac-

https://doi.org/10.17221/331/2023-AGRICECON

tor in determining society's influence on behavioural intentions. Previous studies have ascertained that SNs greatly influence PI for food products (Asif et al. 2018; Zayed et al. 2022; Kamboj et al. 2023). Based on the aforementioned literature, this study proposes the following hypotheses:

H_{4a}: Subjective norms have a positive impact on CM purchase intention.

H_{4b}: Consumers' intention significantly mediates the link between subjective norms and actual purchase behaviour.

The association between behavioural control and purchase intention for CM. Ajzen (1991) defined PBC as an individual's perceived capability to control certain behaviours, indicating the perceived difficulty of declining the invitation to participate in an action. Ajzen (1991) asserted that when an individual purchases food, their behaviour is motivated by intentions, which are influenced by beliefs, attitudes about the person's perceived control, product attributes and the decisions of others whose opinions they consider to be influential. Several studies on food purchase behaviour have argued that the correlation between the intention to execute a specific behaviour and BC significantly influences behaviour (Shahriari et al. 2019; Doanh et al. 2021; Zayed et al. 2022). Research has demonstrated that food safety concerns alter consumers' eating behaviour in relation to quality, which is a key attribute that positively affects consumer food preferences (Sreen et al. 2018; Ling et al. 2021). In this study, BC refers to the consumer's perception of CM quality, which influences PI. Hence, the study proposes the following hypotheses:

H_{5a}: Behavioural control affects consumer intention to purchase CM.

H_{5b}: Purchase intention towards CM mediates the link between behavioural control and actual purchase behaviour.

The role of cultural dimensions. Culture is a crucial element for understanding CB. Hofstede (2001) described culture as 'the collective programming of the mind that differentiates members of one class of persons from other groups'. As such, individuals associated with various nations can carry distinct opinions and attitudes regarding the same topic. It has been argued that cultural elements statistically influence how individuals feel, think, believe and behave. In other words, culture moderates how people perceive their environment and establishes social norms, which influences subsequent behaviours (Sreen et al. 2018; Roseira et al. 2022; Wang et al. 2022b). Cultural moderators may also change the association between PI and APB. We postulate that cultural factors may help to explain conflicting results regarding the chicken meat PI and APB relationship and advance our knowledge regarding the intention–behaviour gap. Therefore, we investigate the role of the UA cultural dimension as an essential moderator of PI and APB in the domain of chicken meat PI and APB. Comprehending the effect of culture is significant for advancing foreign trade, particularly regarding meat, because intrinsic and extrinsic information on meat positively motivates consumers' chicken meat PI.

Hofstede's culture framework is one of the most common theories applied in cross-cultural studies in various domains such as psychology, marketing, agriculture, economics and management (Jiang and Kassoh 2022; Matharu et al. 2023), and we employed the concept of UA in this research. Hofstede (2001) proposed six cultural dimensions for examining cultural differences. Table 1 presents the scores of Hofstede's cultural dimensions between the selected countries.

Based on the number of dimensions suggested by Hofstede, UA (the degree of stress in a community in the midst of an unpredictable future) is assumed to be among the most influential dimensions of consumers' intention and behaviour (Sohaib et al. 2019; Matharu et al. 2023). UA gauges the level of anxiety people experience when they feel threatened by ambiguity due to insufficient knowledge. High UA countries strive to minimise the occurrence of unstructured circumstances through establishing stringent behavioural standards, regulations and procedures, whereas low UA countries tend to foster greater flexibility, openness to change and new ideas and fewer laws and regulations.

UA has been used in previous studies in developed countries to analyse consumers' PI for quality food products, and UA has been demonstrated to exert a significant influence on PI (Sohaib et al. 2019; Ma-

Table 1. Hofstede cultural dimensions' comparison between China and Sierra Leone

Dimensions	China	Sierra Leone
Femininity and masculinity	66	40
Uncertainty avoidance	30	50
Collectivism and individualism	20	20
Long-term and short-term orientation	87	–
Power distance	80	70
Indulgence / restraint	24	–

Source: Hofstede (2001)

https://doi.org/10.17221/331/2023-AGRICECON

tharu et al. 2023). Consumers from low UA nations like China, as opposed to high UA countries like Sierra Leone, accept uncertainty more easily, have good ambiguity management skills and are highly risk-tolerant (Hofstede 2001; Matharu et al. 2023). Furthermore, they are more inclined to search for innovative solutions. In the meat industry, choosing quality chicken production with information as a BF may be considered creative behaviour. For instance, chicken with information BF might reduce consumers' doubts regarding quality and safety. Consumers may feel that CM with a BF label is of better quality compared with meat that is not labelled. In this regard, this study proposes the following hypotheses to examine the link between UA and PI for CM in the study countries:

H_{6a}: Uncertainty avoidance significantly moderates the link between purchase intention and actual purchase behaviour; as such, high uncertainty avoidance will support a favourable association between purchase intention and actual purchase behaviour, while low uncertainty avoidance will diminish the association between uncertainty avoidance.

H_{6b}: Uncertainty avoidance significantly moderates the link between buying features and purchase intention; as such, high uncertainty avoidance will support the favourable association between buying features and purchase intention, whereas low uncertainty avoidance will diminish the associations between buying features and purchase intention.

H_{6c}: Uncertainty avoidance significantly moderates the link between behavioural attitudes and purchase intention, such that high uncertainty avoidance supports the favourable association between behavioural attitudes and purchase intention, while low uncertainty avoidance diminishes the association between behavioural attitudes and purchase intention.

H_{6d}: Uncertainty avoidance significantly moderates the link between social norms and purchase intention, such that high uncertainty avoidance supports the favourable association between social norms and purchase intention, and low UA will diminish the association between social norms and purchase intention.

H_{6e}: Uncertainty avoidance significantly moderates the link between behavioural control and purchase intention, such that high uncertainty avoidance supports the favourable association between behavioural control and purchase intention, and low uncertainty avoidance would likely diminish the link between behavioural control and purchase intention.

MATERIAL AND METHODS

This study applied a quantitative technique to statistically test how UA moderated the impact of BF, BA, SN and BC on PI and APB for CM in China and Sierra Leone. We used descriptive statistics to analyse the participants' socio-economic profiles. The validity and reliability of the variables were thoroughly evaluated to ensure applicability. Finally, structural equation modelling (SEM) was used to determine the effects of the constructs. SEM is a statistical method that uses component analysis and multiple regressions to analyse the structural relationships between measured and latent constructs.

Questionnaire development and pre-testing. We designed the questionnaire based on a thorough review of previous empirical studies. The survey tool included two sections. The first section included questions related to participants' socio-economic profile, and the second section covered questions regarding the variables' measurement scale items. We adopted and modified at least three items from each construct. Details about the constructs and items are presented in Table 2.

All the measurement items used a five-point Likert scale ranging from 1 = completely disagree to 5 = completely agree. We pre-tested the tool among the students in China to assess the questionnaire's content and usability. The survey tool was administered in Mandarin for Chinese buyers and English for Sierra Leonean consumers.

Construct measurement. The evaluation scale referenced previous studies to produce our survey tool for data collection using existing validated measures. Detailed descriptions of the measurement scales and their sources are as follows. We employed five items from Kung et al. (2021) and Javeed et al. (2022) to examine BF and three items to measure BA (Mai et al. 2023; Kamboj et al. 2023). We used three elements from Chang and Chen (2022) and Mai et al. (2023) to measure SN, four items from Song et al. (2017) and Shen and Chen (2020) to examine BC, and evaluated PI using three elements from Ruangkanjanases et al. (2020) and Wang et al. (2022a). UA was measured using four items from Matharu et al. (2023) and Jiang and Kassoh (2022), and we used four elements from Roseira et al. (2022) and Asif et al. (2018) to measure APB.

Sample and data collection procedures. This study employed non-probability (convenience and snowball) sampling strategies. The study was conducted in urban locales that were the major consumers of high-quality

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Table 2. Constructs and their measurement items

Construct	Symbol	Description of items
Buying features	*BF*1	I pay attention to the freshness when buying chicken
	*BF*2	I pay attention to chicken's health when buying.
	*BF*3	I considered chicken that are free from chemical additives, antibiotics, and pesticides.
	*BF*4	I pay attention to the traceability information when buying chicken.
	*BF*5	I pay attention to the place of origin when buying chicken.
Behavioural attitude	*BA*1	I think it is worth buying a chicken with traceable quality information.
	*BA*2	I think it is worth buying a chicken with humanized standard animal rearing.
	*BA*3	I think it is worth buying a chicken with a place of origin brand.
Subjective norms	*SN*1	My family and colleagues give greater attention to the chicken with a place of origin brand.
	*SN*2	My relatives and colleagues consider the chicken with industrialized and intelligent raised.
	*SN*3	My family and colleagues pay more attention to the chicken with traceable quality information.
Behavioural control	*BC*1	I think it is easy to buy chicken with traceability information.
	*BC*2	It is important and easy to buy products.
	*BC*3	I am interested in knowing more about my health status before buying chicken.
	*BC*4	If I want to buy a chicken with a local brand, I can find where to buy it.
Purchase intention	*PI*1	For the following 12 months, I want to buy the chicken with place of origin information.
	*PI*2	For the upcoming 12 months, I want to buy chicken with traceable, safety, and quality information label.
	*PI*3	For the following 6 months, I am willing to purchase chicken with industrialized and intelligent raising.
Cultural factors	*CF*1	Before I make a purchase, I thoroughly investigate the chicken.
	*CF*2	Life is so uncertain that one must continuously be on the alert so as not to be caught at a disadvantage.
	*CF*3	It is essential to consider dissenting views when making personal and social decisions.
Actual purchase behavior	*APB*1	I have frequently purchased chicken with the place of origin brand during the previous 12 months.
	*APB*2	During the previous 12 months, I have often bought chicken with humanized standard animal rearing.
	*APB*3	During the previous 12 months, I have often bought chicken with traceable quality information.
	*APB*4	During the previous 12 months, I have often bought the chicken that are healthier.

Source: Song et al. (2017), Asif et al. (2018), Ruangkanjanases et al. (2020), Shen and Chen (2020), Kung et al. (2021), Chang and Chen (2022), Javeed et al. (2022), Jiang and Kassoh (2022), Roseira et al. (2022), Kamboj et al. (2023), Mai et al. (2023), Matharu et al. (2023)

meat based on residents' economic status that also represented various culture and consumption habits. The countries were selected based on surges in chicken consumption, preferences and cultural variations. The survey was conducted from December 2021 to January 2022, targeting meat consumers who were at least 18 years of age and had been involved in shopping or expressed a desire to buy CM. The study focused on high-quality (domestic and imported) CM that was free from antibiotics and chemical additive residue, for which environmental and ethical issues were considered during production, processing and distribution processes.

The questionnaire was administered via social media platforms such as Facebook, WeChat and WhatsApp. The respondents were fully informed about the research, and their participation was voluntary. Finally, 588 and 410 completed questionnaires were received from Chinese and Sierra Leonean consumers, respectively.

Statistical analysis. A two-stage maximum likelihood analysis was conducted using SPSS Amos 23, ref-

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erencing Hair et al. (2019). Confirmatory factor analysis (CFA) was employed in the first stage to evaluate the model's reliability and validity. A convergent validity test was computed and verified using average variance expected (*AVE*). When the computed *AVE* value was higher than the threshold (0.5), we could conclude that a construct met the convergent validity criteria (Byrne 2016; Hair et al. 2019). Similarly, when the computed value of factor loading was at least 0.5, which was the benchmark, we could conclude that the construct was a reliable and valid predictor (Byrne 2016). Discriminant validity also verified that the *AVE* values were higher than the squared correlation across all the selected variables of the measurement model (Fornell and Larcker 1981; Hair et al., 2019). We used the internal consistency of each construct, the computed value of Cronbach's alpha (α) and composite reliability (*CR*) as indicators. Cronbach's α was used to measure the internal consistency of each construct, which is confirmed when the estimated value is at least 0.7; the minimum threshold value recommended by Hair et al. (2019) and Sarstedt et al. (2020).

In the second stage, we applied the SEM to verify the relationships between all variables by estimating regression paths. The suggested hypotheses were verified using the SEM, which also addressed possible multicollinearity among explanatory variables (Zong et al. 2023). The goodness of fit of the measurement and structural model were evaluated using the chi-squared difference (χ^2 / d*f*), wherein the maximum accepted threshold value should be 5 at most (Roseira et al. 2022). The Tucker–Lewis index (*TLI*), the adjusted goodness of fit index (*AGFI*), the goodness of fit index (*GFI*) and the comparative fit index (*CFI*) were also computed to examine the SEM fit, and the accepted benchmark was ≥ 0.9. We also estimated *AGFI*, and its accepted threshold was ≥ 0.8. Finally, we computed the *R*-squared (R^2) of the two samples.

Table 3 presents the statistical analysis of interviewees' demographic characteristics. The result indicates a relatively similar ratio of men to women in the two sample markets; 51.29% of the Chinese interviewees were women, and 48.71% were men. In Sierra Leone, 54.65% were women and 45.35% were men. The findings also indicated that 73.33% and 75.21% of the Chinese and Sierra Leonean participants fell within the 26–55 age group, which is also referred to as young adults. This class has also been referred to as the main driving force behind buying quality meat.

In terms of education, the respondents in both countries had a similar percentage for all five categories, which is favourable for cross-cultural analysis. According to our findings, 75.54% of the Chinese sample (444 Chinese respondents) had household monthly earnings of USD 1 501 to USD 2 000 or more, reflecting the average income range for Chinese families. Conversely, 261 respondents had a monthly revenue of USD 500 to USD 1 000, representing 63.65% of the sample from Sierra Leone, reflecting the average income of middle-income earners.

Table 3. Socioeconomic profile of the participants

Variables	Category	China (%)	Sierra Leone (%)
Total participants		588	410
Sex	man	48.71	45.35
	woman	51.29	54.65
Age	≤ 25	14.25	13.62
	26–35	47.24	49.86
	36–55	26.09	25.35
	≥ 56	12.42	11.17
Educational level attainment	at most high school	1.73	4.82
	technical / vocational	2.78	12.85
	bachelor's degree	31.93	35.62
	master's degree	46.83	37.47
	doctoral degree	16.73	9.24
Monthly family income (USD)	500–600	6.52	28.73
	601–1 000	8.70	34.92
	1 001–1 500	9.24	17.65
	1 501–2 000	38.58	10.24
	> 2 000	36.96	8.46

Source: Authors's own elaboration

RESULTS

CM purchase frequency in China and Sierra Leone

Figure 2 presents responses to the question: How many times do you normally buy CM for the year? The results indicated that the majority of Chinese participants purchased CM once a week (35.79%), followed by twice a week (28.6%). Only 3.24% of Chinese consumers indicated that they purchased chicken once a year. In Sierra Leone, most of the respondents purchased chicken twice a week (54.04%), followed by once a week (31.39%) and only (1.95%) purchased chicken once a year.

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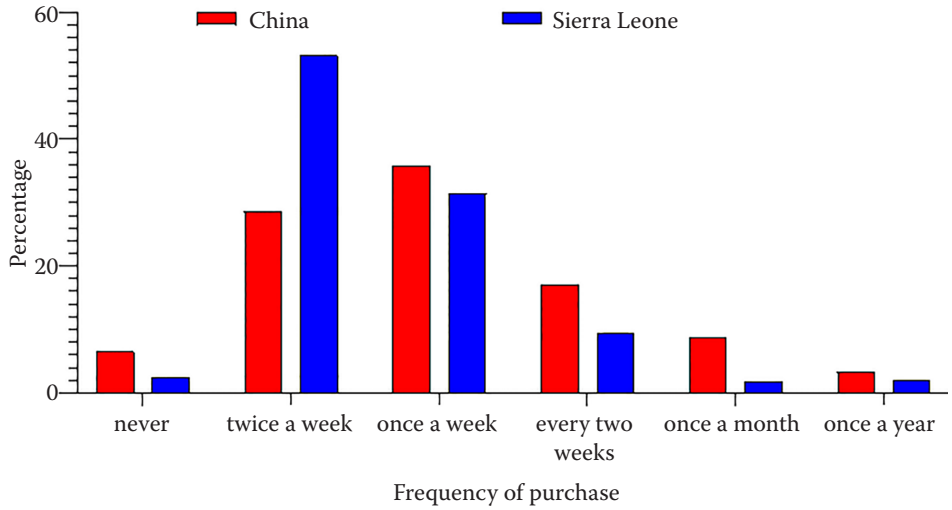

Figure 2. Frequency of purchase of chicken meat

Source: Authors's own elaboration

The results in Figure 3 indicate the major markets from which our respondents purchased CM. About 38.54% of the Chinese respondents purchased CM from supermarkets, followed by small grocery stores (32.5%) and daily retail markets (21.74%). In Sierra Leone, about 49.2% of the respondents bought CM from daily retail markets, followed by cold stores (23.36%) and farm gate markets (13.2%). These were the major markets for chicken in Sierra Leone.

Measurement model for reliability and validity analysis

The initial steps of the research centred on evaluating the internal consistency and reliability of the selected variables. All the constructs were evaluated using Cronbach's α, factor loading, *CR* and *AVE*. Table 4 presents the results of the factor loadings for the two countries, which ranged from 0.831 to 0.911 and were above the recommended threshold (0.5). Similarly, all the computed *CR* and Cronbach's α values for the two sample markets were also greater than the minimum accepted benchmark (0.7), suggesting that the measurement scale was a good fit and reliable. Furthermore, the computed *AVE* values for each construct were higher than the threshold values, implying that the convergent validity is satisfactory (Fornell and Larcker 1981; Hair et al. 2017). Figures 4A and 4B illustrate the measurement models for China and Sierra Leone.

Confirmatory factor analysis and impact factor results. To verify the model, we computed CFA for the total sample using SPSS Amos 23. The model fit showed acceptable values for the primary indicators of the Chinese sample, including χ^2 = 307.62,

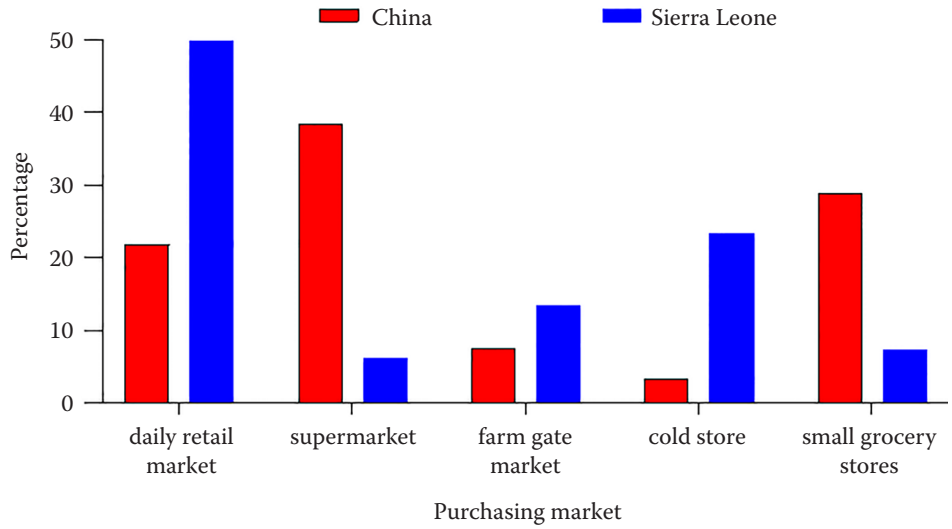

Figure 3. Major markets of purchasing chicken meat

Source: Authors's own elaboration

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Table 4. The psychometric properties of the measurement items

Construct	Item	Chinese sample				Sierra Leonean sample			
		FL	α	*CR*	*AVE*	*LP*	α	*CR*	*AVE*
Buying feature	*BF*1	0.883	0.932	0.940	0.798	0.849	0.862	0.908	0.729
	*BF*2	0.910				0.863			
	*BF*3	0.883				0.831			
	*BF*4	0.901				0.874			
	*BF*5	0.889				0.852			
Behavioural attitude	*BA*1	0.873	0.864	0.898	0.788	0.904	0.886	0.904	0.797
	*BA*2	0.882				0.911			
	*BA*3	0.908				0.863			
Subjective norms	*SN*1	0.893	0.907	0.915	0.815	0.884	0.873	0.895	0.784
	*SN*2	0.912				0.913			
	*SN*3	0.903				0.859			
Behavioural control	*BC*1	0.911	0.862	0.920	0.786	0.893	0.872	0.895	0.742
	*BC*2	0.902				0.874			
	*BC*3	0.863				0.882			
	*BC*4	0.869				0.793			
Purchase intention	*PI*1	0.902	0.868	0.893	0.781	0.902	0.853	0.894	0.782
	*PI*2	0.884				0.910			
	*PI*3	0.864				0.839			
Uncertainty avoidance	*CF*1	0.869	0.769	0.896	0.801	0.873	0.751	0.879	0.761
	*CF*2	0.902				0.881			
	*CF*3	0.913				0.863			
Actual purchase behavior	*APB*1	0.891	0.916	0.928	0.801	0.852	0.904	0.912	0.771
	*APB*2	0.873				0.872			
	*APB*3	0.904				0.910			
	*APB*4	0.912				0.878			

PI – purchase intention; BF – buying feature; BA – behavioural attitude; BC – behavioural control; SN – subjective norms; UA – uncertainty avoidance; APB – actual purchase behavior; α – Cronbach's alpha; *CR* – composite reliability; *FL* – factor loading; *AVE* – average variance expected

Source: Authors's own elaboration

d*f* = 195, χ^2 / d*f* = 1.578, *RMSEA* = 0.046, *GFI* = 0.911, *TLI* = 0.927, *CFI* = 0.942 and *AGFI* = 0.859. In Sierra Leone, the model fit values showed satisfactory values of χ^2 = 288.91, d*f* = 176, χ^2/d*f* = 1.642, *RMSEA* = 0.053, *GFI* = 0.935, *TLI* = 0.948, *CFI* = 0.950 and *AGFI* = 0.884 (Table 5). All indicators' values were within the general thresholds recommended in the pertinent literature (Fornell and Larcker 1981; Hair et al. 2019; Sarstedt et al. 2021).

Discriminant validity. We determined discriminant validity (DV) by comparing the square root of the *AVE* value with the correlation value of the study variables, as shown in Table 6. To verify the DV, the square root of the *AVE*s is shown diagonally across constructs, which were all higher than the correlation with other variables, implying good DV (Fornell and Larcker 1981).

Evaluation of the structural model and proposed hypotheses

After validating the measurement model, this study used SEM to evaluate the suggested hypotheses. Empirical research regarding BA, culture, SN and behavioural intentions has largely adopted SEM for such investigations (Liao et al. 2022; Zayed et al. 2022).

The values for the main indices for the SEM include *CFI* of 0.959 and 0.947, *GFI* values of 0.927 and 0.952,

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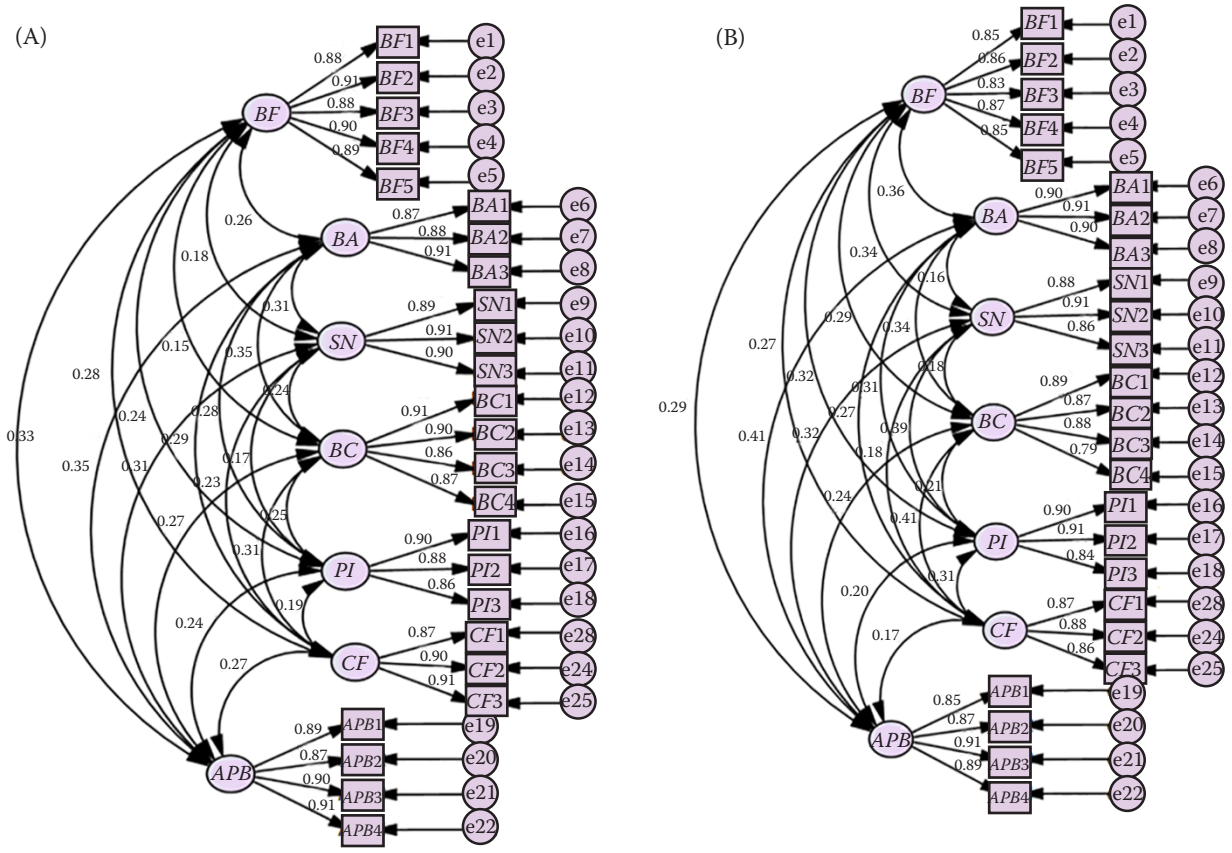

Figure 4. (A) Chinese and (B) Sierra Leonean measurement model

PI – purchase intention; *BF* – buying feature; *BA* – behavioural attitude; *BC* – behavioural control; *SN* – subjective norms; *UA* – uncertainty avoidance; *APB* – actual purchase behavior;
Source: Authors's own elaboration

AGFI of 0.876 and 0.873, *RMSEA* of 0.038 and 0.061 and *TLI* values of 0.933 and 0.926 for China and Sierra Leone, respectively. The χ^2 difference indices for China were $\chi^2_{(215)} = 406.51$ and $\Delta\chi^2 = 1.891$ ($P < 0.0001$), while the χ^2 difference indices for Sierra Leone were $\chi^2_{(194)} = 351.80$, $\Delta\chi^2 = 1.813$ ($P < 0.001$). The critical ratio was determined by dividing the calculated estimate of the regression by the standard error and a matrix was used in questionnaire item evaluation to confirm whether the measurement scale was fit to determine the degree of response of various interviewees. The expected critical ratio was assumed to be significant at the 5% level at most and was estimated using the software SPSS Amos 23. The precise values are provided in Table 7.

The lower section of Table 7 presents the R^2 estimates for each structural model of the two sampled countries. The estimated SEM for the Chinese respondents, the *BF*, *BA*, *SN* and *BC* constructs, explained 87.4% of the variation in chicken meat *PI*. Furthermore, *PI* explained 72.1% of the variation in consumers' *APB* for the same product. For consumers in Sierra Leone,

Table 5. Model fit results of the measurement models

Countries	χ^2	d*f*	χ^2/d*f*	*RMSEA*	*GFI*	*TLI*	*CFI*	*AGFI*
China (588)	307.62	195	1.578	0.046	0.911	0.927	0.942	0.859
Sierra Leone (410)	288.91	176	1.642	0.053	0.935	0.948	0.950	0.884

d*f* – degrees of freedom; χ^2 / d*f* – chi-square difference; *RMSEA* – root mean square error of approximation; *GFI* – goodness of fit index; *TLI* – Tucker Lewis index; *CFI* – comparative fit index; *AGFI* – adjusted goodness of fit index
Source: Authors's own elaboration

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Table 6. Results of discriminant validity and correlation matrix

Country	Constructs	Mean	SD	*BF*	*BA*	*SN*	*BC*	*PI*	*CF*	*APB*
	BF	4.33	0.738	0.893	–	–	–	–	–	–
	BA	4.09	0.613	0.263	0.888	–	–	–	–	–
	SN	4.02	0.901	0.184	0.314	0.903	–	–	–	–
China	*BC*	3.63	0.723	0.149	0.351	0.243	0.886	–	–	–
	PI	4.18	0.748	0.244	0.279	0.171	0.154	0.883	–	–
	CF	3.66	0.662	0.281	0.293	0.234	0.308	0.194	0.895	–
	APB	4.14	0.809	0.332	0.351	0.313	0.273	0.238	0.273	0.895
	BF	4.13	0.738	0.854	–	–	–	–	–	–
	BA	3.51	0.778	0.361	0.893	–	–	–	–	–
	SN	3.97	0.639	0.342	0.163	0.886	–	–	–	–
Sierra Leone	*BC*	4.04	0.904	0.294	0.344	0.182	0.861	–	–	–
	PI	4.04	0.748	0.323	0.309	0.394	0.213	0.884	–	–
	CF	4.21	0.840	0.271	0.274	0.182	0.410	0.314	0.872	–
	APB	4.13	0.807	0.331	0.352	0.312	0.271	0.235	0.274	0.885

BF – buying feature; *BA* – behavioural attitude; *SN* – subjective norms; *BC* – behavioural control; *UA* – uncertainty avoidance; *PI* – purchase intention; *APB* – actual purchase behavior

Source: Authors's own elaboration

Table 7. Hypotheses testing results

Hypothesis	Path	China		Sierra Leone		Confirmed
		estimate	*CR*	estimate	*CR*	
Direct path						
H_1	$PI \rightarrow APB$	0.530***	12.033	0.339***	12.444	yes
H_{2a}	$BF \rightarrow PI$	0.271***	11.353	0.245***	5.563	yes
H_{3a}	$BA \rightarrow PI$	0.195***	7.351	0.083**	2.268	yes
H_{4a}	$SN \rightarrow PI$	0.156***	6.012	0.094**	2.145	yes
H_{5a}	$BC \rightarrow PI$	0.260***	4.899	0.249***	9.614	yes
Mediating relationship						
H_{2b}	$BF \rightarrow PI \rightarrow APB$	0.365***	7.152	0.226***	8.637	yes
H_{3b}	$BA \rightarrow PI \rightarrow APB$	0.240***	7.478	0.079***	5.733	yes
H_{4b}	$SN \rightarrow PI \rightarrow APB$	0.185***	6.012	0.058***	9.093	yes
H_{5b}	$BC \rightarrow PI \rightarrow APB$	0.204***	4.937	0.113***	4.447	yes
Moderating relationships						
H_{6a}	$PI \times CF \rightarrow APB$	0.141	0.625	0.344***	6.781	partial
H_{6b}	$BF \times CF \rightarrow PI$	0.175	0.426	0.276***	8.680	partial
H_{6c}	$BA \times CF \rightarrow PI$	0.124	0.091	0.204***	5.626	partial
H_{6d}	$SN \times CF \rightarrow PI$	0.137	1.332	0.107	0.832	no
H_{6e}	$BC \times CF \rightarrow PI$	0.171	0.835	0.185**	2.930	partial
R^2 values in the direct relationship		*PI*	*APB*	*PI*	*APB*	–
		0.874	0.721	0.815	0.663	–

*,**,*** significant at 10%, 5% and 1% level, respectively; CR – critical ratio; the Sobel test's *z*-values are replaced in the *CR* columns for mediation association; *BF* – buying feature; *BA* – behavioural attitude; *BC* – behavioural control; *SN* – subjective norms; *PI* – purchase intention; *APB* – actual purchase behavior

Source: Authors's own elaboration

https://doi.org/10.17221/331/2023-AGRICECON

the *BF*, *BA*, *SN* and *BC* variables explained 81.5% of the variation in chicken meat PI. For the structural model of Sierra Leone, 66.3% of the variation in chicken meat *APB* could be explained by selected constructs.

We employed the bias-corrected accelerated bootstrapping technique (5 000 subsamples) at the two-tails stage with a significance threshold of 5% and several-group analysis (Hair et al. 2017; Henseler 2017). We also compared the two countries using the permutation test. According to our findings, all hypotheses except H_{3b} were found to have no significant differences. The two countries had a similar view of *BF*, *BA*, *SN* and *BC* in terms of *PI* and *APB*. However, the effects of these relationships differed between the cultures of the two countries.

We determined that *PI* significantly influenced *APB* in China and Sierra Leone. As such, hypothesis H_1 was validated and supported. The findings revealed that *BF*, *BA*, *SN* and *BC* significantly influenced customers' chicken meat *PI* in China and Sierra Leone, validating H_{2a}–H_{5a}. Chinese consumers were more impacted than their Sierra Leonean counterparts regarding chicken meat *PI*. In both sampled nations, we found significant chicken meat *PI* mediating effects between *BF*, *BA*, *SN*, *BC* and *APB*, supporting hypotheses H_{2b}–H_{5b}.

Moderating effect of uncertainty avoidance on the drivers of chicken purchase intention

Regarding the moderating effects of *UA*, a strong positive interaction was found in Sierra Leone, but it was insignificant in China. In Sierra Leone, moderating effects were significant for all constructs, except for that of *SN* and *UA* on *PI*. Since the moderating effect was significant, this indicates a need for further research to determine the nature of UA's moderation.

The moderating association between *PI* and *UA* on *APB* was also significant for the Sierra Leonean sample. To interpret the moderating effect, we observed the trend of the linear lines of *PI* and *APB* at high and low *UA* levels. The moderating effect of *UA* on *PI* and *APB* is illustrated in Figure 5, demonstrating that *UA* enhances the relationship between *PI* and *APB*. Therefore, H_{6a} was supported for Sierra Leone.

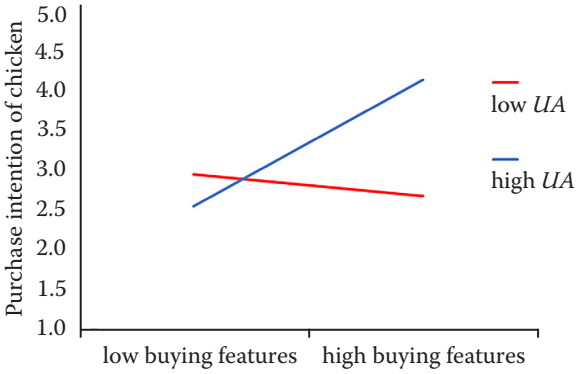

Figure 6. Uncertainty avoidance moderates between *BF* and *PI*

BF – buying feature; *PI* – purchase intention; *UA* – uncertainty avoidance

Source: Authors's own elaboration

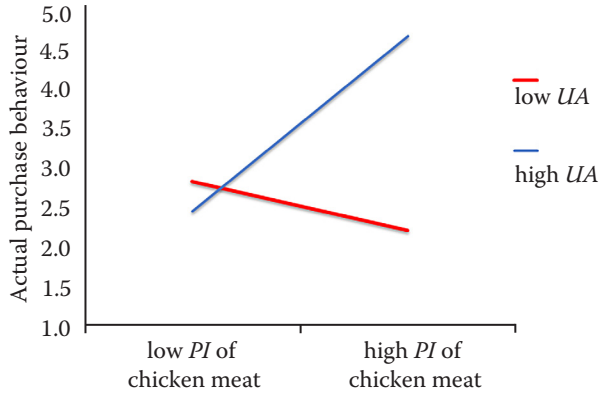

Figure 5. Uncertainty avoidance moderation between *PI* and *APB*

PI – purchase intention; *APB* – actual purchase behavior; *UA* – uncertainty avoidance

Source: Authors's own elaboration

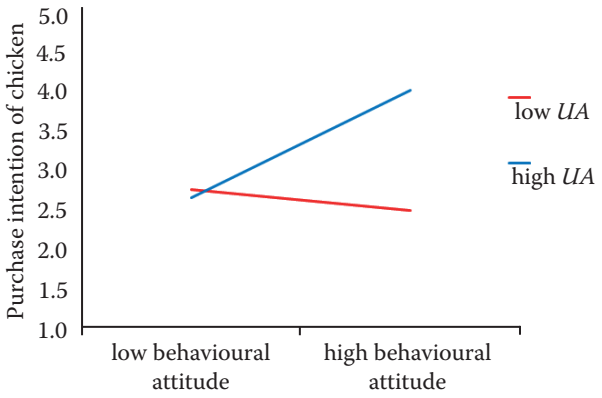

Figure 7. Uncertainty avoidance moderation between *BA* and *PI*

BA – behavioural attitude; *PI* – purchase intention; *UA* – uncertainty avoidance

Source: Authors's own elaboration

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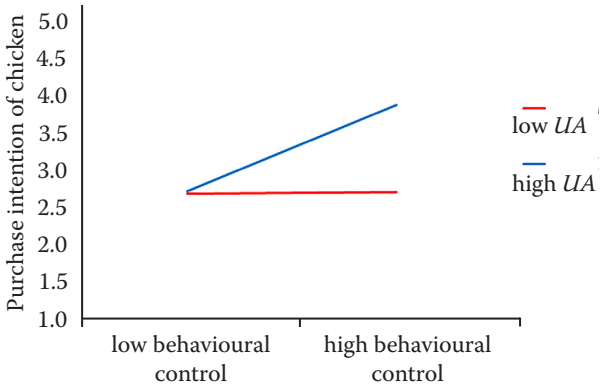

Figure 8. Uncertainty avoidance moderation between *BC* and *PI*

BC – behavioural control; *PI* – purchase intention; *UA* – uncertainty avoidance

Source: Authors's own elaboration

The moderation analysis of *UA* on *BF* and *PI* in Figure 6 revealed a strong positive interaction effect, indicating that *UA* moderates the relationship between *BF* and *PI*. The result in Figure 6 illustrates that *UA* enhanced the relationship between *BF* and *PI*; hence, H_{6b} was confirmed.

The moderation analysis of *UA* on *BA* and *PI* in Figure 7 revealed a strong positive interaction effect, indicating that *UA* moderated the relationship between *BA* and *PI*. The result in Figure 7 illustrates that *UA* enhanced the relationship between *BA* and *PI*; hence, H_{6c} was supported.

The moderation analysis of *UA* on *BC* and *PI* in Figure 8 revealed a strong positive interaction effect, indicating that *UA* moderated the relationship between *BA* and *PI*. The result in Figure 8 demonstrates that *UA* enhanced the relationship between *BA* and *PI*; hence, H_{6e} was supported.

DISCUSSION

This study identified five variables influencing the chicken meat *PI* in China and Sierra Leone. The results of hypotheses H_{2a}–H_{5a} suggest that *BF*, *BA*, *SN* and *BC* were valid indicators that significantly influenced consumers' chicken meat *PI* in both markets. However, the impact of these variables was significantly higher among Chinese consumers than those in Sierra Leone. Our results are consistent with the findings of Li et al. (2021), Roseira et al. (2022) and Sobaih et al. (2023). The impact of these factors on chicken meat *APB* was more noticeable in the Chinese market than in Sierra Leone. This implied that *BF*, *BA*, *BC* and *SN* had a stronger influence on Chinese buyers' purchase decisions. Likewise, the outcome from H_1 indicated that chicken meat *PI* had a substantial effect on consumers' purchase behaviour in the two studied markets. Similar results were found for developing countries by Zayed et al. (2022), which confirmed these findings. We determined that *PI* is a possible indicator that favourably affects chicken meat APB in the two analysed markets.

The findings of the hypotheses H_{2b}–H_{5b} demonstrated that *PI* has an essential role in mediating between *BF*, *BA*, *SN*, *BC* and *APB* towards CM. The mediating effects of *PI* were more apparent in China than those in Sierra Leone, presumably because of high adherence to *BF*, *BA* and the influence of family members and friends (*SN*). Chinese consumers were strongly induced by these factors, which positively influenced their chicken meat *PI*. One study observed that *BF* and *BA* towards purchasing, when used as signals of organic meat *PI*, greatly boosted the meat industry's reputation in Vietnam (Nguyen et al. 2021). Moreover, *BF* has both direct and indirect effects on *CB* (Shahriari et al. 2019). Similarly, *SN* directly and indirectly affects Sierra Leonean and Chinese buyers' behaviour towards CM. These findings are consistent with those of Peña-Garcia et al. (2020), who found that *SN* positively influenced *APB* in Colombia and Spain.

The outcomes of H_{6a-e} revealed a substantial effect of *UA* on Sierra Leonean culture on the predictors of *PI* and *APB*, except for H_{6d}. In contrast, the moderating effect variable (*UA*) of the predictors on *PI* and *APB* was insignificant for China. This indicates that customers from Sierra Leone chose CM to navigate confusing circumstances and prevent uncertainty. This result agrees with Hofstede's rankings, which placed Sierra Leone at 50 points and China at 30 points for *UA*, implying that Sierra Leone and China have high and low *UA* levels. Chinese consumers were more accepting of ambiguity than Sierra Leonean consumers, who preferred to buy CM to avoid uncertainty.

The positive relationships between *PI* and *APB*, *BF* and *PI*, *BA* and *PI* and *BC* and *PI* were strengthened in Sierra Leone by high *UA*, as illustrated in Figures 5–8, while the negative impact of low UA was diminished. Based on the findings, buyers in Sierra Leone with high UA preferred CM over their counterparts in China with low *UA*. The slope of the interactions indicates that further research should be conducted regarding *UA* and premium CM. Therefore, Sierra Leonean consumers' chicken meat *PI* was impacted through *UA*.

https://doi.org/10.17221/331/2023-AGRICECON

Thus, Chinese consumers purchase CM as a result of attributes associated with the product, such as being free from chemicals, freshness, place of origin, certification, breeding method and other product considerations; therefore, it was observed that Chinese buyers are not impacted by UA when buying CM because of confidence in CM quality.

Implications

Theoretical implications. The conclusions of this research have several theoretical implications. The primary novelty of this study was the expansion of the TPB by incorporating the cultural factor of *UA* and the *BF* construct, which could be significant for future cross-cultural research. The second contribution of this work was building on earlier discoveries on the effect of psychological and cultural variables on consumers' chicken meat *PI* in China and Sierra Leone. Additionally, this study adds to the body of knowledge by including *UA* as a moderator in a proposed model, presenting a unique way to measure *UA* in relation to *PI* and *APB*.

This study also offers insight into the potentially new drivers of consumer PI that are thought to have a significant impact on chicken meat *PI* such as *BA*. The study also revealed how consumer responses to chicken meat PI differed across two different cultural value systems, as the first to compare the prevalence of this phenomenon in Asia and Africa. Subsequently, the study offers empirical support for the idea that *UA* is a significant exogenous variable for the TPB model because it affects multiple factors, as demonstrated.

Practical implications. When buyers are presented with a number of influential attributes that signify quality and safety in food buying decisions, as well as culturally inconsistent factors, it can cause them to become more cognitively stressed, resulting in diminished control over the interaction and a loss of focus. Because perceptions of quality differ between nations, consumers behave differently when making purchases to satisfy individual demands for safety and satisfaction. The primary marketing conclusion of this study is that it offers empirical evidence from the analysed markets that cultural dimensions are a significant factor in meat purchasing decisions, leading to a higher impression of meat quality and efficacy. The research indicates some useful approaches for meat producers and marketers who wish to incorporate attractive elements for such consumers into their products. The study's findings may be helpful to managers in the meat industry, who may reference it to develop strategic marketing tactics for nations with various cultures and those with similar cultures. By concentrating on the link between cognitive evaluation and consumer-perceived quality traits, meat producers can use these insights to improve desired outcomes and boost sales.

The practical implications could extend to commercial poultry firms' alteration of marketing strategies that improve sales across cultures. The findings revealed that consumers in both nations have similar chicken meat *PI*. Because consumers are more interested in the *BF* of chicken, the meat sector must understand the purchasing characteristics consumers consider and how they might influence their *APB*.

CONCLUSION

This study examined the impact of traditional psychological factors (*BA*, *SN* and *BC*), *BF* and *UA* on Chinese and Sierra Leonean chicken meat *APB*. We confirmed that the TPB is a vital framework for predicting and explaining the factors influencing chicken meat *APB* in cross-cultural contexts. We constructed a unique conceptual model incorporating cultural factors, buying features and traditional psychological factors to predict chicken meat *PI* and *APB* in the two distinct markets.

The empirical results revealed that Chinese and Sierra Leonean consumers held a positive attitude towards buying CM because of its quality, low cost and availability. Furthermore, *SN* and *BC* had positive and significant effects on chicken meat *PI* and *APB*. Among the extended constructs, *BF* had a positive impact on chicken meat PI and APB. This is an indication for CM traders to use labelling to highlight various features such as colour, appearance, taste and tenderness that will influence *CB* towards CM consumption. The findings revealed that *BA*, *SN*, *BC* and *BF* had a significant impact on chicken meat *PI* and *APB*; however, the impact of these constructs was more significant in China than in Sierra Leone. Thus, the livestock industry, particularly chicken production, should emphasise the inclusion of *BF* information on packaging. The findings of this study also indicated that *PI* mediated the relationship between the independent constructs and *APB*. Finally, *UA* partially moderated the links between *BF*, *BC*, *SN*, *BA* and *PI* and between *PI* and *APB* in the Sierra Leonean sample. Thus, chicken stakeholders in Sierra Leone, can segment their client base and focus on specific categories with persuasive strategies as a result of the cultural factor.

Limitations and recommendations for further study. Although this article addressed an essential con-

https://doi.org/10.17221/331/2023-AGRICECON

cept related to the factors that influence *PI* and *APB* for CM, there are some limitations that could be examined in future research. The study was implemented in two distinct countries. We suggest that future research should include more countries to improve the validity and applicability of culture in consumer purchase behaviour. We also suggest that additional cultural dimensions be included in any subsequent research on *PI* and *APB*. Our investigation considered four predictors (*BF*, *BA*, *SN* and *BC*) of *PI* and *APB* towards CM in the analysed countries. Subsequently, future research could include a larger number of predictors, including safety attributes, trust, health, ethical factors and environmental factors, to gain a more comprehensive view of countries' marketplaces and provide a more detailed picture from which stakeholders along the supply chain can develop strategies.

Acknowledgement: The authors thank the various institution that funded this project. We also thank the staff of College Of Economics and Management of South China Agricultural University.

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Received: October 1, 2023
Accepted: February 20, 2024

Electronic Commerce Research
https://doi.org/10.1007/s10660-024-09906-6

Pricing and duration decisions of pre-sale crowdfunding

Guanxiang Zhang[2] · Mengting Ren[2] · Kexuan Zhai[3] · Hui Li[1]

Accepted: 17 September 2024
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Abstract
Considering the impact of time on consumer decision-making, this paper constructs a two-stage pre-sale crowdfunding model in the crowdfunding stage and the general sales stage considering the degree of consumer patience and the conversion rate of potential consumers, studies the pricing strategy in the case of long-term crowdfunding and short-term crowdfunding, and analyzes the impact of patience and conversion rate on the time decision-making of crowdfunding from the perspective of starting capital and profit. The results show that with the improvement of the conversion rate of potential consumers, the optimal pricing in the two stages increases first and then decreases. With the increase in consumers' patience, the optimal pricing in the crowdfunding stage should be appropriately improved. In addition, from the perspective of start-up capital, in order to meet the minimum start-up capital requirements, initiators should choose short (long) time crowdfunding when consumers' patience is low (high). From the perspective of profit, when consumers' patience is low (high), they should choose short (long) time crowdfunding. When their patience is moderate, they should choose long (short) time crowdfunding when the conversion rate of potential consumers is small (large).

Keywords Pre-sell crowdfunding · Two-stage pricing · Timing decision · Consumer's behavior

✉ Hui Li
smarthuili@qq.com

[1] College of Economics and Management, South China Agricultural University, Guangzhou, Guangzhou, China

[2] Department of Electronic Business, South China University of Technology, Guangzhou, Guangzhou, China

[3] Nanhai Information Technology School, Foshan, Guangdong, China

Published online: 19 November 2024

1 Introduction

Crowdfunding refers to raising funds from the public through the Internet. The sponsors of crowdfunding get project support, and investors get in kind, services and other forms of financing in return [1]. Crowdfunding initially emerged in the USA. In 2003, the "crowdfunding" website artistshare first appeared. In 2008, the Indiegogo comprehensive crowdfunding platform was launched. In 2009, the establishment of KickStarter, a professional crowdfunding website, made a crowdfunding flourish. Various types of crowdfunding platforms have emerged, such as the product crowdfunding platform "Crowdfunder", the equity crowdfunding platform "Fundable", and the public welfare crowdfunding platform "GoFundMe". In 2011, crowdfunding entered China. The classic crowdfunding websites include "dianmingshijian", "renrenchuang", "Diwu Chuang", "dianchouwang" and "kaishiba". In recent years, major Internet giants have also entered the crowdfunding market, such as Zaodian Xinhuo under Taobao, Xiaomi Youpin under Xiaomi, JD crowdfunding under JD and Suning crowdfunding under Suning. According to statistics, the amount successfully raised through crowdfunding worldwide in 2015 exceeded 34 billion US dollars. Nowadays, in addition to the classic KickStarter, Indiegogo and other crowdfunding platforms, various types of crowdfunding platforms (such as Patreon in Europe and America, makuake and green funding in Japan, and modian crowdfunding in China) have entered the market. The world bank predicts that the global crowdfunding market will reach US $ 93 billion by 2025.

Pre-sale crowdfunding, equity crowdfunding, debt crowdfunding, and public welfare crowdfunding are the four categories into which the primary operating modes of crowdfunding are steadily subdivided [2]. Among them, Pre-sale crowdfunding, which includes the pre-sale stage and public sales stage, is the most popular type. Participants in this type of crowdfunding are consumers who pre-order products to participate in crowdfunding. For instance, during the pre-sale period, the "pebble" smart watch raised more than US $10 million through the KickStarter crowdfunding platform. The pre-order product was successfully developed by the initiator and placed into formal production, and the backer was able to get it on time. [1]

However, in practice, pre-sale crowdfunding often faces a high failure rate due to decision-making errors. Among them, pricing strategy and duration decisions have a significant impact on the success of crowdfunding. The pricing is too high and consumers are unwilling to buy; The pricing is too low, and crowdfunding faces the risk of financing failure. It is far from enough to consider only the pricing strategy, and there are also many crowdfunding projects that fail due to the unreasonable time setting of crowdfunding. The crowdfunding time is too short, and the risk of insufficient funding is high; The time of crowdfunding is too long, and consumers' willingness to buy products in the crowdfunding stage is reduced. As for the time of crowdfunding, the officials of mainstream crowdfunding platforms (such as KickStarter, Indiegogo, and Zaodian Xinhuo) give suggestions for 10–60 days, usually 30 or 60 days. Therefore, for enterprises that

use crowdfunding as a means of financing, it is of great practical significance to formulate a reasonable price strategy and select the appropriate crowdfunding duration in the early stage. The majority of current research focused on the pricing strategy and marketing mode in crowdfunding, ignoring the impact of crowdfunding time on consumer decision-making.

Motivated by the observed real-world practices, this paper attempts to explore how the duration of crowdfunding affects consumer choice s, enhances crowdfunding success rate and profit. We mainly consider two research objectives: (1) Provide pricing suggestions of pre-sale crowdfunding for enterprises: how to set two-stage pricing under different crowdfunding durations? how time affects consumer patience and potential consumer conversion rate, and how it further affects pricing decisions? (2) Provide possible guidelines for the duration of pre-sale crowdfunding: When to choose long-term crowdfunding be chosen? When to choose short-term crowdfunding?

To achieve the above two research objectives, we mainly discusses the following issues: (1) How is the two-stage pricing of pre-sale crowdfunding impacted by the various consumer traits in long-term and short-term crowdfunding? (2) How should sponsors pick between long-term and short-term crowdfunding to meet the needs of start-up funds? (3) How should sponsors pick between long-term and short-term crowdfunding in order to maximize profits?

Around the price and time decision-making in pre-sale crowdfunding, we constructs a two-stage advance-selling crowdfunding model that takes into account consumers' patience and potential consumers' conversion rate, investigates the pricing strategy in the case of long-time and short-time crowdfunding, and analyzes the influence of patience and conversion rate on crowdfunding time decision from the perspective of start-up capital and profit.

This paper finds that: (1) with the improvement of the conversion rate of potential consumers, the optimal pricing in the crowdfunding stage and the general sales stage shows a trend of first increasing and then decreasing. The pricing of the crowdfunding stage should be appropriately improved with the increase of consumers' patience. (2) From the perspective of start-up funds, when consumers' patience is low, short-term crowdfunding can make enterprises more likely to raise start-up funds; When consumers' patience is high, long-term crowdfunding can make enterprises more likely to raise start-up funds. (3) From the perspective of profit, if consumers are less patient, the profit of short-term crowdfunding is generally higher than that of long-term crowdfunding; If consumers are more patient, the profit of long-term crowdfunding is always higher. Long-term crowdfunding is the only option because short-term crowdfunding cannot be successful when the conversion rate of potential customers is low to a certain extent.

The organization is as follows. Section 2 reviews the literature related to our study. Section 3 presents the model setup. In Sect. 4, we solve the equilibrium analysis of our models. In Sect. 5, we discuss the crowdfunding pricing model and the duration decision from different perspective. Section 6 concludes the paper.

2 literature review

At present, the research on crowdfunding can be roughly divided into two categories: qualitative influencing factors and quantitative analysis. The majority of the literature on qualitative influencing factors is based on empirical studies, which use big data, questionnaires, and other techniques to empirically test the influence of public values, opinion leaders' social reputations, and other factors on the success of crowdfunding campaigns. First, in terms of project information, internal factors such as financial status, internal governance and risk factors have a greater impact on the success of crowdfunding [3]; The number of project updates is positively correlated with the success rate of crowdfunding [4]; Factors such as average limit are negatively correlated with the success rate of crowdfunding [5]. Many other scholars have conducted research from other perspectives and found that external environmental factors as well as internal and external comprehensive factors will also have an impact on the performance of crowdfunding. These factors include the geographic location of investors [6], the quantity of social media for crowdfunding [7], the social network [8] and the reputation of investors [9], as well as the number of project employees and shareholders [10].

Belleflamme et al. [1] conducted a ground-breaking quantitative research on the optimization of crowdfunding decision-making. They develop mathematical models of the pre-sale and equity crowdfunding modes and put forward the idea of community benefits, which sets crowdfunding participants apart from regular consumers. They then provide the marginal conversion conditions for business owners to choose between pre-sale crowdfunding and equity crowdfunding.On the basis of Belleflamme's research, Liu Bo et al. [11] considered the impact of platform and corporate reputation on the selection of pre-sale crowdfunding and equity crowdfunding modes, and they came to a conclusion regarding the benefits and drawbacks of each mode based on platform and corporate reputation, whether equity crowdfunding investors have preferences for products, starting investment threshold, and the size of initial capital demand. Bi Gongbing et al. [12] considered the impact of production costs and fixed costs and studied the impact of common single-stage crowdfunding and pre-sale two-stage crowdfunding on the project and the optimal decision. Xue Weili et al. [13] considered the impact of the competitive environment on the pricing strategy of pre-sale crowdfunding products and made a comparative analysis of crowdfunding and bank loans to study the optimal decision of enterprises. Zeng Yan et al. [14] studied the interest game behavior of financiers and crowdfunding investors in equity crowdfunding, analysed the optimal decision of financiers, and found that factors such as marginal income, project success probability and expected rate of return would affect the optimal decision. A three-stage crowdfunding approach was developed by Lvxiumei and Shaotengwei [15] and consists of the finance stage, the stage when products are provided to supporters and the stage where products are sold to regular consumers. They investigated the price strategy and financial goals of the sponsors, assuming the increased utility brought by consumers' patience and value-added. [1, 11–15]

Hu 's [16] establishment of a dynamic game choice model at the crowdfunding stage is another significant piece of quantitative research on the optimization of crowdfunding decision-making. He divided the crowdfunding participants into high-valuation users and low-valuation users. On this foundation, the benefits and drawbacks of four pricing strategies—profit-based, sales-based, intertemporal, and menu—as well as their application were examined and contrasted. Following the work of Hu et al., lv Zhengying et al. [17] increased the participant count to three and six price methods and determined the optimum conditions for each pricing strategy. Liu Zhengchi et al. [18] assumed two kinds of participants, ordinary consumers and geek consumers, and constructed a two-stage dynamic game model based on the difference in the perceived value of crowdfunding items, from which they examined the varied pricing strategy of businesses. Based on the assumption that there are two users with high and low valuations, Deng Wanjiang et al. [19] studied the market equilibrium of two types of participants in the context of crowdfunding and sales of new products and provided the pricing strategy and quality design that corresponds to the initiator.

In terms of crowdfunding time, Wu Wenqing et al. [29] found an inverted U-shaped relationship between the funding cycle and the actual amount of funding through empirical research. In the medical crowdfunding project, Zhuzhichao and others [31] also found that the amount of financing increased first and then decreased with time. Linxin et al. [28] based on the perspective of 4C marketing theory, concluded that there was a significant negative correlation between the number of days and the success rate in a library crowdfunding project. Wang Dongmei et al. [27] used the queuing model to study the optimal project cycle and price decision to maximize the profit per unit of time against the background of product crowdfunding. Pre-sale has gradually grown in popularity as a technique of advanced marketing in recent years. When Zhou Xiongwei et al. [30] took into account how consumers arrive and their preferred times, they discovered that whether or not to use a pre-sale strategy depends on the proportion of customers who are ready to make a cash purchase to the cost of sales per unit of time. While the discussion on consumers' time preferences in the quantitative aspect primarily uses the method of queuing theory, this paper innovates the method by taking into account the pricing and time decision-making in the crowdfunding stage and the sales stage. The aforementioned crowdfunding time research is primarily based on the qualitative method.

In particular, the length of time consumers are willing to wait is crucial for enterprises. Given that insufficient consumer patience can have a negative impact on future outcomes and service evaluations [35, 36], it is crucial to identify effective methods to reduce related negative effects impacts [37]. As the willingness to wait for the product or service is crucial, enterprises hope to increase customer patience [38]. However, in previous studies that focused on crowdfunding, there was little investigation into customer patience and its potential mechanisms. In this study, we mainly focus on how the duration of crowdfunding affects consumer patience and willingness to pay.

In addition, lv Xiaohui et al. [20] considered the two-stage crowdfunding model in which the consumer utility was damaged when crowdfunding failed and found that the success rate had a greater impact on the purchase rate of the two stages by

building a mathematical model. Qu Shaojian et al. [21] analyzed the differences in cost, financing amount and unit price between social crowdfunding and non-social crowdfunding. Liu Zhiying et al. [22] analyzed the optimization of the profit function of investors and fundraisers under different information conditions based on four explanatory variables: output, product launch, discount coefficient and innovation degree. Du et al. [25] established a general model to compare the sequential and synchronous mechanisms of product crowdfunding considering the fuzziness and over-financing effect of incentive crowdfunding. Ji Ying et al. [26] studied how enterprises can reduce the losses caused by imitation competition by optimizing the design of crowdfunding contracts, that is, to achieve a balance between the distortion of the traditional product market caused by crowdfunding and external imitation competition. Liu et al. [32] considered the observation learning effect in crowdfunding. They established a two-stage Stackelberg game model and found that under different pricing strategies (static or dynamic pricing), observation learning may be beneficial or harmful to profits. Liu et al. [33] then extended the pricing strategy to four types and discussed how to set the menu price under different financing objectives. [20–22, 25, 26, 32] and [33]

In conclusion, the present study on crowdfunding is primarily qualitative and examines a wide variety of topics, such as the influence of project information (corporate image, project concept) on crowdfunding success rate and the influence of external environmental factors on crowdfunding performance (social media, geographical location). On the quantitative side, researchers primarily examined the choice of crowdfunding mode, crowdfunding pricing strategy, and other issues, such as cost, user valuation, consumer utility, investors, platforms, and other aspects. This research was based on the two models created by Belleflamme and Hu. Unfortunately, not enough consideration has been given to how time, a significant influencing element, affects crowdfunding decision-making. This paper believes that it is worth further research on how crowdfunding time affects market demand, the impact of crowdfunding time on crowdfunding pricing, and the optimization decision-making of crowdfunding time. Therefore, this paper introduces the level of patience and conversion rate of potential consumers, builds the pre-sale crowdfunding price and time decision-making model based on the model of Belleflamme et al. [1], analyzes the crowdfunding optimization pricing taking the impact of time into account, and discusses the crowdfunding time optimization decision-making in different situations.

3 Model design

3.1 Model description and variable definition

Suppose an enterprise publishes a pre-sale crowdfunding project through the crowdfunding platform, and the starting capital is K. Consumers can participate in crowdfunding at price p_1 and p_2 in the crowdfunding stage and the general sales stage respectively. The supply chain structure is presented in Fig. 1.

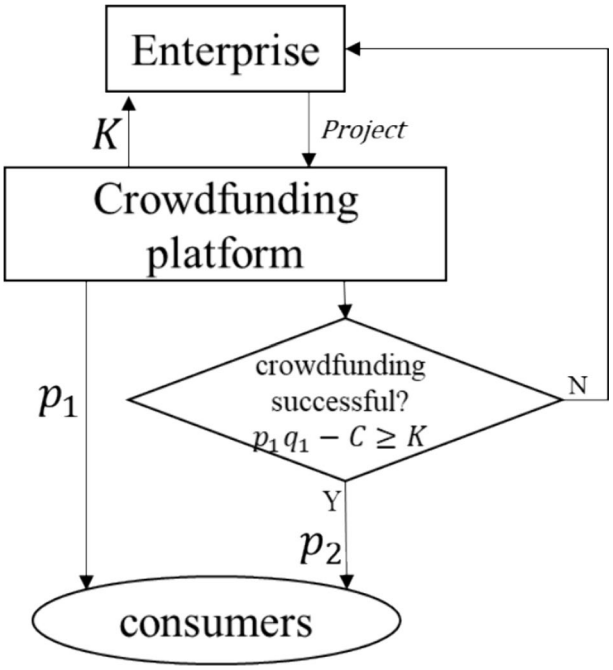


Fig. 1 The supply chain structure

Enterprises are faced with two stages: crowdfunding stage and general sale stage, with the goal of maximizing profit projects.

Decision making sequence of two stages

Crowdfunding stage

Suppose an enterprise publishes a crowdfunding project through the crowdfunding platform, it needs to make the following decisions before the release of the crowdfunding project: the first stage pricing (p_1), the second stage pricing (p_2), the starting capital (K) (i.e. the minimum amount of funding) and the choice of crowdfunding duration (long-term crowdfunding or short-term crowdfunding). After the approval of the platform, the crowdfunding project will be released, and the crowdfunding participants will participate in the crowdfunding in the form of pre-purchase. The pre-sale money will be kept by the platform temporarily. After the deadline of the crowdfunding, if the total amount of the pre-sale money minus the Commission, marketing and other costs is not less than the starting capital, the crowdfunding of the project will be successful. Otherwise, the crowdfunding of the project will fail, and all the pre-sale money will be returned to the crowdfunding participants. This is the first stage (crowdfunding stage).

(2) General sale stage

After the success of crowdfunding, the platform will transfer the funds to the enterprise, the enterprise will put into production and deliver the products to the crowdfunding investors, and the follow-up products will be officially listed.

General consumers can participate in the purchase, which is the second stage (general sale stage). The main decisions in this process are shown in Fig. 2.

Main factors to be considered for enterprises to make time decisions:

(1) Relationship between crowdfunding duration and consumer patience

Previous studies have used subjective ratings [39], and the willingness to wait [40, 41] and [42] to explore consumer patience. In this study, we examined consumer patience by the willingness to wait, which is related with time. The consumers' patience is taken into account only in the crowdfunding stage because they must wait until the end of the crowdfunding period to obtain products, but they can get products immediately in the general sales stage. With the same waiting time, the higher the degree of patience, the greater the consumer's valuation of the product. In this article, ε denotes the degree of consumer's acceptance of waiting and $\varepsilon \in (0, 1)$. If the waiting time is t, the degree of the consumer's patience is ε^t. Assuming that the time of crowdfunding participants' consumption behavior is evenly distributed, the average waiting time is half of the crowdfunding time, that is, when the crowdfunding time is 30 days, consumers need to wait for 15 days; When the crowdfunding time is 60 days, consumers need to wait 30 days. As mentioned above, the crowdfunding time is 30 days or 60 days, making 15 days a cycle, and the waiting time of long-term crowdfunding is twice that of short-term crowdfunding, that is. The longer the crowdfunding time, the less patient consumers are, that is $\varepsilon^s = \varepsilon, \varepsilon^l = \varepsilon^2$ and $\varepsilon^s > \varepsilon^l$.

(2) The relationship between the duration of crowdfunding and the conversion rate of potential consumers

As for the conversion rate of potential consumers, it is reasonable to assume that all potential customers will participate in the purchase during the general sales stage due to the unlimited sales time, whereas not all potential customers have access to the product during the crowdfunding stage due to the limited time. The same assumption has been mentioned in some literature [45]. The conversion rate of potential customers is calculated during the crowdfunding phase as the proportion of consumers who can actually purchase the product to all consumers who are interested in it. λ_i denotes the conversion rate of potential consumers [44]. When presale lead-time is longer, consumer's presale intent is higher [43].The longer the crowdfunding time, the longer the product exposure time, the more potential consumers who can contact crowdfunding products, and the higher the conversion rate of consumers, that is $\lambda_s < \lambda_l$.

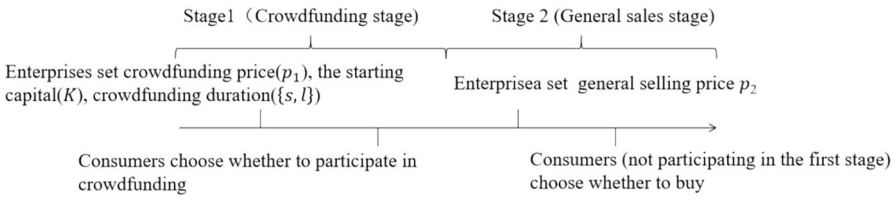


Fig. 2 Schematic diagram of the two-stage pre-sale crowdfunding decision

Table 1 summarizes the symbols and definitions of relevant variables in this paper.

3.2 Model construction

The total market volume is 1. θ is the valuation of the product by consumers and follows the uniform distribution in [0,1]. Overvalued consumers may participate in crowdfunding in the first stage (crowdfunding stage), while undervalued consumers may purchase crowdfunding products in the second stage (general sale stage). In the first stage, the time is limited, and not all potential consumers can access the project, so the conversion rate of consumers should be considered; There is no time limit in the second stage, and it is reasonable to assume that all potential consumers will participate in the purchase, so it is not necessary to consider the conversion rate of consumers.

The first stage consumer utility function is

$$U_{1i} = \varepsilon^i \theta - p_{1i} \tag{1}$$

In Eq. (1), since consumers in the first stage cannot obtain products immediately, it is necessary to consider the patience of consumers. The longer the crowdfunding time, the smaller ε^i.

When $U_{1i} = 0$, $\theta_{1i} = \frac{p_{1i}}{\varepsilon^i}$.According to the classic supply chain model established by Chiang et al. [23], not all potential consumers can access the project in the first stage, so it is necessary to consider the consumer conversion rate. The sales volume in the first stage is [23]

Table 1 Model symbols and definitions

symbol	Definition description
θ	Consumers' valuation of products follows the uniform distribution in [0,1]
i	Crowdfunding duration $i = \{s, l\}$.s denotes short-term crowdfunding,l denotes long-term crowdfunding and $l = 2s$
ε	The degree of consumer patience is equivalent to the discount factor,$\varepsilon \in (0, 1)$
λ_i	λ_i denotes the conversion rate of potential consumers. The longer the presale lead-time, the higher the conversion rate of potential consumers,$\lambda_i \in (0, 1)$
p	Product pricing. p_{1i} denotes pricing for the first stage, p_{2i} denotes pricing for the second stage
q	The sales volume of products. q_{1i} denotes the sales volume of the first stage and q_{2i} denotes the sales volume of the second stage
C_i	Costs, including commissions paid to crowdfunding platforms and marketing and customer service costs, are linearly related to time
π_{1i}	Profit.π_{1i} is the first stage profit and π_{2i} is the second stage profit
Π_i	Total profit
K	Starting capital

$$q_{1i} = \lambda_i \int_{\theta_{1i}}^{1} d\theta = \lambda_l (1 - \frac{p_{1i}}{\varepsilon^i}) \tag{2}$$

The sponsors of crowdfunding need to pay a certain commission to the crowdfunding platform for the release of crowdfunding projects, including the follow-up costs of marketing and customer service. These costs are basically linear with time, so the cost is reasonably expressed as

$$C_i = \begin{cases} b, i = s \\ 2b, i = l \end{cases} \tag{3}$$

Therefore, the profit in the first stage is

$$\pi_{1i} = \lambda_i \left(1 - \frac{p_{1i}}{\varepsilon^i}\right) p_{1i} - C_i \tag{4}$$

In the second stage, consumers can get products immediately without considering the degree of the patience of consumers. Therefore, the second stage consumer utility function can be expressed as

$$U_{2i} = \theta - p_{2i} \tag{5}$$

As the sales time is not limited, it is reasonable to assume that all potential consumers will be transformed into real consumers. Since the sales volume in the second stage includes potential consumers in the first stage (see Fig. 3), in order to avoid double counting, this part should be excluded. Therefore, the sales volume in the second stage is

$$q_{2i} = \int_{\theta_{2i}}^{\theta_{1i}} d\theta + (1 - \lambda_i) \int_{\theta_{1i}}^{1} d\theta = 1 - p_{2i} + \frac{\lambda_i p_{1i}}{\varepsilon^i} - \lambda_i \tag{6}$$

Therefore, the profit in the second stage is

$$\pi_{2i} = p_{2i} \left(1 - p_{2i} + \frac{\lambda_i p_{1i}}{\varepsilon^i} - \lambda_i\right) \tag{7}$$

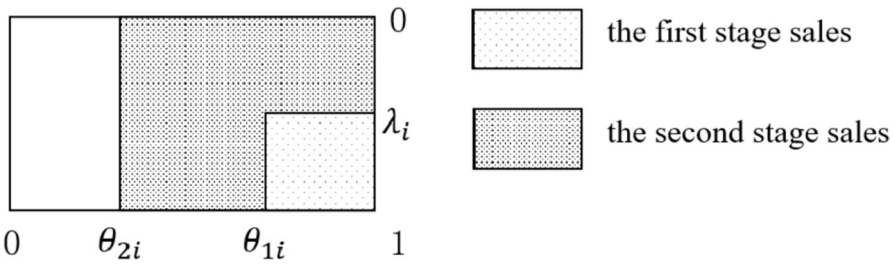


Fig. 3 Schematic diagram of two-stage sales

To sum up, the total profit obtained by subtracting the total cost from the income of the two stages is

$$\Pi_i = \pi_{1i}+\pi_{2i}=\lambda_i\left(1-\frac{p_{1i}}{\varepsilon^i}\right)p_{1i} - C_i + p_{2i}\left(1-p_{2i}+\frac{\lambda_i p_{1i}}{\varepsilon^i}-\lambda_i\right) \tag{8}$$

4 Model solving

Referring to the model of Belleflamme et al. [1], we use the reverse induction method to solve the price decision problem.

41. Without considering the constraint of starting capital

The decision-making problem of the enterprise in the second stage is $\max_{p_{2i}} \pi_{2i}$. Bring Eq. (7) into it and find the first partial derivative of the formula with respect to p_{2i}

$$p_{2i}^* = \frac{1-\lambda_i+\frac{\lambda_i p_{1i}}{\varepsilon^i}}{2} \tag{9}$$

Substitute Eq. (9) into Eq. (8) to obtain the total profit function:

$$\Pi_i = \lambda_i\left(1-\frac{p_{1i}}{\varepsilon^i}\right)p_{1i} + \frac{\left(1-\lambda_i+\frac{\lambda_i p_{1i}}{\varepsilon^i}\right)^2}{4} - C_i \tag{10}$$

The decision problem in the first stage is $\max_{p_{1i}} \prod_i$. According to the first-order condition, the optimal price in the first stage is $p_{1i}^* = \frac{\varepsilon^i(2\varepsilon^i-\lambda_i+1)}{4\varepsilon^i-\lambda_i}$, the optimal price in the second stage is $p_{2i}^* = \frac{\varepsilon^i(2-\lambda_i)}{4\varepsilon^i-\lambda_i}$, and the total profit is $\Pi_i^* = \frac{\varepsilon^i(\varepsilon^i\lambda_i-\lambda_i+1)}{4\varepsilon^i-\lambda_i} - C_i$.

4.2. Considering the constraint of starting capital

Without considering the constraint of starting capital, enterprises can use the optimal pre-sale price to maximize profits. However, the funds raised in the crowdfunding stage may be less than the starting funds, that is $\pi_{1i} < K$, the project cannot be started. For this purpose, let $\pi_{1i} = K$ to obtain the boundary conditions for the project start-up. Two roots can be obtained by solving the quadratic equation. Because the enterprise pursues greater profits, the larger root is taken as the solution of the equation. The optimal boundary solutions of short-time crowdfunding and long-time crowdfunding are

$$p_{1s} = \frac{\varepsilon}{2} + \frac{\sqrt{\varepsilon^2 \lambda_s^2 - 4K\varepsilon\lambda_s - 4\varepsilon b\lambda_s}}{2\lambda_s} \tag{11}$$

$$p_{1l} = \frac{\varepsilon^2}{2} + \frac{\sqrt{\varepsilon^4 \lambda_l^2 - 4K\varepsilon^2\lambda_l - 8\varepsilon^2 b\lambda_l}}{2\lambda_l} \tag{12}$$

The analysis shows that the pricing strategies of short-term crowdfunding and long-term crowdfunding sometimes get the boundary solution, and sometimes get the optimal solution. Taking short-term crowdfunding as an example, as shown in Fig. 4A, the value range of p_{1s} is limited to the shaded part and the straight line is the analytical optimal solution of the first stage price. When the analytical optimal solution is not within the shadow range, no solution can be obtained; When the analytical optimal solution is at the boundary of the shadow region, the boundary solution of the shadow region (oval region) is obtained; When the analytical optimal solution is within the shadow range, the optimal solution within the shadow region (rectangular region) is obtained. The same is true of long-term crowdfunding, as shown in Fig. 4B.

Next, we solve the transformation conditions between the optimal solution and the boundary solution. By substituting the optimal solution of the first stage price into Eqs. (11) and (12), the marginal conversion rates of the optimal solution and boundary solution of short-time crowdfunding and long-time crowdfunding are obtained as follows:

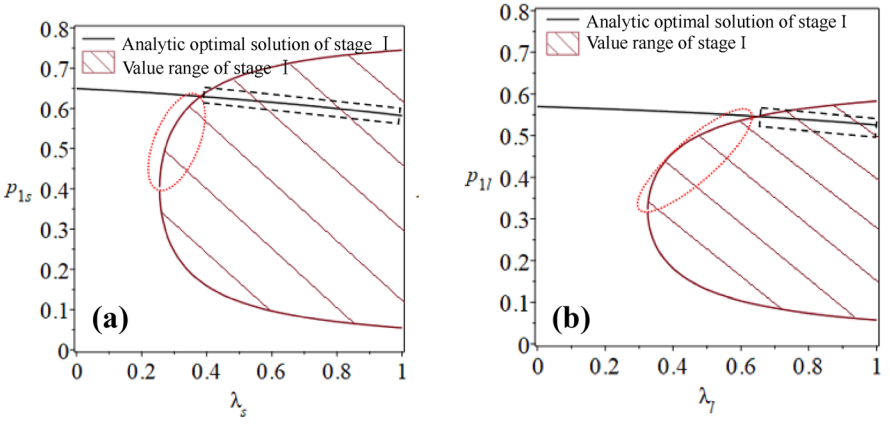


Fig. 4 **A** pricing range of the first stage of short-term crowdfunding. **B** pricing range of the first stage of long-term crowdfunding

$$R_s=\frac{\left(4\varepsilon^2+8K+8b-1-\sqrt{(1-2\varepsilon)^2\left(4\varepsilon^2-16K+4\varepsilon-16b+1\right)}\right)\varepsilon}{4\varepsilon^2+2K-2\varepsilon+2b} \tag{13}$$

$$R_l=\frac{\left(4\varepsilon^4+8K+16b-1-\sqrt{\left(2\varepsilon^2-1\right)^2\left(4\varepsilon^4-16K+4\varepsilon^2-32b+1\right)}\right)\varepsilon^2}{4\varepsilon^4+2K-2\varepsilon^2+4b} \tag{14}$$

5 Summary

According to the above analysis, the profit function of pre-sale crowdfunding can be expressed as a piecewise function of the conversion rate of potential consumers. The optimal pricing and total profit of short-term crowdfunding and long-term crowdfunding are summarized as follows.

When the analytical optimal solution of p_{1s} and p_{1l} can be obtained, the first stage pricing is substituted to obtain the second stage pricing and total profit.

From the above calculation, we can get the optimal pricing and total profit of short-term crowdfunding and long-term crowdfunding.

Proposition 1 *The two-stage optimal pricing and total profit of short-term crowdfunding can be divided into two cases according to the conversion rate, as shown in Table 2.*

$$\text{where } R_s=\frac{\left(4\varepsilon^2+8K+8b-1-\sqrt{(1-2\varepsilon)^2\left(4\varepsilon^2-16K+4\varepsilon-16b+1\right)}\right)\varepsilon}{4\varepsilon^2+2K-2\varepsilon+2b}$$

Proposition 2 *Two-stage optimal pricing and total profit basis for long-term crowdfunding. The conversion rate is divided into two cases, as shown in Table 3.*

Table 2 Optimal pricing strategy of short-term crowdfunding

	$0<\lambda_s\le R_s$	$R_s\le\lambda_s\le 1$
p_{1s}^*	$\frac{\varepsilon}{2}+\frac{\sqrt{\varepsilon^2\lambda_s^2-4K\varepsilon\lambda_s-4\varepsilon b\lambda_s}}{2\lambda_s}$	$\frac{\varepsilon\left(2\varepsilon-\lambda_s+1\right)}{4\varepsilon-\lambda_s}$
p_{2s}^*	$\frac{-\varepsilon\lambda_s+\sqrt{\varepsilon^2\lambda_s^2-4K\varepsilon\lambda_s-4\varepsilon b\lambda_s+2\varepsilon}}{4\varepsilon}$	$\frac{\varepsilon\left(2-\lambda_s\right)}{4\varepsilon-\lambda_s}$
Π_s^*	$\frac{(2-\lambda_s)\sqrt{4\left(\frac{\varepsilon\lambda_s}{4}-K-b\right)\varepsilon\lambda_s+\varepsilon\lambda_s^2-2(K+b+\varepsilon)\lambda_s+(8K+2)\varepsilon}}{8\varepsilon}$	$\frac{\varepsilon\left(\varepsilon\lambda_s-\lambda_s+1\right)}{4\varepsilon-\lambda_s}-b$

Table 3 Optimal pricing strategy of long-term crowdfunding

	$0 < \lambda_l \le R_l$	$R_l \le \lambda_l \le 1$
p_{1l}^*	$\frac{\varepsilon^2}{2} + \frac{\sqrt{\varepsilon^4\lambda_l^2 - 4K\varepsilon^2\lambda_l - 8\varepsilon^2 b\lambda_l}}{2\lambda_l}$	$\frac{\varepsilon^2(2\varepsilon^2-\lambda_l+1)}{4\varepsilon^2-\lambda_l}$
p_{2l}^*	$\frac{(2-\lambda_l)\varepsilon^2+\sqrt{\varepsilon^2(\lambda_l\varepsilon^2-4K-8b)\lambda_l}}{4\varepsilon^2}$	$\frac{\varepsilon^2(2-\lambda_l)}{4\varepsilon^2-\lambda_l}$
Π_l^*	$\frac{(\lambda_l-2)\sqrt{4\varepsilon^2\left(\frac{\lambda_l\varepsilon^2}{4}-K-2b\right)\lambda_l+\lambda_l^2\varepsilon^2-2(K+2b+\varepsilon^2)\lambda_l+(8K+2)\varepsilon^2}}{8\varepsilon^2}$	$\frac{\varepsilon^2(\varepsilon^2\lambda_l-\lambda_l+1)}{4\varepsilon^2-\lambda_l} - 2b$

where $R_l = \dfrac{\left(4\varepsilon^4 + 8K + 16b - 1 - \sqrt{\left(2\varepsilon^2-1\right)^2\left(4\varepsilon^4 - 16K + 4\varepsilon^2 - 32b + 1\right)}\right)\varepsilon^2}{4\varepsilon^4 + 2K - 2\varepsilon^2 + 4b}$

Proposition 1 and Proposition 2 show that there is an inflection point R_i in both short-term crowdfunding and short-term two-stage pricing. Taking this point as a boundary, the sensitivity analysis of optimal pricing is carried out.

Corollary 1 *When $\lambda_i < R_i$, the optimal pricing in the first stage and the second stage increased with the increase of potential consumer conversion rate*; *When $R_i \le \lambda_i \le 1$, the optimal pricing in the first and second stages decreased with the increase of the conversion rate of potential consumers.*

Proof: When $\lambda_i < R_i$, the first-order partial derivative can be obtained $\frac{\partial p_{1i}^*}{\partial \lambda_i} = \frac{\varepsilon^i(K+C_i)}{\lambda_i\sqrt{(\varepsilon^i\lambda_i-4K-4C_i)\varepsilon^i\lambda_i}}$. Because $\varepsilon^i \in (0,1)$, $K > 0$ and $C_i > 0$, obviously, the equation is positive. The same can be said, $\frac{\partial p_{2i}^*}{\partial \lambda_i} = \frac{2\varepsilon^i\lambda_i - 2K - 2C_i - \sqrt{\varepsilon^i\lambda_i(\varepsilon^i\lambda_i - 4K - 4C_i)}}{4\sqrt{\varepsilon^i\lambda_i(\varepsilon^i\lambda_i - 4K - 4C_i)}} > 0$

When $R_i \le \lambda_i \le 1$, the first-order partial derivative can be obtained $\frac{\partial p_{1i}^*}{\partial \lambda_i} = \frac{\varepsilon^i(\varepsilon^i-1)}{(4\varepsilon^i-\lambda_i)^2}$. Because $\varepsilon^i \in (0,1)$, this formula is obviously negative. $\frac{\partial p_{2i}^*}{\partial \lambda_i} = \frac{-4\varepsilon^{i2}}{(4\varepsilon^i-\lambda_i)^2}$ can be obtained by solving the first partial derivative, which is obviously negative.

To sum up, When $\lambda_i < R_i$, $\frac{\partial p_{1i}^*}{\partial \lambda_i}$ and $\frac{\partial p_{2i}^*}{\partial \lambda_i}$ were both positive; When $R_i \le \lambda_i \le 1$, $\frac{\partial p_{1i}^*}{\partial \lambda_i}$ and $\frac{\partial p_{2i}^*}{\partial \lambda_i}$ were both negative.

Corollary 1 Shows that when the conversion rate is low, the consumer group is small. If the pricing is too low, it is more likely that the starting capital requirements will not be met after the completion of crowdfunding. Therefore, in order to make crowdfunding successful, it is necessary to appropriately raise the price to obtain higher profits; When the conversion rate is high, the consumer group is large. Under the premise of meeting the requirements of start-up funds, the price can be appropriately reduced to attract more consumers to participate in crowdfunding, so as to improve the total profit.

Corollary 2 *If $\lambda_i < R_i$, the optimal pricing in the first stage and the second stage increased with the increase of patience*; *If $R_i \le \lambda_i \le 1$, the optimal pricing in the first stage increased with the increase of patience, and the optimal pricing in the second stage decreased with the increase of patience.*

Proof: When $\lambda_i < R_i$, the expressions of the optimal pricing in the first stage and the second stage are respectively.

$p_{1i}^* = \frac{\varepsilon^i}{2} + \frac{\sqrt{\varepsilon^{i2}\lambda_i^2 - 4K\varepsilon^i\lambda_i - 8\varepsilon^i b\lambda_i}}{2\lambda_i}$ and $p_{2i}^* = \frac{(2-\lambda_i)\varepsilon^i - \sqrt{\varepsilon^{i2}\lambda_i^2 - 4K\varepsilon^i\lambda_i - 8\varepsilon^i b\lambda_i}}{4\varepsilon^i}$, which can be obtained by solving the first partial derivative α_i.

$\frac{\partial p_{1i}^*}{\partial \alpha_i} = \frac{\varepsilon^i\lambda_i - 2K - 2C_i + \sqrt{(\varepsilon^i\lambda_i - 4K - 4C_i)\varepsilon^i\lambda_i}}{2\sqrt{(\varepsilon^i\lambda_i - 4K - 4C_i)\varepsilon^i\lambda_i}}$,

$\frac{\partial p_{2i}^*}{\partial \varepsilon^i} = \frac{\lambda(K + C_i)}{2\varepsilon^i\sqrt{\varepsilon^i\lambda_i(\varepsilon^i\lambda_i - 4K - 4C_i)}}$. If the optimal pricing in the first stage exists, then there is $\varepsilon^i\lambda_i - 4K - 4C_i \ge 0$. Since K, b, C are all positive, we can get that $\frac{\partial p_{1i}^*}{\partial \varepsilon^i}$ and $\frac{\partial p_{2i}^*}{\partial \varepsilon^i}$ are all positive.

When $R_i \le \lambda_i \le 1$, the expression of the optimal pricing in the first stage was $p_{1i}^* = \frac{\varepsilon^i(2\varepsilon^i - \lambda_i + 1)}{4\varepsilon^i - \lambda_i}$. the first-order partial derivative of α_i was $\frac{\partial p_{1i}^*}{\partial \varepsilon^i} = \frac{(2\varepsilon^i - \lambda_i)^2 + 4\varepsilon^{i2} + \lambda_i}{(4\varepsilon_i^i - \lambda_i)^2}$, which was obviously positive. The optimal pricing expression in the second stage is $p_{2i}^* = \frac{\varepsilon^i(2-\lambda_i)}{4\varepsilon^i - \lambda_i}$. By solving the first-order partial derivative of α_i, we can get. $\frac{\partial p_{2i}^*}{\partial \varepsilon^i} = \frac{(-2+\lambda_i)\lambda_i}{(4\varepsilon^i - \lambda_i)^2}$. Because $\lambda_i \in (0, 1)$, the above equation is obviously negative.

To sum up, if $\lambda_i < R_i$, $\frac{\partial p_{1i}^*}{\partial \varepsilon}$ and $\frac{\partial p_{2i}^*}{\partial \varepsilon}$ were both positive; if $R_i \le \lambda_i \le 1$, $\frac{\partial p_{1i}^*}{\partial \varepsilon}$ is positive and $\frac{\partial p_{2i}^*}{\partial \varepsilon}$ is negative.

Corollary 2 shows that the optimal pricing should consider both the conversion rate and the degree of patience. When the conversion rate is low, the consumer group is small. If the patience of consumers is low, the possibility of consumers' loss is greater when increasing the price. Therefore, it is necessary to reduce the price appropriately. On the contrary, consistent with inference 1, the price can be increased appropriately. When the conversion rate is high, the consumer group is large. Since the goal of the first stage is to raise start-up funds, the pricing of the first stage can be appropriately improved according to the degree of patience; The second stage is the general sales stage. At this time, reducing the price to attract consumers will bring more profits than the loss of price reduction, so the pricing in the second stage can be appropriately reduced.

It can be seen from Fig. 3 that the optimal pricing can only be obtained within the shadow range, that is, there is a lower boundary for the optimal pricing, and proposition 3 and proposition 4 can be obtained by discussing this boundary.

Proposition 3 *The upper limit of start-up funds for successful short-term crowdfunding is $K \le \frac{\lambda_s\varepsilon}{4} - b$.*

Proof the conditions for the success of short-term crowdfunding are.

$$\frac{\varepsilon}{2}-\frac{\sqrt{\varepsilon^2\lambda_s^2-4K\varepsilon\lambda_s-4\varepsilon b\lambda_s}}{2\lambda_s}\le p_{1s}\le\frac{\varepsilon}{2}+\frac{\sqrt{\varepsilon^2\lambda_s^2-4K\varepsilon\lambda_s-4\varepsilon b\lambda_s}}{2\lambda_s}$$

For the existence of a condition, we need to solve.p_{1s} $0\le\varepsilon^2\lambda_s^2-4K\varepsilon\lambda_s-4\varepsilon b\lambda_s$ $K\le\frac{\lambda_s\varepsilon}{4}-b$.

Proposition 4 *The upper limit of start-up funds for successful long-term crowdfunding is* $K\le\frac{\lambda_l\varepsilon^2}{4}-2b$.

Proof: The conditions for successful long-term crowdfunding are.
$\frac{\varepsilon^2}{2}-\frac{\sqrt{\varepsilon^4\lambda_l^2-4K\lambda_l\varepsilon^2-8b\lambda_l\varepsilon^2}}{2\lambda_l}\le p_{1l}\le\frac{\varepsilon^2}{2}+\frac{\sqrt{\varepsilon^4\lambda_l^2-4K\lambda_l\varepsilon^2-8b\lambda_l\varepsilon^2}}{2\lambda_l}$.For the existence of a condition, we need to solve $0\le\varepsilon^4\lambda_l^2-4K\lambda_l\varepsilon^2-8b\lambda_l\varepsilon^2$.We can get $K\le\frac{\lambda_l\varepsilon^2}{4}-2b$.

Proposition 3 and proposition 4 show that the upper limit of starting capital of long-term and short-term crowdfunding increases with the increase of conversion rate and patience. The conversion rate and patience will increase.

Inference 3 can be obtained from proposition 3 and proposition 4.

Corollary 3 *If* $\lambda_l>\frac{\lambda_s\varepsilon+4b}{\varepsilon^2}$, *the upper limit of starting capital for long-term crowdfunding was high*, *on the contrary*, *the upper limit of short-term crowdfunding was high*.

Inference 3 shows that there are conversion conditions between the upper limit of long-term crowdfunding and short-term crowdfunding, and enterprises should choose long-term crowdfunding and short-term crowdfunding according to the level of start-up funds.

6 Numerical analysis and discussion

6.1 Impact of conversion rate and patience on pricing strategy

In order to analyze the impact of potential consumer conversion rate and consumer patience on the two-stage pricing strategy, according to the research of Yiangos and Savva [24], we set $K=0.05$, $\varepsilon=0.3,\ 0.6,\ 0.9$ and draw the images of the two-stage pricing strategy of short-term crowdfunding and long-term crowdfunding, as shown in Figs. 5 and 6. From left to right indicates the situation when $\varepsilon=0.3,\ 0.6,\ 0.9$. [24]

It can be found from the figure that:

(1) Whether it is short-term crowdfunding or long-term crowdfunding, the optimal pricing in the first stage (crowdfunding stage) and the second stage (general sale stage) increases first and then decreases with the increase of conversion rate,

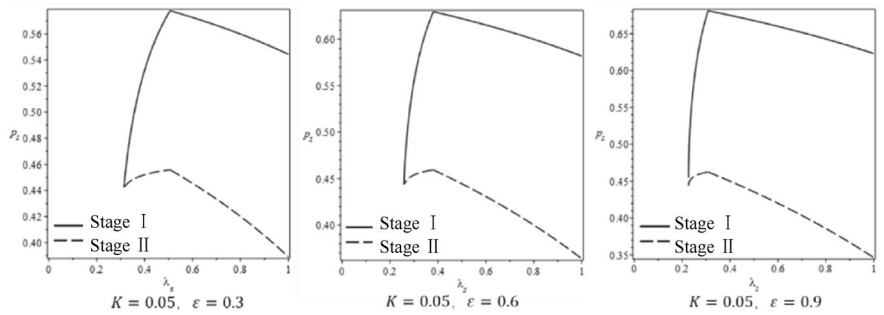


Fig. 5 impact of conversion rate and patience on pricing strategy under short-term crowdfunding

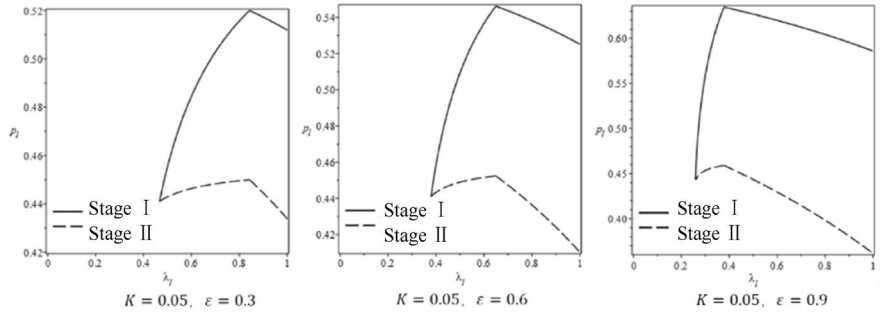


Fig. 6 impact of conversion rate and patience on pricing strategy under long-term crowdfunding

and there is a turning point in the middle. This is consistent with inference 1. On the left side of the inflection point, the conversion rate of potential consumers is relatively small and the consumer group is small, so it is necessary to formulate lower crowdfunding pricing to achieve the goal of minimum starting capital; As the conversion rate increases and the consumer base increases, the crowdfunding price can be appropriately raised. At this time, although the overall market demand has declined, the enterprise profit can be increased on the premise of meeting the minimum starting capital. On the right side of the inflection point, the optimal crowdfunding price is not constrained by the start-up capital. At this stage, more high-priced consumers can be attracted. Enterprises can appropriately reduce pricing and expand sales at the crowdfunding stage to obtain greater profits.

(2) The higher the degree of patience, the more left the turning point. At this time, as the degree of patience increases, the higher the consumer valuation, and the optimal crowdfunding price is constrained by the starting capital, the requirement for the minimum conversion rate is reduced, and the value range of the conversion rate that can get the analytical optimal solution will increase, and the turning point will be more left.

(3) Whether it is short-term crowdfunding or long-term crowdfunding, the higher the degree of patience, the higher the optimal pricing in the first stage (crowdfunding

stage). This is consistent with inference 2. Because the more patient consumers are, the more consumer surplus can be extracted. Enterprises can make more profits by appropriately raising the price of crowdfunding.

6.2 Duration decision of crowdfunding from the perspective of startup funds

Start-up funding is a practical problem that enterprises need to consider in crowdfunding. If the funds raised in the first stage cannot meet the start-up fund standard, the crowdfunding project will fail. This section will analyze what kind of crowdfunding time decisions enterprises should make to meet the requirements of target start-up funds.

Let $\varepsilon = 0.3, 0.6, 0.9$, according to inference 3, we can draw the partition of long-time crowdfunding and short-time crowdfunding on the conversion rate (see Fig. 7). Among them, the upper limit of long-term crowdfunding start-up funds is high in the region I, and the upper limit of short-term crowdfunding start-up funds is high in the region II.

Compared with figure (a), figure (b) and figure (c), it can be found that when the patient degree is small, the area of region II is larger; With the increase of patience, the area of the region I increases, that is, the upper limit of long-term crowdfunding start-up funds is higher than that of short-term crowdfunding start-up funds.

Therefore, in order to meet the requirements of start-up funds, enterprises often choose short-term crowdfunding when they are less patient; When the degree of patience is large, it is more likely to choose long-term crowdfunding. This is because when consumers are less patient, the longer the crowdfunding time, the more likely consumers are not willing to wait, and the more customers are lost in the crowdfunding stage. Therefore, there are more cases where the upper limit of short-term crowdfunding is higher than that of long-term crowdfunding, and short-term crowdfunding is more suitable. With the improvement of consumers' patience, the disadvantage of long waiting time for crowdfunding is no longer obvious. The advantage of long-time crowdfunding with a high conversion rate is highlighted, which can attract more potential consumers to participate in the first stage. Therefore, the upper limit of long-term crowdfunding is higher than that of short-term crowdfunding, and long-term crowdfunding is more suitable.

6.3 Duration decision of crowdfunding from the perspective of profit

In order to maximize profits, enterprises should make what kind of crowdfunding time decision. This section will discuss how patience and conversion rate affect crowdfunding time decisions from a profit perspective.

Since the conversion rate of long-term crowdfunding must be higher than that of short-term crowdfunding, that is $\lambda_l > \lambda_s$, referring to the research on the relationship between conversion rate and time in the existing paper [9] and the reality, two situations are analyzed here. $(1)\lambda_l = 1.6\lambda_s, \lambda_s \in \left(0, \frac{5}{8}\right)$.The conversion

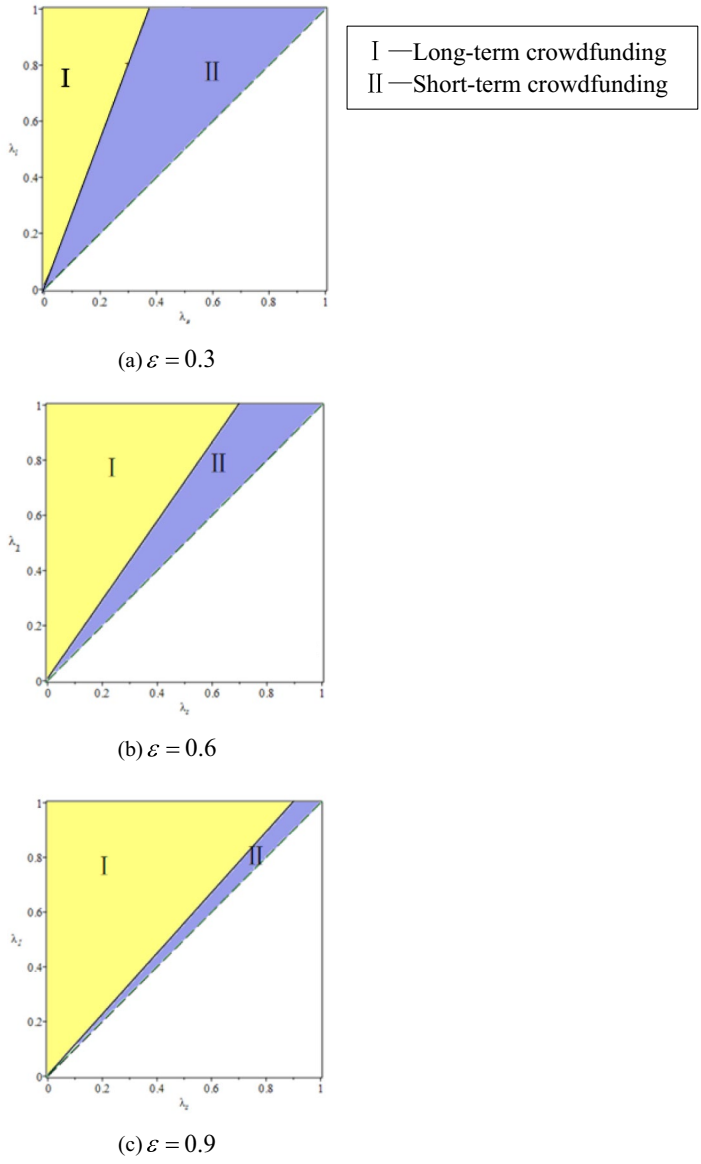
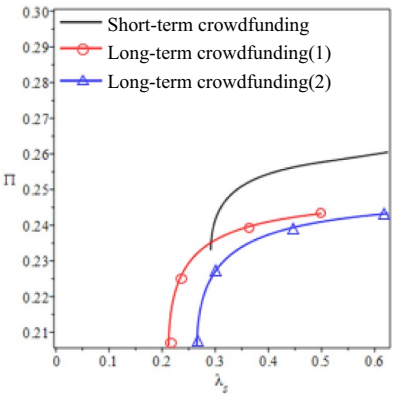


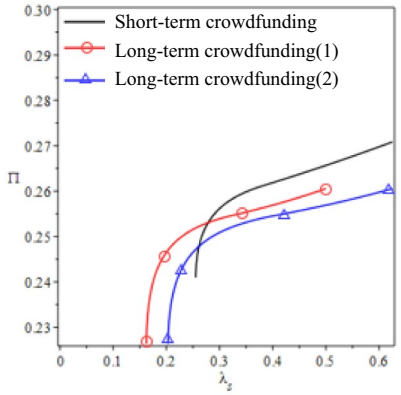
Fig. 7 impact of starting capital ceiling on crowdfunding time decision

rate is a concave function with respect to time; (2)$\lambda_l = 2\lambda_s$,$\lambda_s \in \left(0, \frac{1}{2}\right)$.The conversion rate is a linear function with respect to time[9] .

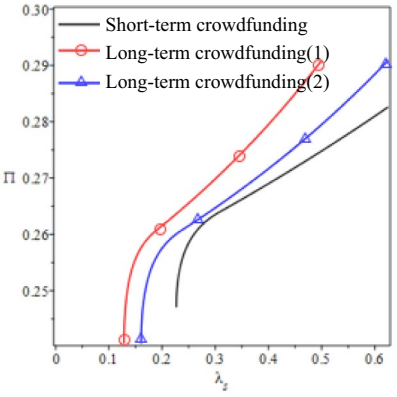
According to the optimal profit function (proposition 1 and Proposition 2) of long-time crowdfunding and short-time crowdfunding, we set $K = 0.05$,$\varepsilon = 0.3$, 0.6, 0.9 and draw the profit changes of long-time crowdfunding and short-time crowdfunding under different conversion rates, as shown in Fig. 8.



(a) $\varepsilon = 0.3$



(b) $\varepsilon = 0.6$



(c) $\varepsilon = 0.9$

Fig. 8 Effect of the conversion rate on time decision

By comparing the three images, it can be found that the profit gap between long-term crowdfunding and short-term crowdfunding is large when consumers' patience is different.

(1) Figure (a) shows that when the patient degree is small, the short-term crowdfunding profit is higher in general, because when the patient degree of consumers is low, the long-term crowdfunding will lose a large number of customers. However, when the conversion rate is small to a certain extent, short-term crowdfunding is unlikely to succeed. At this time, only long-term crowdfunding can be selected.
(2) Figure (b) shows that when the degree of patience is slightly greater, the profit advantage of short-term crowdfunding over long-term crowdfunding gradually weakens. When the conversion rate is large, select short-term crowdfunding, and when the conversion rate is small, select long-term crowdfunding.
(3) Figure (c) shows that: when the patient degree is large, choosing long-term crowdfunding is always more profitable, because consumers are more patient at this time. Choosing long-term crowdfunding can improve product exposure, attract more potential consumers to participate in the first stage of crowdfunding, and thus improve the total profit.

7 Conclusions and managerial implications

According to the impact of crowdfunding time on the characteristics of consumers, this paper introduces two variables: the patience of potential consumers and the conversion rate of potential consumers to build a mathematical model, considers the starting capital constraint to solve the optimal pricing, and analyzes the choice of crowdfunding time in different situations. The results show that: ① the impact of conversion rate and patience on crowdfunding pricing decision: with the increase of conversion rate of potential consumers, the optimal pricing in both stages increases first and then decreases; As consumers' patience increases, the optimal pricing in the first stage (crowdfunding stage) is higher. ② The impact of the start-up capital constraint on the time decision of crowdfunding: in order to meet the requirements of the minimum amount of financing for enterprises, when consumers' patience is low, enterprises should choose short-term crowdfunding; When consumers' patience is high, enterprises should choose long-term crowdfunding. ③ The impact of profit on crowdfunding time decision: if the total profit is considered to be increased and the patience of consumers is small, the general profit of enterprises choosing short-term crowdfunding is higher; When consumers' patience is moderate, they should flexibly choose long-term crowdfunding or short-term crowdfunding according to the conversion rate of potential consumers, that is, choose long-term crowdfunding when the conversion rate is low, and choose short-term crowdfunding when the conversion rate is high; When consumers are more patient, enterprises always have higher profits when they choose long-term crowdfunding.

In business practice, under the condition of a moderate conversion rate of consumers, enterprises with the goal of raising the minimum starting capital can

appropriately raise prices and raise the amount of financing; When the conversion rate of consumers is very high, enterprises aiming at obtaining more profits can appropriately reduce prices and expand the market. It is similar to the view in previous literature that crowdfunding is a tool for price discrimination [18] [34]. Based upon user experience working with thousands of crowdfunding campaigns on Kickstarter or Indiegogo, 93% of crowdfunding backers choose to purchase in the crowdfunding stage for rewards rather than for instant access. In order to get project fully funded as quickly as possible, enterprise can offer a carefully-limited number of rewards at "early-bird" discount prices. Some campaigners even present not a single "early-bird" discount but a series of diminishing ones.

Enterprises should make decisions on long-term crowdfunding and short-term crowdfunding according to the characteristics of consumers. Major studies have used subjective ratings [39] to measure consumer patience. According to stats released by Kickstarter in March 2019, over 67 percent of backers are new users lack of specific expertise, and they are subject to herding behavior. Products with short life cycles and fast renewal can not meet the preferences of all consumers, so consumers' patience is low. For crowdfunding of such products, it is more common for enterprises to choose short-term crowdfunding and consumers to choose to participate in crowdfunding. Besides, there is evidence that projects in Kickstarters lasting any longer than 60 days are rarely successful. The platform recommended setting project to run for 30 days or less. Campaigns with shorter durations often have higher success rates, and create a helpful sense of urgency around project. To improve the success rate of crowdfunding projects, enterprises should give priority to short-term crowdfunding. In other words, when consumers' patience is low or the success rate of project is low, choosing short-term crowdfunding can expand market demand and increase success rate. Products with long product life cycles and a high degree of personalization tend to have high user stickiness, such as game users and enthusiasts of electronic products, so consumers are more patient. For crowdfunding of this type of products, enterprises choose long-term crowdfunding, which can obtain more potential users in the market without losing viscous users. Therefore, enterprises can use the network effect to expand market demand and improve enterprise profits.

Combined with the complexity of actual crowdfunding, this paper puts forward the possible research directions in the future: (1) At this stage, crowdfunding is mostly initiated by relying on the Internet, so considering the network characteristics of crowdfunding participants can further expand the application scope of the model; (2) With the development of crowdfunding platforms, third-party platforms will also have an impact on the decision-making of enterprises' crowdfunding projects. In the future, the model can be extended to consider third-party crowdfunding platforms.

Funding 1. Humanities and Social Sciences Research Project of the Ministry of Education of the People's Republic of China [grant number 19YJA630107]. 2. Guangdong Office of Philosophy and Social Science [grant numberGD20CGL46]. 3. 2023 Annual Project of Guangzhou Philosophy and Social Science Planning [grant number 2023GZYB20].

Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Meat Science 195 (2023) 108994

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Emerging market for pork with animal welfare attribute in China: An ethical perspective

Yaoming Liang [a,b], Yanjie Xu [a], Debao Lai [a], Gengrong Hua [c], Donglin Huang [a], Hao Wang [a,*], Hui Li [a,d,e,*], Li Han [d,**]

[a] College of Economics & Management, South China Agricultural University, 510642 Guangzhou, China
[b] College of Veterinary Medicine, South China Agricultural University, 510642 Guangzhou, China
[c] Faculty of Social Sciences, University of Macau, 999078 Macao, China
[d] College of Public Management, South China Agricultural University, 510642 Guangzhou, China
[e] College of Natural Resources and Environment, South China Agricultural University, 510642 Guangzhou, China

ARTICLE INFO

Keywords:
Farm animal welfare
Consumer preferences
Ethics
Choice experiment

ABSTRACT

There is growing public concern about the welfare of farm animals, and farm animal welfare can be considered an ethical attribute of product quality. This paper elicits consumers' willingness to pay (WTP) for animal welfare attributes in pork products using a choice experiment (CE) in China. Consumers are willing to pay a premium of 13.923 to 18.493 CNY/500 g for more desirable product attributes in terms of animal welfare, branding, humane slaughter, and environmental friendliness. There is a complementary relationship between ethical morality in public policy and animal welfare farming. The findings of the study contribute to an increasing understanding of consumer preferences for animal-friendly products in emerging countries. A wide range of relevant, practical initiatives to help promote animal welfare development are needed in China, by strengthening the education of ecological ethics and animal welfare ideology, establishing an animal welfare security system by global standards, and optimising contractual arrangements for the value chain of animal-friendly products.

1. Introduction

The coronavirus (COVID−19) outbreak has triggered reflections on their relationship between humans and nature (Zhang & Xu, 2022). Societal attitudes towards animals are changing and a very high proportion of the people believe that welfare is important for both animals and humans (María, 2006). As a matter of fact, the public are showing more concern for the animal welfare, particularly in the domain of food production (de Queiroz et al., 2018; Schuck-Paim, Negro-Calduch, & Alonso, 2021). Farm animals, which are raised for the purpose of human consumption, provide proteins and other essential nutrients for human diets and deserve humane treatment, including respect, care, and humane slaughter (Phillips et al., 2010). For example, farm animals should be treated with animal welfare in mind and entitled to their five freedoms along the supply chain including the logistics and production processes, and this involves much more than good feeding. Many consumers hold that animal welfare and other social and moral attributes should be taken into account (Boogaard, Oosting, & Bock, 2006; Tonsor, Olynk, & Wolf, 2009; Van Loo, Caputo, Nayga, & Verbeke, 2014).

Animal welfare is recognised as an important attribute of high-end and high-quality food in the evolving livestock industry. Numerous studies in animal science have revealed a direct relationship between better animal welfare and higher-quality meat. For example, high welfare animals with less stress produce more palatable meat, and they also produce better milk, eggs, or wool, etc. Anderson and Barrett (2016) found that meat paired with factory farm descriptions looked, smelled, and tasted less pleasant than meat paired with humane farm descriptions. It implies that individual beliefs or values about how animals are raised can influence the consumers' eating experience. In fact, animal welfare is not only an important quality attribute of food products (Ortega, Hong, Wang, & Wu, 2016), but it is also indicative of human conscience and ethical norms (Bodur, Gao, & Grohmann, 2013). Wang and Gu (2014) argued that animal welfare products possess the characteristics of both private goods and public goods, which constitute the underlying economic attributes of farm animal welfare; the same authors also noted that consumers' willingness-to-pay (WTP) for animal

* Corresponding authors at: College of Economics & Management, South China Agricultural University, 510642 Guangzhou, China.
** Corresponding author at: College of Public Management, South China Agricultural University, 510642 Guangzhou, China
E-mail addresses: hwang@scau.edu.cn (H. Wang), smarthuili@scau.edu.cn (H. Li), lynn_han1216@scau.edu.cn (L. Han).

https://doi.org/10.1016/j.meatsci.2022.108994
Received 24 April 2022; Received in revised form 19 August 2022; Accepted 22 September 2022
Available online 30 September 2022
0309-1740/© 2022 Published by Elsevier Ltd.

welfare products may in essence originate not only from their self-interest tendencies, but also from their altruistic tendencies of consumers, or a combination of both. Hence, the willingness to pay a premium for animal welfare products may indicate consumers' altruistic tendencies, showing their humanitarian concern for animals.

Higher animal welfare products normally mean higher production costs, as animals require better feeding, care, housing and transport conditions, among other things. The additional costs are passed on to the consumers. A meta-analysis concluded that WTP for animal welfare could be viewed as relatively non-species specific (Lagerkvist & Hess, 2011), or consumer preference for animal welfare are product- rather than animal-specific (Olynk & Ortega, 2013). It is expected that consumers will pay more attention to food safety and environmental risks arising from meat production processes, and are willing to pay extra for meat products with such attributes as animal welfare, health, and environment-friendliness from the intensive production systems (de Passille & Rushen, 2005; Lai, Wang, Ortega, & Olynk Widmar, 2018; Liljenstolpe, 2008). A survey found that 34% of Australian respondents were willing to pay an additional 5% to 10% for animal products in conformity with the Five Freedoms of Animal Welfare (Taylor & Signal, 2009). A US study reported that the average consumer was willing to pay about 20% higher for pork and egg labelled as products without the use of gestation crates for pigs or cages for laying hens (Tonsor & Wolf, 2011).

Hog farming has been an important sector and the cornerstone of the animal husbandry industry in China. Topics related to pig welfare will likely gain traction among researchers and decision-makers alike. Since the 1980s, meat production in the country has been gaining strong momentum, with pork accounting for the biggest proportion (see Fig. 1). Despite the African swine fever in 2018 causing public panic and a drop in pork production, the output of pork in 2020 still reached 41.13 million tons, making up about 53.08% of total meat production.[1] It can be seen that the pig industry provides an important source of protein for Chinese residents. In 2014, China introduced the first set of farm animal welfare standards, Farm Animal Welfare Requirements: Pigs. Soon, a widening range of animal-friendly products will be available to meet the consumers' demand in China.

Previous research has confirmed consumers' willingness to pay price premium for farm animal welfare products in China. Although over 60% of respondents had never heard of the concept of animal welfare in mainland China (You, Li, Zhang, Yan, & Zhao, 2014), Wang and Gu (2014) found that respondents were willing to pay 16.2% higher for animal-friendly products without being informed of the link between animal welfare and meat quality and to pay 21.3% higher when given with the related information based on a survey in Jiangsu province. Ortega, Wang, Wu, and Hong (2015) compared the differences in consumer preference for animal welfare products from various retail channels in Beijing. Their study found that consumers were willing to pay a premium of 3.68 CNY per kilogram for pork with animal welfare attributes at domestic supermarkets. Most of these studies focus on Chinese consumers' attitudes towards and willingness to pay for animal welfare products. There is a lack of empirical research on consumers' motivation behind their preferences for animal welfare attributes in products available in China.

Studies have shown that most values are often associated with the direction of food choice motivation (De Boer, Hoogland, & Boersema, 2007) and that individuals' values can be used as a good predictor of animal welfare consumption preference (Sonoda, Oishi, Chomei, & Hirooka, 2018). In fact, many concepts, phrases, proverbs and sayings in the Chinese culture have been widely recognised to be full of ecological wisdom and passed on for generations, or even for centuries. "Unity of heaven and human" "inherent value" and "natural order of things under the heaven"[2] are just a few examples of such longstanding concepts. Therefore, the objective of this paper is to shed a new light – from an ethical perspective – on consumers' motivations to purchase welfare-friendly pork.

The main contributions of the present study cover the following aspects. Firstly, this study adds to a limited CE literature examining preferences for animal welfare and provides an estimation of Chinese consumers' willingness to pay (WTP), which extends the understanding of how consumers in emerging countries value the attributes associated with animal welfare. Secondly, consumer preference for pork with animal welfare attribute is explored from the ethical perspective using Random Parameter Logit (RPL) models. It helps stakeholders to better understand the basis of payment premium and consumption of pork products with animal welfare attribute. And finally, the findings of this study can also provide theoretical support for cultivating the high-end animal product market and provide guidelines for upgrading the production structure of the animal husbandry industry in emerging countries like China.

2. Material and methods

2.1. Research design

2.1.1. Choice experiment design

Considering that fresh lean pork is widely accepted by the vast majority of consumers, we chose it as an option for respondents in the shopping scenario. The quality of pork depends on many factors, including not only intrinsic characteristics such as colour, smell, tenderness, and nutrition, safety, appearance, convenience (Lebret & Čandek-Potokar, 2022; Wu, Wang, Zhu, Hu, & Wang, 2015), but also attributes based on eco-ethical standards such as animal welfare and environmental protection (Edwards, 2005; Gaviglio & Pirani, 2015).

Animal welfare should be conceived as an element of the agro-ecosystem that encompasses the entire logistical process from the farm of origin to the final product as well as the entire process of on-farm rearing, transport of the animals and slaughter at the abattoir. As the standards of animal welfare vary greatly from process to process, we focused our study on the welfare of animal farming like other researchers such as Li et al. (2017) and Denver, Sandøe, and Christensen (2017). Humane slaughter is an important aspect for the public to show their tenderness to animals. Many western developed countries, such as the US and the UK, have enacted laws that mandate more humane slaughtering of animals for human consumption. Protection of the natural ecological environment has been highly valued in recent years and the Chinese market has a high perception of environmental impact. Consumers can become an important positive contributor to a sustainable society by choosing healthy foods that meet environmental and social ethical standards (Ghvanidze, Velikova, Dodd, & Oldewage-Theron, 2016). Therefore, drawing on previous studies, animal welfare farming, humane slaughter, and environmental friendliness were chosen as the eco-ethical attributes in the present study.

Due to the limited information about pork production available at domestic supermarkets or wet markets, brand is an important consideration for consumers. In order to make the CE closer to reality, brand was included as one of the product characteristics. The price attribute consisted of three levels, using the average prices of lean pork in Guangzhou's large, medium and small-sized supermarkets, wet markets, and three major online fresh markets in China (*JD Fresh*, *Suning Commerce*, *Fresh Hema*) in February 2020. In the design, marketing pricing strategies were also taken into consideration. For example, while pricing at 49.9 or 50 CNY may have little impact on the sellers, 49.9 CNY would be perceived by the consumers as much cheaper than 50 CNY which is a round number. The characteristic attributes and levels of pork

[1] Source: 2020 China Statistical Yearbook.

[2] "天人合一" "天赋价值" "天道生生" in Chinese.

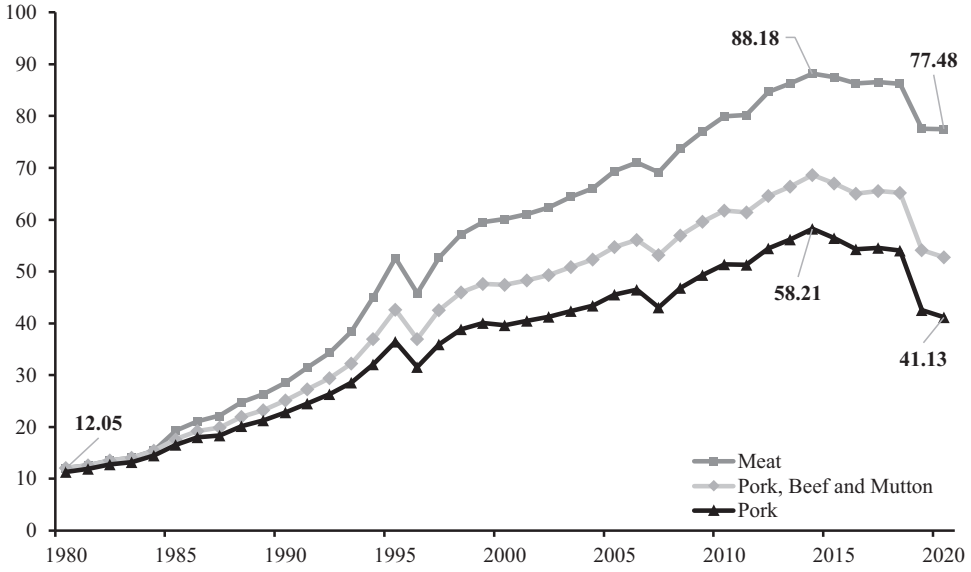

Fig. 1. China's meat production (in million tons).
Source: National Bureau of Statistics, China.

are shown in Table 1.

The choice experiment (CE) is a survey-based method designed with questions to elicit information on consumers' product preferences at the attribute level. These questions, called choice tasks, comprise two or more alternatives described by combinations of different product attributes. Respondents were presented with a series of choice tasks, which differ by the attribute's levels, and then asked to select an alternative. In this study, we selected five attributes as pork quality characteristics. A total of $2 \times 2 \times 2 \times 2 \times 3 = 48$ possible product options were available based on the above product attributes and their levels. Accordingly, $48 \times 47 = 2256$ product combinations or choice sets would be generated. Having three or more factors involved in the experiment might result in interactions between factors and increase the workload or complexity, making the experiment too difficult to implement. Accordingly, 12 choice sets were designed to estimate consumers' utility of pork attributes based on a D-optimal fractional causal analysis experimental design by using the Ngene 1.2.1 software package.[3] The choice sets were divided into two groups, each with six choice tasks in order to reduce the probability of selection fatigue.

Table 1
Pork attributes and levels used in discrete choice experiment.

Attribute	Description	Level
Welfare Farming	Farming practices that provide farm animals with comprehensive physical and mental care during the breeding process, including good feeding, good housing, good health and appropriate behaviour.	Yes, no.
Brand	The brand name that distinguishes one supplier's pork products from those of others.	Yes, no.
Humane Slaughter	Gentle care given to pigs prior to slaughter and techniques to make the process of slaughter (including transportation, slaughtering facilities, etc.) more humane, and thereby reduce the excessive stimulation and pain of pigs.	Yes, no.
Environmental Friendliness	The process of pork production causing minimal or no pollution to the surrounding environments such as air, water and soil.	Yes, no.
Price	Prices at which people usually buy fresh lean meat in supermarkets or wet markets (CNY/500 g).	49.9, 59.9, 69.9.

In the choice experiment, each choice set included two hypothetical alternatives and an opt-out or "no purchase" option, which made the experiment closer to reality. The purchase scenarios were randomly assigned to respondents based on the parity (singular or double) of the last digit of their mobile phone number. Furthermore, the order in which the choice tasks were presented was randomised to mitigate any ordering effects. In order to avoid the interference of different choice scenarios on the respondents and to ensure data quality within an acceptable range, the respondents were presented with only one choice scenario each time and made to stay in each choice scenario for no <12 s during the experiment. Meanwhile, in order to reduce the impact of hypothetical bias, a cheap talk strategy was used to inform respondents of the hypothetical bias prior to completion of the selection task (Cummings & Taylor, 1999). Fig. 2 shows a sample of the choice sets.

2.1.2. Survey design

The consideration of animal welfare is highly dependent on regional levels of economic and social development. Animal welfare may be more appealing in economically developed regions. Guangdong province (see Fig. 3) was selected as the survey area for the following reasons. Firstly, Guangdong is at higher levels of economic and social development, and has retained its place as the top province with the highest GDP in China for 33 consecutive years, with its GDP reaching approximately 1.92 trillion USD[4] in 2021. Guangdong's per capita disposable household income was 50,257 CNY or 7678 USD[5] in 2020, higher than the national average (32,189 CNY). The Engel coefficient[6] of Guangdong stood at 33.21%, close to the UN well-off line, better than that of Beijing (20.97%) and Shanghai (25.68%). With better performance than the national average in terms of various economic and social indicators, Guangdong stands out as more representative of the developed regions in China. Secondly, Guangdong, adjacent to Hong Kong and Macao, is

[3] Retrieved January 1, 2021, from http://www.choice-metrics.com.
[4] Exchange rate: 1 USD/CNY 6.1798, December 31, 2021 (CFETS).
[5] Exchange rate: 1 USD/CNY 6.5458, December 31, 2020 (CFETS).
[6] Engel coefficient = Per Capita Food Consumption Expenditure (in CNY) / Per Capita Consumption Expenditure (in CNY).

Attributes	Pork A	Pork B
Welfare Farming	×	√
Brand	√	×
Humane Slaughter	×	√
Environmental Friendliness	√	×
Price	49.9 CNY/500 g	59.9 CNY/500 g
I will buy:	A. Pork A	B. Pork B	C. None of these pork

Fig. 2. A sample of the choice sets.

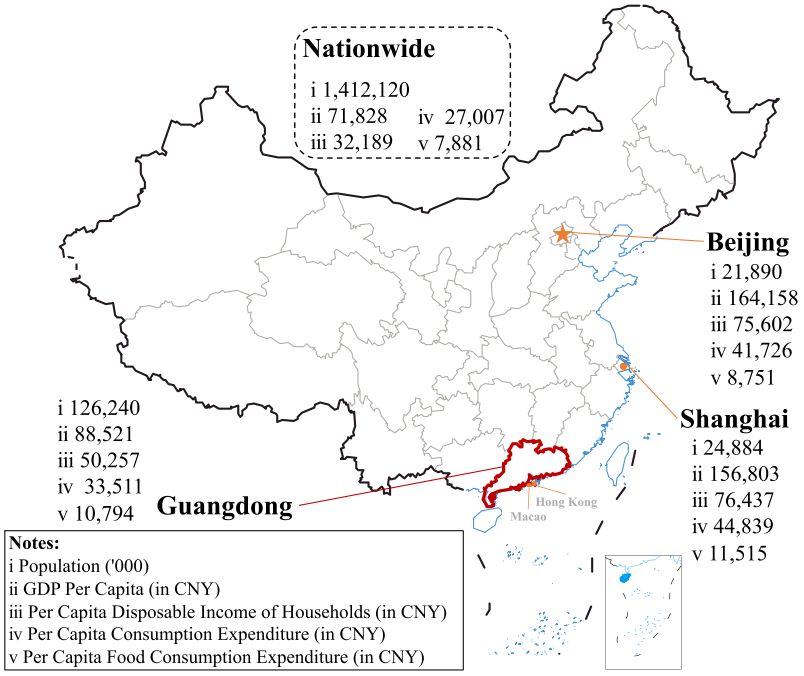

Fig. 3. Location of Guangdong province in mainland China.
Map Source: Amap.com. Data Source: National Bureau of Statistics of China. National data do not include data of Hong Kong, Macao and Taiwan. Data shown in the figure are for 2020.

the most vibrant province in opening up to the outside world, and apt to understand, discuss, and embrace new ideas and concepts like animal welfare. This receptive attitude can better predict China's future focus on animal welfare. Thirdly, Guangdong people (also known as "Cantonese people") are widely recognised as "truly discerning gastronomes" in the country, with Guangdong cuisine (better known as "Cantonese cuisine") being among the Eight Great Cuisines of China. This good reputation, in turn, means that Cantonese people may pay more attention to pork consumption. All of the above-mentioned facts and observations helped to control unobserved factors that were not clearly controlled, such as household food supplies, regional tastes, diet and other cultural factors.

Face-to-face surveys may significantly increase investigation costs and lead to the deviation caused by interviewees' limited cognitive resources including time and energy during the survey. Due to the COVID−19 quarantine and isolation rules, the questionnaires were

conducted online through *Wenjuanxing*,[7] the largest online survey platform in China. The platform recruits and maintains a group of consumers who participate in surveys from time to time with small incentives. Participants will randomly receive email invitations and URLs of the survey, and subsequently receive their rewards in the form of credits that can be converted to vouchers for shopping. Participation in each investigation is voluntary. A standardised set of instructions are compiled by the researchers, including the purpose and significance of their study.

This survey was anonymous and ethical approval had been granted by College of Economics & Management, South China Agricultural University. The following criteria were used to target the qualified respondents: They are in charge of purchasing fresh food for their families, they personally consume pork products, and they are over 16 years old. The survey data collected included the consumers' demographic background, ethical and moral cognition, and their pork consumption behaviour, among other things. Choice experiments were conducted on the selection of fresh lean pork to obtain consumers' WTP for pork with animal welfare and other quality attributes.

In February 2020, a pilot survey was conducted among 90 consumers who were the principal purchasers of family food. In the pre-test, most respondents had stated that they did not know about the "animal welfare" concept. Hence, we provided clear definitions of farm animal welfare and products with this particular attribute in the instruction part of the formal questionnaire. Based on the feedback and suggestions from sample consumers, we rephrased the questionnaire to make it more concise and easier to understand, removed survey questions inconsistent with the local situation, and added some more valuable questions.

The formal survey was conducted in March 2020 and a total of 1637 questionnaires were collected. Using completeness and quality of information as the screening criteria, we eliminated invalid questionnaires where crucial information or logical basis was missing. Respondents with monotonous response behaviour were also excluded because they might not have thoroughly read the questions but completed the survey only for the rewards. A total of 1274 valid questionnaires were finally obtained, with 7644 choices (1274 respondents × 6 choice sets) completed. The effective rate of the survey was 77.83%. All statistical analysis was carried out using the software package Stata 16.0 (Stata Corp. 2019, Stata Statistical Software: Release 16, Stata Corp LLC).

2.1.3. Statistical analysis

Discrete selection model has become an important tool to study consumer demand and to inform marketing strategy and food policy. Evaluation of consumer choice behaviour can help estimate the marginal value of various characteristics embodied in different commodities. In the literature on agriculture and applied economics, this method was adopted to analyse Chinese consumers' food safety concerns (Ortega, Wang, Olynk, Wu, & Bai, 2012; Phillips et al., 2010), country-of-origin labels (Ortega et al., 2016; Ying, Huihui, Goodman, Shangwu, & Huiqin, 2009), product traceability (Bai, Zhang, & Jiang, 2013; Wu et al., 2017; Wu, Liang, & Chen, 2020; Xu & Wu, 2010; Yuan, Wang, & Yu, 2020), organic or green food certification (Tariq, Wang, Tanveer, Akram, & Akram, 2019; Yu, Gao, & Zeng, 2014; Zheng, Li, & Peterson, 2013), animal welfare (Lai et al., 2018; Ortega et al., 2015) and the welfare effect of food policy (Wahl, Seale, & Bai, 2018).

Traditional literature assumes that consumer preferences are homogeneous, thereby it can be estimated using the conditional Logit model (McFadden, 1974; Train, 2009). However, consumer preferences are heterogeneous in reality (Wedel & Kamakura, 2012). In a body of literature on discrete choice models, different methods are used to model or explain preference heterogeneity. A commonly used method is to estimate the RPL model, also known as mixed Logit (Train, 2003). For food selection models, if the price coefficient is limited to a fixed range (e.g. estimating the RPL model in preference space), then when the change of actual scale exceeds the observed value, the change of scale will be mistakenly attributed to the WTP change of product characteristics. Hence, we estimated the RPL model in the WTP space which allowed variations on the price coefficient and directly estimated the distribution of WTP (See the full estimation methods and econometric models in the Appendix I for additional details).

2.2. Descriptive statistics

2.2.1. Sample characteristics

Table 2 reports the sample characteristics of the survey. The lack of reliable urban consumer demographic data (Ortega et al., 2012) hinders a clear comparison with our sample, thus making it challenging to establish how representative our sample might be. Nevertheless, official data available did show the female proportion of Chinese residents (48.76%), their average age (38.8 years), household disposable monthly income (32,189 / 12 = 2682.42 CNY), and the ratio of education with a college degree or above (15.47%) as of 2020.

In our study, the respondents spanned a wide range of industries, including but not limited to healthcare, science and technology, education, culture, business and government. Over 60% of respondents were female, which was in line with the fact that more women were responsible for the family diet. The average age of the respondents was about 32 years, and >65% of them had received higher education. Nearly 70% of the respondents' household income was between 6000 and 24,000 CNY per month. Our sample characteristics were consistent with that of Beijing surveyed by Lai et al. (2018), whose study included fewer samples.

In comparison to the Chinese population, our sample was younger, better educated, and better off financially. However, we argue that our sample can be considered fairly representative of the high-end supermarket consumers, who may be more likely to accept the idea of animal welfare and have more access to information that might drive changes in production systems.

2.2.2. Pork consumption habits

With regards to consumption habits, Table 3 shows that over 80% of respondents buy pork more than twice a week, and approximately 15% do it daily, indicating the importance of pork in consumer diet. Over 50% of respondents purchase >500 g of pork per time. Wet markets are the top source of meat products for consumers (82.34%), followed by large supermarkets (51.65%), small and medium-sized supermarkets (32.34%). Although our survey was carried out during the COVID−19 epidemic, only a minority of consumers order meat online, accounting for <7% of the total respondents. The possible reason for this is that online stores such as Fresh Hema and Wal-mart deliver their fresh meat (and produce) only to customers located within half an hour's drive or one kilometre from their premises, in order to ensure the hygienic condition and preservation of their products.

In recent years, especially since the outbreaks of African swine fever in 2018, China's pork imports have been constantly on the rise, with the

[7] Wenjuanxing (www.wjx.cn) has released 125 million questionnaires and collected 9.923 billion questionnaires from respondents as of July 2021. By recruiting and maintaining a clientele, the sample service provider can sometimes offer consumers rewards for participating in surveys. The rewards offered to participants are credits that can be accumulated and redeemed for retail vouchers. Emails with a link to the survey are sent to participants randomly and based on the researchers' requirements for the sample. Participation of each investigation is voluntary. Researchers can contact the sample provider, send the latter their survey and pay certain fees for access to consumers who are readily available to participate in their online survey. The fees depend on complexity of the questionnaire and duration of the survey as well as the required characteristics and number of the consumers.

Table 2
Socio-demographic characteristics of the sample.

	Consumers			Residents
	Guangdong	Shanghai	Beijing	China
Source	Our survey	Lai et al. (2018)	Lai et al. (2018)	National Bureau of Statistics, China (2020)
Study object	Pork	Pork	Pork	–
Sample size	1274	221	259	1.41 billion
Female (%)	62.48	68	63	48.76
Average age (in years)	32.25	43	33	38.8
Education level (%)				
Primary school and below	0.55	4	4	34.92
Junior high school	5.18			34.51
High school (secondary vocational school)	10.08	43	19	15.10
College (higher vocational school)	16.64	20	19	
Undergraduate	54.00	24	49	15.47
Graduate students and above	13.58	9	9	
Number of family members dining together (%)				
2 people and below	17.04			
3 people	24.88			
4 people	26.14			
5 people	21.11			
6 or more people	10.83			
Monthly household income (%)				
< 6000 CNY	17.03	27	36	
6000–12,000 CNY	33.28	43	38	
12,000–18,000 CNY	20.88	12	15	
18,000–24,000 CNY	13.34			
24,000-30,000 CNY	8.01	18	12[1]	
> 30,000 CNY	7.46			
Occupation (%)				
Personnel from healthcare, science and technology, education and culture	11.62			
Business staff	28.89			
Government and military personnel	12.32			
Workers and farmers	10.91			
Students	11.77			
Other (including retirees)	22.92			
Animal-related work (%)	5.18			
Raising pets at home (%)	23.86			

[1] Percentages may total >100% because of rounding.

deficit going up from 13,309 million CNY in 2017 to 63,228 million CNY.[8] When purchasing pork, consumers are most concerned with freshness (89.40%), followed by price (58.40%), colour (51.18%), pig varieties (19.00%), feeding methods (17.19%), convenience of purchase (16.64%), as well as brands (13.11%). It can be seen that consumers still mainly rely on their own experience when purchasing pork. The reasons for this may include the limited availability of pork product information in China and the lack of consumer confidence in the products. Therefore, consumers continue to use their experience and stick to "seeing is believing".

2.2.3. Consumer ethics and morality

When investigating one's ethical and moral status through self-reporting, a potential problem is that respondents may try to respond in a way more in line with social expectations, thereby increasing societal approval. Johansson-Stenman (2018) argued that animal welfare should matter intrinsically in public decision-making, and the intrinsic value of animal welfare should be included in conventional welfare economics. To ensure a higher level of objectivity in our measurement, consumers' opinions on how great a weight should be given to animal suffering in public decision-making were investigated to examine consumers' ethical and moral values towards animals. The question was based on a human-centred hypothesis and respondents were asked to compare the weight per suffering unit for animals and for humans in public decision-making. Following the practice of Johansson-Stenman, we further divided respondents' views into six levels of propositions, from "should not be taken into account at all' to 'should be highly considered", assigning 1–6 points.

As shown in Table 4, only 24.6% of Chinese respondents believe that animal suffering should be taken into account to the same extent as human suffering, much lower than the percentage (49.3%) of their Swedish counterparts in the survey conducted by Johansson-Stenman. The majority (about 66.3%) of Chinese consumers hold that animal suffering should be taken into consideration to some extent but given a

Table 3
Consumers' pork consumption habits.

Features	Effective Percentage (%)	Features	Effective Percentage (%)
Frequency of pork purchases per week		Most concerned when buying pork (multiple-choice)	
1 time and below	17.35	Brand	13.11
2–3 times	47.65	Packing	1.81
4–5 times	20.33	Origin	5.73
Almost every day	14.68[1]	Pig breeds	19.00
Pork quantity per purchase (500 g)		Freshness	89.40
≤ 0.5	10.28	Pork colour	51.18
0.5–1	39.09	Feeding methods	17.19
1–2	37.29	Mode of transport	1.10
> 2	13.34	Slaughtering methods	3.85
Purchase location (multiple-choice)		Growth time of Pig	6.36
Wet markets	82.34	Price	58.40
Small and medium-sized supermarkets	32.34	Convenience of purchase	16.64
Big supermarkets	51.65	Other	0.94
Online	6.99		
Other	1.96		

[1] Percentages may total >100% because of rounding.

Table 4
Distribution of consumer opinions on the weight that should be given to animal suffering in public decision-making.

Society can reduce the suffering of animals and humans through various measures, but these measures can be expensive. Do you think that animal suffering should be taken into account in public decision-making?	Frequency (%)	
	China	Sweden
A. Animal suffering should not be taken into account at all.	0.78	0.8
B. Animal suffering per se should not be taken into account, but the fact that some people suffer when knowing about animal suffering should be taken into account.	5.97	3.2
C. Animal suffering should be taken into account to some extent, but it should be given a much lower weight than human suffering.	33.99	13.2
D. Animal suffering should be taken into account to a large extent, but it should be given a lower weight than human suffering.	32.34	30.3
E. Animal suffering and human suffering should be taken into account to the same extent.	24.57	49.3
F. Animal suffering should be taken into account to a high degree and given a higher weight than human suffering.	2.35	3.2

Note: The data of China are based on the survey in this study, and those of Sweden are from the survey results of Johansson-Stenman (2018).

[8] Source: General Administration of Customs of People's Republic of China.

Table 5
Regression results of the RPL model for animal welfare consumption preference.

Attributes	Coefficient	Std. Dev.
Welfare Farming	17.678***	−9.467***
	(1.013)	(0.946)
Brand	15.376***	21.299***
	(0.981)	(1.114)
Humane Slaughter	13.923***	9.969***
	(0.893)	(1.141)
Environmental Friendliness	18.493***	7.845***
	(1.012)	(0.821)
Not to Buy	−56.284***	−37.875***
	(1.661)	(2.269)
Price / Scale	−2.525***	0.612***
	(0.060)	(0.052)
Wald chi2	2817.38	
Log likelihood	−5596.276	
AIC	11,216.55	

Note: Values with *** are statistically significant at the 1% level. Each number in () is the standard error.

lower or much lower weight than human suffering. Only 0.78% of Chinese respondents think that animal suffering should not be taken into account at all. Therefore, the standard economic assumption that animals should be seen as tools has to be questioned, and it would be fair to assert that Chinese consumers generally have good ethical beliefs about animals.

3. Results

3.1. Consumer preference and its heterogeneity

Table 5 presents the regression results of the RPL model in the WTP space. Empirically, consumers have strong preference for pork with various attributes such as welfare farming, brand, humane slaughter, and environmental friendliness. The premium price for pork with welfare farming attribute is 17.678 CNY/500 g, slightly lower than that for pork with environmental friendliness attribute (18.493 CNY/500 g), followed by that for pork with brand attribute (15.376 CNY/500 g) and humane slaughter attribute (13.923 CNY/500 g). The coefficients are all statistically significant at the 1% level.

The standard deviations of four attributes, including welfare farming, brand, humane slaughter, and environmental friendliness, are significant at the 1% level, indicating that consumer preferences for the attributes are heterogeneous. However, Ortega, Chen, Wang, and Shimokawa (2017) found that consumers from Guangzhou had homogeneous preferences for pork with animal welfare and environmental attributes, whereas those from Hong Kong had heterogeneous preferences.

Fig. 4 presents individual-level (conditional) estimates of WTP for the various attributes[9] and intuitively shows the heterogeneity of consumer preferences. It shows that consumers' preferences for the brand attribute differ the most, indicating that consumers have yet to form a unified understanding of brands. This may be due to the absence of unified production standards in the livestock industry, making it difficult to achieve the brand effect. For example, on Jingdong,[10] consumers can choose from many international brands such as Iberico (Spain), HuaDong (Canada), Sam (American), Elpozo (Spain), Joselito (Spain), Cinco Jotas (Spain), Lamontanera (Spain), Senorio (Spain) and Iber Bellota (Spain), in addition to domestic brands such as Muyuan, Zhengbang, and Wens, just to name a few. In contrast, consumer preferences for such attributes as welfare farming, humane slaughter and environmental friendliness differ less, and these attributes may be more representative for consumers to evaluate pork quality.

3.2. Ethics and animal welfare consumption preference

Interaction terms, including welfare farming variable and brand, humane slaughter, and environmental friendliness variables, were constructed and put into the baseline model for regression estimates. Regression results of RPL models are listed in Table 6. Coefficients of the interaction terms in Model (1) are positively significant at least at the 5% level, indicating that the welfare farming attribute is complementary to other attributes including brand, humane slaughter, and environmental friendliness.

Animal welfare covers the whole process of on-farm rearing, transport of the animals and slaughter at the abattoir. Thus, in order to examine how ethical values affect consumer preferences for animal welfare, interaction terms including consumer ethics and welfare farming, ethics and humane slaughter were sequentially put into Model (1) for regression estimates.

Results of Model (2) and Model (3) in Table 6 demonstrate that the coefficients of the interaction terms are all significantly positive. This indicates that improving consumers' ethical morality may increase their recognition of welfare farming and human slaughter, and thus help improve consumers' score utility and consumption confidence in pork products with animal welfare attribute.

3.3. Ethics orientations and pork consumer segments

Lund, Denver, Nordström, Christensen, and Sandøe (2021) identified consumer segments on the basis of animal ethics orientations. Building on their practice, we divided respondents into three types based on respondents' opinions on the weight that should be given to animal suffering in public decision-making: anthropocentrism,[11] animal protection,[12] and animal rights,[13] omitting the lay utilitarian orientation because it primarily relates to extreme trade-offs between animal pain and human benefits (Lund, Kondrup, & Sandøe, 2019). It helps to further explore consumer preference with different ethical and moral positions.

The regression results in Table 7 show that consumers with different ethical views have significantly positive preferences for various attributes including welfare farming, brand, humane slaughter and environmental friendliness. Respondents with anthropocentric values are willing to pay a premium of 6.563 CNY/500 g for pork with the welfare farming attribute, while animal protection respondents are willing to pay an additional 15.060 CNY/500 g, and animal rights respondents 44.516 CNY/500 g. All three types of consumers are also willing to pay relatively high premiums for pork with the humane slaughter attribute, namely 5.076, 11.064 and 35.409 CNY/500 g, respectively. The payment premiums for pork with the environmental friendliness attribute are 6.731, 16.080 and 40.514 CNY/500 g, respectively.

[9] Individual estimates are derived using the population distributions in conjunction with consumers' observed choices over different choice sets. These distributions represent an estimate of individual-specific preferences, conditional upon observed choices and the distribution of preferences in the population (Train, 2003).

[10] Jingdong, also known as JD.com, Inc., (https://www.jd.com) is a leading e-commerce platform in China, running its online fresh supermarket in addition to its longstanding retail business.

[11] On public decision-making, respondents with anthropocentric values hold that "animal suffering should not be taken into account at all", or that "animal suffering per se should not be taken into account, but the fact that some people suffer when knowing about animal suffering should be taken into account".

[12] On public decision-making, respondents with animal protection values hold that "animal suffering should be taken into account to some or a large extent, but it should be given a lower or much lower weight than human suffering".

[13] On public decision-making, respondents with animal rights as their values hold that "animal suffering and human suffering should be taken into account to the same extent", or that "animal suffering should be taken into account to a high degree and given a higher weight than human suffering".

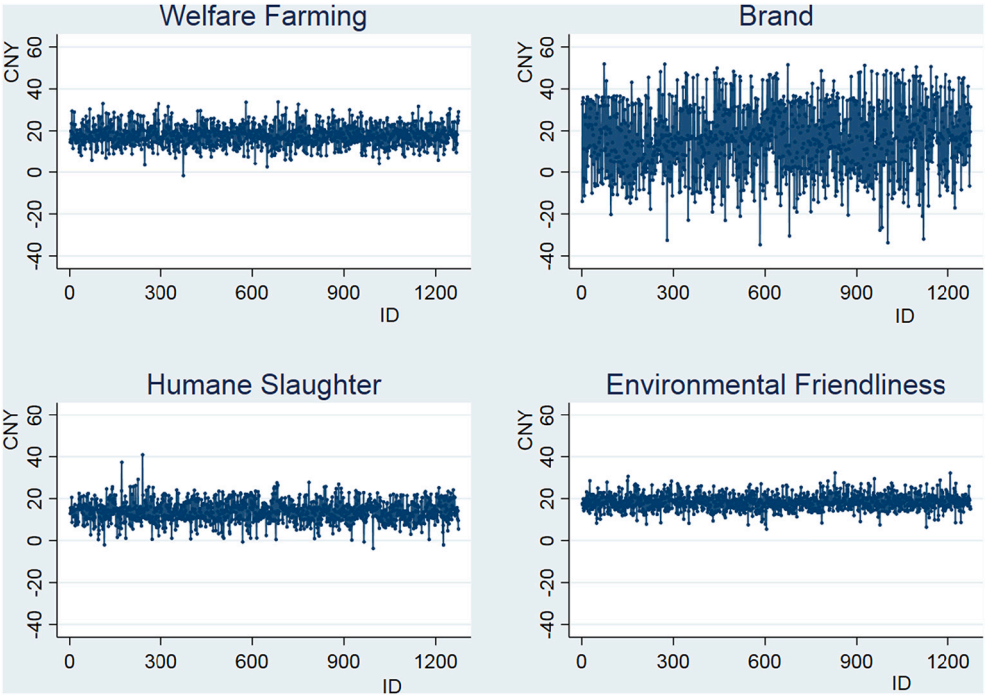

Fig. 4. WTP (conditional) estimation of pork attributes at the consumer level. Each dot represents an individual's expected WTP from conditional estimates.

Table 6
Regression results of RPL model of ethics and animal welfare preferences.

Attributes	Model (1)		Model (2)		Model (3)	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Welfare Farming	3.579	5.329***	−4.678	−0.644	−8.173**	7.977***
	(2.970)	(1.870)	(3.816)	(2.969)	(3.762)	(1.802)
Brand	11.413***	−20.383***	12.240***	21.040***	12.550***	20.443***
	(1.731)	(1.314)	(1.702)	(1.236)	(1.704)	(1.254)
Humane Slaughter	10.945***	−5.659***	10.999***	9.192***	−0.837	3.307
	(1.590)	(1.686)	(1.589)	(1.123)	(2.637)	(2.467)
Environmental Friendliness	11.265***	5.235***	11.944***	6.112***	11.994***	5.626***
	(1.798)	(1.774)	(1.856)	(1.522)	(1.789)	(1.375)
Welfare Farming × Brand	8.328***	−14.739***	6.902**	−8.934***	6.482**	−13.319***
	(2.836)	(2.597)	(2.752)	(2.518)	(2.712)	(2.342)
Farming × Humane Slaughter	6.048**	9.681***	6.323**	−3.928	7.008**	7.392***
	(2.856)	(2.286)	(2.788)	(2.396)	(2.752)	(2.281)
Welfare Farming × Environmental Friendliness	14.742***	−11.979***	12.936***	−7.796***	13.596***	13.333***
	(3.166)	(2.435)	(3.147)	(2.389)	(3.103)	(2.299)
Ethics × Welfare Farming			2.474***	2.306***	3.340***	1.127*
			(0.667)	(0.353)	(0.660)	(0.636)
Ethics × Humane Slaughter					3.106***	1.456***
					(0.609)	(0.364)
Not to Buy	−68.954***	38.516***	−66.707***	−38.787***	−66.419***	37.619***
	(3.069)	(2.678)	(3.089)	(2.791)	(2.904)	(2.621)
Price / Scale	−2.626***	0.464***	−2.612***	0.516***	−2.628***	0.390***
	(0.061)	(0.058)	(0.061)	(0.057)	(0.063)	(0.063)
Wald chi2	2240.98		2391.87		2105.60	
Log likelihood	-5582.240		−5562.782		-5561.214	
AIC	11,200.48		11,165.56		11,166.43	

Note: Values with ***, **, and * are statistically significant at the 1%, 5%, and 10% levels, respectively. Each number in () is the standard error.

Fig. 5 intuitively shows the WTP for different pork attributes among consumers with different ethical positions. The brand attribute is most valued by anthropocentric respondents. A possible reason is that with insufficient information provided, most consumers have to try to judge the safety and quality of pork through their perception of the brand and their own experience. Therefore, the identification and description of the brand should be improved in terms of labelling and traceability. Animal protection respondents value the environmental friendliness attribute most. Animal rights respondents are willing to pay much higher premiums than other consumers. Their favourite attribute is welfare farming, followed by attributes of environmental friendliness, humane slaughter and brand.

Table 8 shows the socio-demographic characteristics of the three pork consumer segments. We identify statistically significant differences regarding all four socio-demographic variables reported among the segments. Anthropocentric respondents are mainly distributed in groups

Table 7
Regression results of RPL model for the three consumer segments.

Attributes	Anthropocentric		Animal Protection		Animal Rights	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Welfare Farming	6.563***	7.324***	15.060***	−5.841***	44.516***	25.711***
	(2.421)	(2.045)	(1.030)	(1.013)	(8.244)	(5.894)
Brand	14.504***	16.534***	14.493***	18.759***	28.372***	−31.199***
	(3.064)	(2.222)	(1.036)	(1.157)	(5.455)	(5.973)
Humane Slaughter	5.076**	6.812***	11.064***	−5.542***	35.409***	−22.080***
	(2.031)	(2.229)	(0.853)	(1.135)	(6.991)	(4.920)
Environmental Friendliness	6.731***	0.463	16.080***	7.617***	40.514***	13.354***
	(2.041)	(1.859)	(1.035)	(1.034)	(7.618)	(4.149)
Not to Buy	−59.874***	24.462***	−58.756***	−31.060***	−40.379***	60.364***
	(6.887)	(5.130)	(2.245)	(2.503)	(7.687)	(14.804)
Price / Scale	−1.928***	0.801**	−2.388***	0.613***	−3.241***	0.559***
	(0.300)	(0.342)	(0.076)	(0.073)	(0.213)	(0.122)
Number of Experiments	516		5070		2058	
Wald chi2	490.14		1491.19		666.77	
Log likelihood	−359.270		−3681.064		−1491.898	
AIC	742.540		7386.127		3007.796	

Note: Values with *** and ** are statistically significant at the 1% and 5% levels, respectively. Each number in () is the standard error.

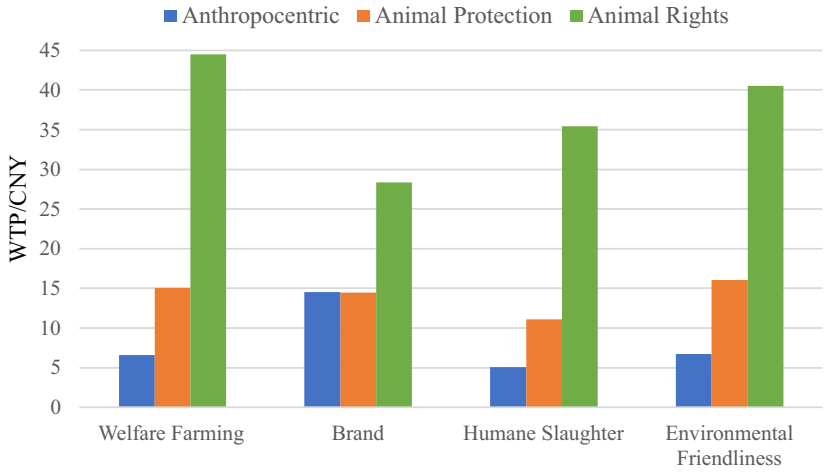

Fig. 5. Three segments of consumers' WTP for different pork attributes.

of male (58.14%), low-educated (43.02%), low-income (59.30%), and older age (35.465). The socio-demographic characteristics of animal protection respondents and animal rights respondents are more or less consistent, mainly concentrated in female, moderately-educated, and young age groups. The females show more concern for animal protection (61.30%) and animal rights (70.55%) than the male. Interestingly, the proportion of highly-educated respondents in the anthropocentric segment (20.93%) is higher than those in animal protection and animal rights segments (14.56%, 9.33%), while the proportion of the moderately-educated in the animal protection (56.33%) and the animal rights segments (52.77%) is higher than that in the anthropocentric segment (36.05%). We note that income differences between the segments are relatively modest, and that no clear pattern emerges.

4. Discussion

In China, the world's largest emerging country, there are different opinions among the public about animal welfare. “Why should we be concerned with animal welfare when issues related to human welfare remain unsolved?” This is the first question that the advocates should answer. There are no easy answers to this question, but there are at least two possible answers the literature provides. On the one hand, a large number of experiments have proved that improving farm animal welfare can help reduce the occurrence of infectious diseases (Deng, Mao, Feng, Gao, & Yin, 2016), eliminate the risks of food safety, and improve the quality of animal-derived products effectively (Boyle & O'Driscoll, 2011; Phillips et al., 2010). On the other hand, the idea of animal rights is different from that of animal welfare: The former is mainly about advocating for equality between animals and humans, while the latter is about advocating for humane use of animals and against any form of animal abuse, with the proposition that animals should not suffer unnecessary pain from human activities, which is consistent with the traditional Chinese ecological ethics. Generally speaking, improving animal welfare is conducive to the improvement of human welfare in both the material perspective of food quality and the spiritual perspective of ethical requirements. Hence, more concern for animal welfare is particularly necessary for the livestock industry in China.

The study finds that Chinese consumers have a fairly strong moral identity and emotional demand when it comes to animal welfare. The ethical relationship between human beings and other animals is a philosophical issue that transcends the traditional humane treatment (Phil, 1998). Fundamentally, people's moral concern for animals is also the moral concern for human beings. Our survey also found that >80% of respondents would feel bad when they saw animals being abused or suffering. Avoiding animals' unnecessary suffering can not only solve the problems of food quality and safety caused by the stress response by suffering, but also meet the special emotional needs of people for animal humanitarian care. The global outbreak of the COVID−19 epidemic in

Table 8
Socio-demographic characteristics of consumers with the three pork consumer segments (shares and mean (s.e.) and test of differences by Kruskal-Wallis).

Socio-demographics	Anthropocentric	Animal Protection	Animal Rights	*p*-Value (X2 (df))
Gender				
Male (%)	58.14	38.70	29.45	$p < 0.001$ (324.510 (2))
Female (%)	41.86	61.30	70.55	
Education[1]				
Highly-educated	20.93	14.56	9.33	$p < 0.001$ (171.895 (2))
Moderately-educated	36.05	56.33	52.77	
Low-educated	43.02	29.11	37.90	
Income[2]				
High-income	40.70	52.31	45.48	$p < 0.001$ (101.623 (2))
Low-income	59.30	47.69	54.52	
Age (in years) Mean (s.e.)	35.465 (11.625)	32.006 (9.666)	32.047 (10.222)	$p < 0.001$ (117.002 (2))

[1] Education is classified into three categories: highly-educated (graduate and above), moderately-educated (undergraduate) and low-educated (college, higher vocational education and below).
[2] Income is classified into two categories: high-income (monthly household >12,000 CNY) and low-income (monthly household <12,000 CNY).

2020 provokes profound rethinking of the relationship between humans and animals, and that between humans and the ecological environment. The concept of harmonious development among humans, animals and the ecological environment has been increasingly recognised by the Chinese public. The study also finds that only 6.75% of consumers are anthropocentric, while animal protection consumers account for 66.33% and animal rights consumers 26.92%. The public's strong consumption preference for animal welfare products may become an important incentive to promote farm animal welfare.

Furthermore, the study indicates a complementary relationship between consumer ethics and animal welfare preference, and positive eco-ethics helps to improve consumer preference for products with the animal welfare attribute. Though notably, consumers tend to exaggerate their propensity to buy ethical products (Langen, 2013), consumers' WTP for high welfare products may in essence originate not only from self-interest tendencies, but also from altruistic tendencies of consumers, or from a combination of both (Wang & Gu, 2014). At the point of purchasing meat, the information of egoistic attributes, such as freshness, price, nutrition, production date, and variety, is a focus to most consumers (Klink-Lehmann & Langen, 2019). While the information of altruistic attributes, namely ethical attributes, such as transportation process to slaughterhouses, breeding environment and slaughter conditions, may become less important (Grunert, Bredahl, & Brunsø, 2004; Klaus, 1997; Klink-Lehmann & Langen, 2019; Verbeke & Ward, 2006).

In general, there is a gap between consumers' WTP and actual purchase behaviour for animal welfare products. One highly possible explanation for this is that low income prevents them from doing what they actually believe they should do in practice. However, providing animal welfare information may become an important and indispensable strategy to better meet the differentiated needs of Chinese consumers, regardless of their income. Probably, this is because products with the animal welfare attribute can be regarded as credence goods (Darby & Karni, 1973), and the production process information through the identification of products, such as labels or certification, helps consumers buy the proper products (Dimara & Skuras, 2005; Sans & Sanjuán-López, 2015). In this regard, meat retailers play a key role in the purchasing behaviour of their customers and are the main source of information for their buying selection (Miranda-de la Lama, 2013). It is particularly important for retailers to explain the virtues of meat and its origin, both of which may increase consumers' confidence in animal welfare products. However, one aspect that consumers would highly value is the actual price charged by producers for the meat they are buying. Dual labelling with the price at origin and the final price could greatly affect the purchasing decision.

5. Conclusions and policy implications

The study empirically analyses the effect of ethical morality on animal welfare consumption preference by discrete choice experiment. There are several findings as below: consumers were willing to pay 13.923 to 18.493 CNY/500 g price premium for pork attributes that regarded welfare farming, brand, humane slaughter and environmental friendliness. Consumer preferences were significantly heterogeneous, where the brand differed most, followed by humane slaughter, welfare farming and environmental friendliness. There was a complementary relationship between consumer ethics considering public policy and animal welfare. It means that, the stronger the consumer ethics, the higher the WTP for the animal welfare attribute. Overall, consumers who held different animal ethics orientations have significant differences in their preferences and willingness to pay for welfare-enhanced pork. There are several policy implications as below.

Firstly, education on animal welfare is needed. People who are involved in animal welfare-related studies and activities may be generally more committed to animal welfare. It is important to make the public believe that animal welfare is an important issue. The government can seek to strengthen the education of ecological ethics and animal welfare ideology by means of media, organisation, education and training, so as to better inform the decision-making process. For example, it is advisable to teach humanism during compulsory education to instill generally recognised ideas, concepts, and values about animal protection and harmonious coexistence of humans and animals; provide animal welfare courses in colleges, enterprises and institutions in the field of animal husbandry offered to enhance the awareness of animal welfare; and to further popularize the concept and practice of moral consumption among the general public by means of media-based publicity and education.

Secondly, a security system of animal welfare is necessary. Animal welfare regulation is designed for preventative purposes and consists mainly of requirements relating to interior house design and management, i.e., resource- and management-based requirements, in order to detect and limit welfare risks (Lundmark Hedman, Berg, & Stéen, 2021). On one hand, a more systematic legal system should be established to provide long-term guidance on animal welfare, e.g. to address the regulation of aspects that affect all systems transversally: transport and slaughter. On the other hand, it is necessary to incorporate animal welfare into the industry production standards, which is helpful for animal husbandry enterprises to optimise their production structures and improve product quality. In addition, a system of farm animal welfare certification should be set up to eliminate information asymmetry, particularly in an emerging market. This is equally important to ensure food quality as regards imports of pork and pork- products and help increase the value and recognition of foreign agricultural products. Tough mandatory labelling may lead to negative selections of low-quality animal products, reducing consumers' choices. Mandatory legislation on animal welfare can improve the social welfare by increasing the private value of animal welfare products (Uehleke & Hüttel, 2016).

Thirdly, an innovative contractual arrangement for the value chain of the product is recommended. Farmers or enterprises are often bound by contracts at the downstream production stage. It is necessary to involve the slaughter and processing industries in the development of animal welfare standards, so that farmers or enterprises have the opportunity to produce under higher animal welfare standards. At the same time, compliance with higher animal welfare standards is a long-term capital investment. Producers may be able to leverage the financial guarantees provided by the downstream industry, both to gain the

opportunity to produce a high-quality product, and to avoid the financial pressure of improving animal welfare on their farms by increasing the profitability of their animal products. In this regard, it is important to identify target customers (e.g. female, moderately-educated, and low-age, etc.) and develop efficient marketing strategies for consumers with different ethics orientations. Through new contractual arrangements, animal industry practitioners can help better respond to the public demand and improve their reputation among the public.

The study has some shortcomings and limitations. First, the attribute level interaction effects should be considered in the choice experiment design to match the RPL model used, which is of particular concern in future studies. Second, the cross-section research design was applied, whereas future studies may use a longitudinal design to collect data at various points to better understand consumers' animal welfare preferences and the factors influencing those preferences. Finally, research funds and time limited the scope of the study in Guangdong province, China. Future research should expand the samples to other provinces to obtain more reliable empirical results.

Author statement

Liang Y. conceived and designed the project and experiments. Liang Y., Xu Y. and Huang D. conducted the experiments and investigations. Liang Y., Lai D. and Hua G. prepared the manuscript. Han L., Li H. and Wang H. performed critical review of the manuscript.

Declaration of Competing Interest

There are no conflicts to declare.

Data availability

Data will be made available on request.

Acknowledgement

The authors are thankful to Prof. Qinying He, South China Agricultural University for fruitful discussions during the making of this paper, to Mr. Jon Zou for the help in language polishing.

Appendix I. Estimation methods and econometric models

According to the random utility theory (McFadden, 1974), it is assumed that the indirect utility is linear in parameters and is composed of deterministic components and random components. Therefore, the personal indirect utility function can be expressed as:

$$V_{ijt}^{*} = \beta_i^{'} X_{ijt} + \epsilon_{ijt} \tag{1}$$

Where, X_{ijt} represents the vector of attributes obtained from the *jth* alternative in scenario *t*, β_i represents the vector of individual preference parameters, and ϵ_{ijt} represents a random utility component that is independent and identically distributed with a known (extreme) distribution. The random utility component denotes changes and errors unobserved in consumer preference. The indirect utility V_{ijt}^{*} is obtained by the actual selection V_{ijt}^{*}, where if $V_{ijt}^{*} = max\,(V_{1it}^{*}, V_{12t}^{*}, \ldots, V_{1kt}^{*})$, then $V_{ijt} = 1$, otherwise 0.

According to Train's explanation for the RPL model, the probability of individual *i* choosing alternative *j* in scenario *t* is:

$$Prob\left(V_{ijt} = 1 | X_{i1t}, X_{i2t}, \ldots, X_{ikt}, \Omega\right) = \int \frac{exp\left(\beta_i, X_{ijt}\right)}{\sum_{k=1}^{K} exp(\beta_i, X_{ikt})} f(\beta|\Omega) d\beta \tag{2}$$

Where, the vector Ω defines parameters characterised by preference distribution. Since the integral in Eq. (2) lacks a closed solution, simulated Maximum Likelihood Estimate (MLE) technique is usually used to estimate the model.

To estimate Eq. (2), it is necessary to specify the distribution family and draw random parameters from it. Typically, some studies specify that non-price parameters are normally distributed, while allowing the normal distribution of price coefficients is problematic, including the possible violation of downward-tilt demand curves and the derivation of WTP estimates with infinite variance (e.g., Revelt & Train, 1998). This is similar to assuming that people's preferences for the price are homogeneous, denoting that the standard deviation of unobserved utility or scale parameters are the same for all observations (Scarpa, Thiene, & Train, 2008).

Louviere (2004) believes that the scale parameters can and often change the observations randomly, ignoring this change will lead to wrong conclusions. For food selection models, if the price coefficient is limited to a fixed range, then when the change of actual scale exceeds the observed value, the change of scale will be incorrectly attributed to the WTP change of product characteristics.

One possible solution is to introduce heterogeneity and limit the sign of the price coefficient by specifying a distribution (such as lognormal distribution) whose domain is strictly located on one side of zero. Although the empirical and modifiable distribution of utility coefficients is consistent with the demand theory, it does not necessarily mean that WTP is a convenient distribution and vice versa (Scarpa et al., 2008).

Another solution is to estimate the model in the WTP space, where the model is re-parameterised so that the estimated parameter is the WTP of each attribute, rather than the marginal utility coefficient. For example, specifying utility in Eq. (1) is separable in the price *P* and non-price *X* attributes. Dividing the utility function by the scale parameter μ_i, we get:

$$V_{ijt}^{*} = -\left(\frac{\alpha_i}{\mu_i}\right) P_{ijt} + \left(\frac{\beta_i}{\mu_i}\right)^{'} \chi_{ijt} + \varepsilon_{ijt} \tag{3}$$

Where, ε_{ijt} is the extreme value of the independent identically distributed type I. Note that the WTP of each attribute is the ratio of attribute coefficient to price coefficient $\left(w_i = \frac{\beta_i}{\alpha_i}\right)$, thereby Eq. (3) can be converted into:

$$V_{ijt}^{*} = -\lambda_i \mathrm{P}_{ijt} + (\lambda_i \omega_i)^{'} \chi_{ijt} + \varepsilon_{ij} \tag{4}$$

Where, $\left(\lambda = \frac{\alpha_i}{\mu_i}\right)$ and w_i is the vector of WTP estimates for product attributes with normal distribution independent of scale.

Appendix II. Robustness test

In order to test the robustness of the above results, we firstly estimated the RPL models of Table 5 in the preference space.

Table 9 presents the regression results of the RPL model in the preference space. The AIC value of the RPL model in the WTP space estimation is smaller than that in the preference space estimation, and the premium for each attribute in the WTP space estimation is lower. Compared with the preference space estimation, the WTP space estimation using normal distribution of random parameters and logarithmic normal distribution of scaling factors is more suitable for our data.

Thereafter, we then estimated the RPL models of Table 6 in the preference space. The preference space estimation results in Table 10 are basically consistent with those in Table 6, and the AIC values estimated in Table 6 are smaller than their counterparts in Table 10. It can be seen that the regression results of RPL model based on the WTP space estimation in Table 6 are better.

Finally, we divided the ethics variable into two levels (high and low) based on its mean and median, and re-estimate Model (2) and Model (3) of Table 6 in the WTP space. Results in Table 11 and Table 12 show that the signs and significance of coefficients of the interaction between consumer ethics and animal welfare-related variables are basically consistent with their counterparts in Table 6. Therefore, the results are robust and reliable.

Table 9
Regression results of RPL model of animal welfare consumption preference based on the preference space estimation.

Attributes	Coefficient	Std. Dev.	WTP
Welfare Farming	1.134***	−0.694***	18.453
	(0.052)	(0.070)	[16.133, 20.773]
Brand	1.000***	1.397***	16.271
	(0.058)	(0.071)	[14.038, 18.504]
Humane Slaughter	0.917***	0.534***	14.929
	(0.045)	(0.086)	[12.875,16.983]
Environmental Friendliness	1.165***	−0.327***	18.963
	(0.050)	(0.105)	[16.648, 21.277]
Not to Buy	−3.768***	2.630***	
	(0.237)	(0.142)	
Price	−0.061***		
	(0.003)		
LR chi2	1452.80		
Log likelihood	−5631.566		
AIC	11,285.13		

Note: Values with *** are statistically significant at the 1% level. Each number in () is the standard error. Each number in [] is the 95% confidence interval.

Table 10
Regression results of RPL model of ethics and animal welfare preferences based on the preference space estimation.

Attributes	Model (1)		Model (2)		Model (3)	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Welfare Farming	0.142	−0.549***	−0.326	0.103	−0.654**	0.527***
	(0.198)	(0.116)	(0.254)	(0.196)	(0.255)	(0.125)
Brand	0.766***	1.331***	0.770***	1.364***	0.812***	1.345***
	(0.114)	(0.081)	(0.113)	(0.074)	(0.114)	(0.078)
Humane Slaughter	0.662***	0.509***	0.678***	−0.251	−0.048	0.015
	(0.107)	(0.102)	(0.107)	(0.156)	(0.180)	(0.227)
Environmental Friendliness	0.679***	−0.228	0.669***	0.249**	0.687***	0.347***
	(0.120)	(0.146)	(0.119)	(0.121)	(0.120)	(0.093)
Welfare Farming × Brand	0.452**	−0.977***	0.474**	0.519**	0.462**	−0.914***
	(0.194)	(0.216)	(0.191)	(0.217)	(0.192)	(0.148)
Welfare Farming × Humane Slaughter	0.538***	−0.141	0.520***	−0.798***	0.503***	0.297
	(0.191)	(0.450)	(0.193)	(0.129)	(0.191)	(0.204)
Welfare Farming × Environmental Friendliness	1.013***	−0.749***	1.043***	0.824***	1.067***	0.897***
	(0.209)	(0.152)	(0.212)	(0.152)	(0.209)	(0.143)
Ethics × Welfare Farming			0.120***	−0.126***	0.214***	0.077**
			(0.042)	(0.027)	(0.044)	(0.034)
Ethics × Humane Slaughter					0.200***	0.113***
					(0.040)	(0.019)
Not to Buy	−4.384***	2.693***	−4.478***	2.624***	−4.518***	2.647***
	(0.258)	(0.135)	(0.269)	(0.125)	(0.264)	(0.122)
Price	−0.062***		−0.062***		−0.064***	
	(0.003)		(0.003)		(0.004)	
LR chi2	1505.68		1517.93		1514.63	
Log likelihood	−5603.034		−5578.356		−5570.583	
AIC	11,240.07		11,194.71		11,183.17	

Note: Values with *** and ** are statistically significant at the 1% and 5% levels, respectively. Each number in () is the standard error.

Table 11
Regression results of RPL model in the WTP space with the ethics variable classified by means.

Attributes	Model (1)		Model (2)	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Welfare Farming	0.751	6.732***	2.142	9.441***
	(3.244)	(1.715)	(3.060)	(1.675)
Brand	12.935***	−21.459***	12.941***	20.640***
	(1.864)	(1.310)	(1.723)	(1.254)
Humane Slaughter	10.899***	−7.792***	6.872***	−0.863
	(1.684)	(1.443)	(1.629)	(4.038)
Environmental Friendliness	12.372***	−5.435***	12.523***	5.269***
	(1.967)	(1.351)	(1.814)	(1.395)
Welfare Farming × Brand	7.138**	10.060***	6.297**	−12.802***
	(3.006)	(3.780)	(2.731)	(2.487)
Welfare Farming × Humane Slaughter	8.685***	−1.123	7.410***	7.193***
	(3.001)	(3.351)	(2.805)	(2.443)
Welfare Farming × Environmental Friendliness	14.786***	−9.367***	12.912***	12.651***
	(3.452)	(2.923)	(3.209)	(2.750)
Ethics × Welfare Farming	5.086***	8.713***	5.287***	2.819
	(1.323)	(2.012)	(1.343)	(6.181)
Ethics × Humane Slaughter			6.798***	9.084***
			(1.236)	(1.328)
Not to Buy	−70.060***	−43.879***	−65.585***	37.204***
	(3.371)	(3.422)	(3.317)	(2.827)
Price / Scale	−2.668***	0.529***	−2.625***	0.402***
	(0.063)	(0.059)	(0.073)	(0.076)
Wald chi2	2129.24		1588.24	
Log likelihood	−5565.995		−5557.673	
AIC	11,171.99		11,159.35	

Note: Values with *** and ** are statistically significant at the 1% and 5% levels, respectively. Each number in () is the standard error.

Table 12
Regression results of RPL model in the WTP space with the ethics variable classified by median.

Attributes	Model (1)		Model (2)	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Welfare Farming	4.027	−4.438	3.703	6.573**
	(3.064)	(3.349)	(3.077)	(3.109)
Brand	12.421***	−21.197***	13.276***	20.794***
	(1.762)	(1.245)	(1.800)	(1.375)
Humane Slaughter	11.382***	−6.114***	9.821***	6.439***
	(1.645)	(1.517)	(1.670)	(1.578)
Environmental Friendliness	12.332***	−5.985***	12.124***	6.005***
	(1.899)	(1.312)	(1.901)	(1.671)
Welfare Farming × Brand	7.055**	3.355	5.965**	−13.434***
	(2.816)	(3.726)	(2.889)	(3.869)
Welfare Farming × Humane Slaughter	6.365**	−7.393**	7.556**	2.347
	(2.933)	(3.010)	(2.946)	(4.530)
Welfare Farming × Environmental Friendliness	13.268***	−11.990***	13.957***	11.437***
	(3.352)	(2.261)	(3.318)	(3.012)
Ethics × Welfare Farming	3.783**	14.255***	4.837***	13.388***
	(1.576)	(2.360)	(1.699)	(3.710)
Ethics × Humane Slaughter			4.535***	−1.582
			(1.443)	(5.032)
Not to Buy	−68.926***	−42.346***	−68.604***	40.609***
	(3.448)	(3.562)	(3.139)	(2.993)
Price / Scale	−2.645***	0.528***	−2.692***	0.365***
	(0.067)	(0.058)	(0.065)	(0.062)
Wald chi2	2071.36		2309.96	
Log likelihood	−5569.467		−5576.712	
AIC	11,178.93		11,197.42	

Note: Values with *** and ** are statistically significant at the 1% and 5% levels, respectively. Each number in () is the standard error.

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Article

Knowledge of Animal Welfare and Consumers' Behavioral Intentions in China: A Moderated Mediation Model of Product Cognition and Empathy

Yaoming Liang [1,2], Gengrong Hua [1], Weiyou Cai [3], Gen Li [2], Hao Wang [1,*] and Hui Li [1,4,5,*]

[1] College of Economics & Management, South China Agricultural University, No. 483 Wushan Road, Tianhe District, Guangzhou 510642, China; evanliang@scau.edu.cn (Y.L.); hua_gr@foxmail.com (G.H.)
[2] College of Veterinary Medicine, South China Agricultural University, Guangzhou 510642, China; ligen223@126.com
[3] Animal Disease Prevention and Control Center, Chenghai District, Shantou 515800, China; ccweiyou@163.com
[4] College of Public Administration, South China Agricultural University, Guangzhou 510642, China
[5] College of Natural Resources and Environment, South China Agricultural University, Guangzhou 510642, China
* Correspondence: hwang@scau.edu.cn (H.W.); smarthuili@scau.edu.cn (H.L.)

Simple Summary: In this study, consumer perceptions of animal welfare have been assessed. The results can strongly support the development of policies and legislation regarding animal-friendly production. In China, the demand for animal-friendly products is increasing, but so far, the research on the relationship between the knowledge of animal welfare and animal-friendly consuming intentions is limited. The objective of this study was to examine the impact of the knowledge of animal welfare on consumers' behavioral intentions and its mechanism. The survey covered 1499 food consumers in Guangdong province, China. Our empirical results suggest that increasing knowledge of animal welfare is significantly positive for the intention of animal-friendly products consumption. Furthermore, empathy moderates the indirect effect between animal-friendly product cognition and the behavioral intention both to purchase and recommend.

Abstract: As purchase power and consumption knowledge increase, consumers gradually demand safer and healthier products. Animal welfare is expected to be an important attribute of high-end food in the future and a major concern for the high-quality development of the livestock industry. The objective was to shed new light on our understanding of consumers' perceptions and behavioral intentions toward animal-friendly food. Using sample data of 1499 food consumers in Guangdong province, China, this study explored the role of product cognition and empathy in the relationship between consumers' knowledge and behavioral intentions. Results indicate that knowledge of animal welfare significantly influences consumers' behavioral intentions, and there is a mediating effect on cognition. Meanwhile, empathy moderates the relationship between product cognition and consumers' intentions to purchase or recommend animal-friendly products. Improving consumers' knowledge of animal welfare and cognitive levels of animal-friendly products may contribute to promoting animal-friendly product consumption and sustainable development of the livestock industry.

Keywords: animal welfare; knowledge; behavioral intention; product cognition; empathy

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Citation: Liang, Y.; Hua, G.; Cai, W.; Li, G.; Wang, H.; Li, H. Knowledge of Animal Welfare and Consumers' Behavioral Intentions in China: A Moderated Mediation Model of Product Cognition and Empathy. *Animals* **2022**, *12*, 1043. https://doi.org/10.3390/ani12081043

Academic Editor: Fabio Napolitano

Received: 25 February 2022
Accepted: 13 April 2022
Published: 16 April 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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1. Introduction

Animal welfare has been a widely discussed topic in recent decades. It plays an important role in promoting food safety and quality and achieving sustainable development of animal husbandry. As the largest and most populous developing country worldwide, China has been making heroic efforts to address the issue of human welfare, yet animal

welfare has been less of a concern. With the remarkable improvement in people's living standards, Chinese people have paid more and more attention to a healthy diet and food production management processes. High-end foods represented by organic foods are increasingly popular with the public. The number of product varieties has risen roughly every year since the implementation of organic food acts (China's Certification and Accreditation Administration (CNCA) developed Organic Product Certification Implementation Rules in 2005 and revised them in 2012, 2014, and 2019 to standardize the food certification process.) in 2012, and sales of organic food products have grown tremendously, reaching CNY 804 billion in 2020 (See Figure 1). The structure of public food consumption structure in China is moving toward an emphasis on quality together with economic development.

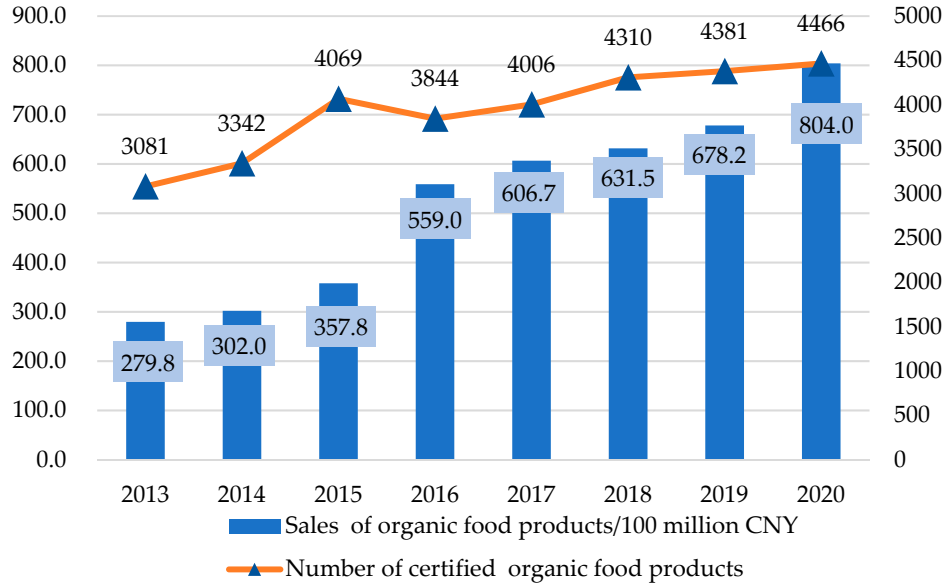

Figure 1. Trends of Chinese Organic Food Products. (Source: Green Food Development Center China and Prospective Industry Research Institute.)

Animal welfare is generally regarded as one of the quality attributes of food products [1]. Although over 60% of respondents had never heard of the concept of animal welfare in mainland China [2], based on a survey in Jiangsu province, Wang and Gu [3] found that consumers were willing to pay 16.2% more for animal-friendly products when not informed about the correlation between animal welfare and meat quality, and 21.3% more when informed of that information. Though there is no animal welfare product label in China at present, consumers are increasingly turning to products with higher welfare standards in Chinese daily consumption, exhibiting a positive perception and increased demand. Additionally, a growing number of Chinese consumers seem to consume broiler chickens from the free-range poultry system, natural grain-fed fattening pigs, and milk products without exogenous agents such as antibiotics, etc. These products with animal welfare attributes also tend to be more expensive. For example, fresh tenderloin of ecological black pigs fed with Chinese herbal medicine for more than 300 days sold for 129 CNY/kg on JOYBUY (JOYBUY, powered by jd.com, is one of the largest e-commerce companies in China.) on 31 December 2020, and the price was at least 1.5 times higher than that for ordinary pork.

Animal welfare is consistent with ethical requirements. Numerous scientific studies have demonstrated that increasing animal welfare may benefit animal production and health and the quality of animal-derived products while minimizing food safety risks and other related issues in the livestock industry [4,5]. Chinese consumers' willingness to pay (WTP) for animal welfare products may be because they think not only that animal welfare products are better, but also that animals deserve more consideration. In 2018, China

promulgated the Law of Wildlife Protection, aiming to maintain biodiversity and ecological balance and promote the harmonious development of man and nature. Particularly, under the influence of the global pandemic caused by COVID-19 in 2020, China has comprehensively banned eating wild animals, and the concept of a "community of destiny" between humans and animals has become more popular. In 2021, China moved to introduce the Animal Epidemic Prevention Law to prevent, control, purify and eliminate animal epidemics, promote the development of aquaculture, prevent and control zoonotic infectious diseases, and ensure public health safety and human health. Farm animal welfare plays a crucial role in promoting food safety and quality and achieving the sustainable development goals of animal agriculture. Currently, Chinese consumers' attitudes and willingness to pay for animal welfare improvements have been studied in a few articles [1,2,6]. There are also very few studies that show that information about the husbandry system may affect consumers' willingness to pay for animal-friendly products [7]. However, research on the relationship between knowledge of animal welfare and consumers' behavioral intentions in China remains rare.

As knowledge about animal welfare has increased, growing consumer demand has prompted the agricultural sector to adopt more sustainable and animal-friendly practices. The Chinese government is gradually becoming more aware of the need to provide higher standards of animal husbandry, so as to ensure farm animal health, the quality of animal-derived products, and the development of green agriculture. The International Cooperation Committee of Animal Welfare (ICCAW) of the China Association for the Promotion of International Agricultural Cooperation (CAPIAC) was approved by the Chinese Ministry of Agriculture in 2013. Since then, more regulations and policies have been introduced in China, such as Farm Animal Welfare Requirements: Pigs, China's first set of farm animal welfare standards. Soon, a widening range of animal-friendly products will be available to meet the consumer demand in China. Furthermore, behavioral intentions are a strong predictor of behavioral performance and a prerequisite for behavior [8]. A more intensive understanding of Chinese consumers' behavioral intentions regarding products with animal welfare attributes and in-depth research on its formation process and mechanism are urgently needed.

This paper is concerned with consumers' behavioral intentions regarding animal welfare products in China, and in particular, examines the impact of animal welfare knowledge and product cognition on consumers' behavioral intentions and its mechanism, and further seeks to investigate the role of empathy in the above mechanism. The main contributions of our work are reflected in the following aspects. Firstly, this study may shed new light on the relationship between knowledge of animal welfare and consumers' behavioral intentions. Secondly, it may provide an analytical foundation for stakeholders to better understand the heterogeneity in Chinese consumers' behavioral intentions toward animal welfare products and its intrinsic causes. And finally, the findings of this study can also provide a rationale for increasing demand for high-end animal husbandry products and promoting improvements in food consumption structure in China.

The structure of this paper is organized as follows. The theoretical background and hypotheses are discussed in Section 2. Sample data and measures are explained in Section 3. Empirical results are presented and discussed in Section 4. Conclusions and policy implications are presented in Section 5.

2. Theories and Hypotheses

Consumer knowledge refers to stored information or general background knowledge used to identify products in consumers' memory [9], such as product properties, users' experiences, etc. Knowledge focuses on consumers' degree of familiarity with and level of expertise in products, as well as professional opinions about the products [10]. Studies have shown that knowledge affects consumers' preferences for new products. For example, Suárez-Cáceres et al. [11] found that consumers' knowledge significantly affected their attitudes and WTP for aquaponic products in Spain and Latin America. Particularly, con-

sumers were more likely to pay a premium for products from aquaponics systems when the benefits of these products (i.e., the sustainability perspective) were highlighted [12,13]. Furthermore, some studies show that subjective knowledge has a stronger predictive effect on consumer purchase-related behavior than objective knowledge [14]. House et al. [15] found that a higher level of subjective knowledge would significantly improve the willingness to accept genetically modified foods, while objective knowledge did not play a role. Donoghue et al. [16] showed that subjective knowledge played a predictive role in the willingness of South African consumers to pay a premium for Karoo lamb, but that objective knowledge did not.

Animal welfare is a state of complete mental and physical health in which farm animals are in harmony with their surrounding environment. It generally refers to everything necessary to maintain animal physiology, mental health, and normal growth, such as good feeding, good housing, good health, and appropriate behavior [17]. Animal-derived products with high welfare standards are more guaranteed in terms of both nutritional quality and safety [18], and consumers are demanding safer, healthier, and higher quality foods under the same conditions [19]. If animal welfare information is readily available to the public, particularly through mass media, consumers will learn more about animal welfare and understand more about animal welfare products. Importantly, consumers can seek and find useful knowledge in their daily lives and use it to make purchase decisions, which implies consumers' different subjective purchase intentions and preferences [20,21]. It can be inferred that if consumers learn more about animal welfare knowledge, they will realize that animal welfare is beneficial, and their acceptance of and preference for animal-friendly products are likely to increase. On this basis, we propose a hypothesis:

Hypothesis 1 (H1). *Consumers' animal welfare knowledge has a positive effect on their behavioral intentions*.

Cognition is the process in which consumers choose, organize and explain external information and convert it into internal information [22]. It can be further specified as consumers' perceptions of specific products [23], that is, the better consumers' understanding of animal welfare products, the higher the level of consumer awareness. Consumers use knowledge to convert objective information into subjective cognition in purchasing decisions, thus affecting consumer attitudes and behaviors [24]. However, changes in consumer attitudes or perceptions of a product may affect one's consumption habits [25]. Vermeir and Verbeke [26] argued that a positive attitude towards sustainable products was closely related to purchase intentions. Part of what makes animal welfare an important issue in livestock husbandry is that people can recognize the impact of improved animal welfare on the public or consumer utility [27]. Heng et al. [28] found that consumers' cognition of animal welfare would be increased by appropriate education, promoting consumption of animal welfare products. Wang et al. [2] analyzed consumers' understanding of animal welfare and perception of food safety using a survey conducted in Jiangsu Province, China. They found that consumers were willing to pay a certain premium for animal welfare. Yan et al. [29] and Clark [30] found that education level had a positive and significant impact on people's understanding and behavioral intentions regarding animal welfare, and those with higher knowledge levels would be more likely to choose animal welfare products. Accordingly, animal welfare knowledge affects consumers' understanding, judgment, and evaluation of animal welfare products, and thus affects their own consumption preferences and actual consumption behaviors. We propose a hypothesis:

Hypothesis 2 (H2). *Product cognition has a mediating effect on the relationship between animal welfare knowledge and consumers' behavioral intentions*.

Various brain structures process information, and our decision-making processes involve both reason and emotion [31]. These two systems communicate with each other, impacting behavior together [32,33]. Empathy is an ability to put oneself in the position of

others and to understand or feel what others have experienced [34] and contains cognitive factors that make people think from the perspective of people in need [35]. According to ecological ethics, animal welfare originates from humans' moral responsibility for animals, and its core assumption is that animals have equal moral status and rights with humans to some extent [36]. Treating animals kindly conforms to people's ethical cognition, affects people's emotions, and increases people's utility [37]. If animal welfare products arouse consumers' empathy, consumers' purchasing desire may increase [38]. Cornish et al. [39] found that younger females with lower household income had a higher level of empathy for animals, which was related to the intention to buy animal welfare products.

Empathy focuses on people's subjective feelings about others, the other side of which is rational feelings and emotions. Product cognition is a comprehensive understanding of products, including composition, function, usage, advantages and disadvantages, characteristics, market, consumer groups, etc. It is the standard to measure consumers' awareness and understanding of brand connotation and value. It can be seen that product cognition is based on objective feelings and rational emotions. Usually, rational consumers tend to make purchase decisions according to their familiarity with products. However, the decision-making process cannot be described as exclusively rational and conscious, as it is affected by emotional and subjective elements [40]. If emotion is a key factor in consumers' purchase decision-making process [41], product cognition and behavioral intentions may be different between people with strong empathy and weak empathy. If consumers belong to the weak empathy group, their intentions to purchase or recommend may depend more on product cognition. If consumers belong to the strong empathy group, their purchase intention may rely more on empathy itself rather than product cognition. Specifically, consumers with strong empathy for animals may consider whether animals are suffering rather than whether animal products are delicious or not. That is, the effect of consumers' cognition of the products on their behavioral intentions may be adjusted by empathy. Therefore, we hypothesize:

Hypothesis 3 (H3). *Empathy negatively moderates the relationship between knowledge of animal welfare and consumers' behavioral intentions via product cognition.*

Figure 2 shows a conceptual model of this study. As indicated, product cognition mediates the relationship between knowledge of animal welfare and consumers' behavioral intentions. In addition, empathy moderates the link between product cognition and consumers' behavioral intentions. Thus, the indirect effect of knowledge of animal welfare on consumers' behavioral intentions based on product cognition is strong when empathy is weak and weak when empathy is strong.

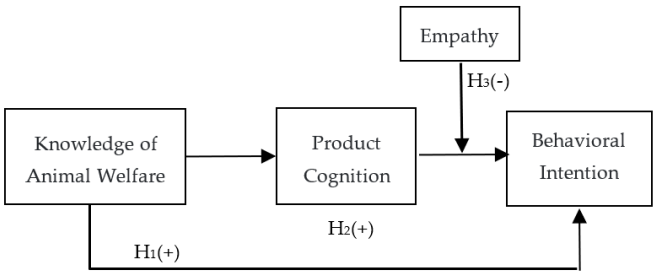

Figure 2. The conceptual framework of animal welfare knowledge, product cognition, empathy, and consumers' behavioral intentions.

3. Data, Variables, and Methods

3.1. Data

The development of animal welfare is constrained by the level of regional economic and social development. In order to control costs, our survey was limited to major cities in Guangdong province. There were mainly two reasons for this. On the one hand, Guang-

dong province, neighboring two special administrative regions, Hong Kong, and Macao, is one of the provinces at the forefront of reform and opening up in China. Additionally, Guangzhou and Shenzhen, both located in Guangdong, are two of the top four cities, making Guangdong province a major province for foreign trade in China. On the other hand, Cantonese cuisine in Guangdong is one of the eight major cuisines in China. Cantonese people generally speak (or listen to) Cantonese, eat Cantonese cuisine, and have a good reputation for being "food experts". All of these facts help control the unobserved factors not controlled in the data, such as household food supply, regional tastes, diet, and other cultural factors.

Since we were interested in consumers' knowledge of animal welfare and behavioral intentions toward animal-friendly products instead of societal opinions, our survey respondents were those who buy food for their families, eat meat products, and over the age of 16 years. As such, our survey may have avoided the bias problem of measuring consumers' willingness to pay for private products with a sample including some consumers who buy the products for others.

Due to the coronavirus disease (COVID-19) outbreak worldwide, China has implemented strict epidemic prevention and control measures based on home isolation. Many Chinese people have had to transfer their daily studies, work, and lives to the Internet. For this reason, the questionnaires were uploaded onto Wenjuanxing (By recruiting and maintaining clientele, Wenjuanxing can sometimes offer consumers rewards for participating in surveys. The rewards offered to participants are points that they can collect and exchange for retail vouchers. Surveys are sent to participants randomly via email and online according to the sample requirements of the researchers. Participation in each investigation is voluntary. Researchers can contact and provide suppliers with questionnaires and pay fees in exchange for access to consumers who are prepared to participate in online surveys. The cost depends on the difficulty of the questionnaire, the duration of the survey, consumer characteristics and number of samples.), the first and largest domestic online questionnaire survey and test platform in China. Data were collected in two phases: a pilot survey and formal survey.

In February 2020, a pilot survey was conducted among 90 consumers mainly responsible for purchasing household food. In the pre-test, most respondents were not familiar with the concept of "animal welfare". Searching for information is a key factor in the consumer decision-making process [42,43], and should be given enough attention in studies of consumer preferences [44]. Consequently, we clearly defined farm animal welfare and its products in the guide for the formal questionnaire. According to the feedback and suggestions of sample consumers, we revised the expressions in the questionnaire to make it simpler and easier to understand, removed the survey questions inconsistent with the local situation, and added some more valuable questions.

In March 2020, we conducted a formal survey through the Wenjuanxing platform and collected 1637 completed questionnaires in total. We treated completeness and quality of information as the screening criteria and eliminated invalid questionnaires that lacked crucial information or logic. Respondents with monotonous response behavior were also excluded because they may not have thoroughly read the questions or only completed the survey to obtain rewards. Finally, 1499 valid questionnaires with responses regarding demographics, meat consumption habits, knowledge of animal welfare, product cognition, and consumers' behavioral intentions were obtained, with an effective response rate of 91.6%. All statistical analysis was carried out using Stata 16 (Stata Corp. 2019, created by StataCorp LLC, Texas, TX, USA).

3.2. Variables

3.2.1. Dependent Variables

Purchase and recommendation are two common behaviors in consumers' food decision-making. Following the practice of Weinrich et al. [45], we treated respondents' willingness to purchase or recommend animal-friendly products as dependent variables to exam-

ine consumers' behavioral intentions. Thus, the purchase intention variable measured one's willingness to buy animal-friendly products and the recommend intention variable measured one's willingness to promote animal-friendly products to friends. The above dependent variables were quantified by a 5-point scoring method, ranging from 1 for "absolutely not" buy or recommend to 5 for "always" buy or "absolutely" recommend. Table 1 shows that more than 80% of the respondents wanted to purchase and recommend farm animal welfare products.

Table 1. Consumers' behavioral intentions regarding farm animal welfare products.

Purchase Intention			Recommend Intention		
Options	**Number of People**	**Ratio**	**Layer**	**Number of People**	**Ratio**
Absolutely not	55	3.67%	Absolutely not	20	1.33%
Rarely	135	9.01%	Rarely	151	10.07%
Sometimes	879	58.64%	Possibly	670	44.70%
Often	368	24.55%	Probably	509	33.96%
Always	62	4.14%	Absolutely	149	9.94%

3.2.2. Core Independent Variables

At the beginning of the questionnaire, we asked respondents whether they knew about farm animal welfare. However, measuring animal welfare knowledge by simply asking respondents about their understanding of animal welfare is prone to bias. In order to make all respondents reach the same level before evaluating the dependent variables, we then provided a detailed description of the connotation of animal welfare. Respondents were told that animal welfare was a way of farming that met the basic natural needs of animals and kept animals in good living conditions, mainly including five freedoms for animals: freedom from hunger and thirst, freedom from discomfort, freedom from pain, injury and disease, freedom from fear and distress and freedom to express normal behavior [46].

In addition, respondents were informed that animal welfare products or animal-friendly products referred to products that meet animal welfare standards to varying degrees in the process of farm feeding, such as free-range chicken, eggs, pork, etc. According to the connotations of animal welfare and opinions that may easily be misunderstood by the public, we examined respondents' cognition of animal welfare from four aspects: the ethical relationship between human beings and animals, weight between human welfare and animal welfare, opinions of animal health as well as the understanding of animal welfare cultural basis.

Table 2 presents items for evaluating consumers' animal welfare knowledge in our questionnaire and the descriptive statistics of respondents' answers to the questions. It can be seen that respondents had a high level of awareness of animal health and animal welfare culture, with correctness ratings of up to 88.99% and 88.59%, respectively. Unlike animal rights, animal welfare advocates the humane use of animals against any form of animal abuse rather than equating animals with humans. In this regard, 33.16% of respondents correctly understood this relationship, and 83.92% of respondents believed that animal welfare should not be considered before human welfare was guaranteed. It shows that most Chinese consumers tend to put people's interests first when considering the relationship between humans and animals.

We further assigned values based on respondents' answers to questions about animal welfare knowledge. Respondents who answered correctly would receive 1 point for one question, otherwise, 0, and thus, respondents' knowledge of animal welfare was obtained. In order to observe the changes in respondents' knowledge before and after providing animal welfare information, we also assigned values for respondents' understanding of animal welfare before the survey, ranging from 0 for "do not know animal welfare at all" to 4 for "know animal welfare very well". Table 3 shows that 50.63 % of the respondents did not know about animal welfare at all, and 28.75% had heard of but did not know

about animal welfare before receiving animal welfare information. This corresponded to 40.56% of respondents who obtained a full score of 4 points, and 41.96% who obtained 3 points after receiving animal welfare information. Although most respondents did not know about animal welfare at first, their cognitive level of animal welfare was significantly improved after a brief animal welfare literacy review during the survey. This indicates that Chinese consumers have good cognitive ability regarding animal welfare.

Table 2. Answers to questions related to animal welfare knowledge.

Items	Correct	Wrong	Do Not Know
Animal welfare is completely equating animals with people.	33.16%	54.30%	12.54%
People's welfare has not been achieved yet, so there is no need to consider animal welfare.	6.74%	83.92%	9.34%
Animal welfare considers both the "physical" and "mental" health of the animal	88.99%	3.87%	7.14%
Animal welfare conforms to people's modern ecological and ethical requirements for animals.	88.59%	4.14%	7.27%

Table 3. Respondents' mastery of animal welfare knowledge.

Types	0	1	2	3	4	Mean Difference
Self-statement	50.63%	28.75%	14.88%	4.67%	1.07%	−2.390 ***
Knowledge test	1.67%	3.94%	11.87%	41.96%	40.56%	

*** is statistically significant at 1% level.

3.2.3. Mediating Variables

Product cognition is the result of consumers internalizing objective animal welfare information about the product into subjective cognition, which in turn reflects consumers' understanding of the quality of animal-friendly products. Animal welfare is related to attributes such as health [47], delicacy [7,48]), safety [49,50]), ethics [51,52]) and environmental friendliness [53–55]). Thus, we measured consumers' cognition of animal welfare products from the five aspects mentioned above. The expression of the items was adapted from Carnovale et al. [56]. Each item was measured on a 5-point Likert scale, from "1" as "very disagree" to "5" as "very agree". To avoid sequential effects, all items of the same scale were displayed at random in the survey. Internal consistency was measured using Cronbach's α coefficient. Table 4 demonstrates that the reliability coefficient of each item was greater than 0.75, and total reliability was over 0.84, which was in line with the standard of a good reliability coefficient (above 0.6). The KMO value was close to 1 (0.82), the significance level of LR test results was less than 0.001 (chi-square value 3161.32). The reliability and validity were shown to be good.

Table 4. Cognition of farm animal welfare products.

Items	Mean	Standard Deviation	Reliability (Cronbach's α)	Total Reliability
Meat from friendly-treated animals is healthier.	3.953	0.971	0.785	0.842
Meat from friendly-treated animals tastes better.	3.610	1.043	0.817	
Meat from friendly-treated animals is safer.	3.966	0.956	0.797	
It is more ethical to eat animal products with better welfare.	3.660	1.073	0.840	
Eating animal products with better welfare is better for the environment.	3.783	1.014	0.812	

3.2.4. Moderating Variable

We measured empathy for animals by seeking respondents' comments on the statement "I feel uncomfortable every time I see animals being abused or suffering" [57]. According to the survey results, the proportion of respondents reporting "very disagree", "relatively disagree", "general", "relatively agree" and "very agree" was 3.94%, 3.67%, 17.95%, 46.43% and 35.62%, respectively. It can be seen that the respondents had a high level of empathy. In order to analyze the relationship between empathy and other variables more effectively, we merged the lowest three categories ("very disagree", "relatively disagree" and "general") into the level of "low", making the distribution of categories that made up the moderating variable more balanced. Accordingly, empathy was defined on three levels: low, medium and high, corresponding to "disagree or generally agree", "relatively agree" and "very agree".

3.2.5. Control Variables

Following previous research, we treated four kinds of demographic variables as controls. They included personal characteristics such as gender, age, years of education, household registration, family characteristics such as household income, number of people dining together, dining together with a child under 18, dining together with an elderly person over 60, and behavioral variables related to animal contact such as whether to raise pets, engaged in animal-related occupations, heard of animal welfare before. Additionally, the variable indicating whether the city of the respondent was a first-tier city was also included to control unobserved factors that were not clearly controlled in the data, such as regional economic development levels, household food supply, etc. Table 5 reports definitions and descriptive statistics of all variables used in the analyses.

Table 5. Definition and descriptive statistics of each variable.

Variables	Definition and Assigned Values	Mean	Standard Deviation
	Dependent variables		
Purchase intention	Willingness to buy animal welfare products: Absolutely not = 1, Rarely = 2, Sometimes = 3, Often = 4, Always = 5	3.165	0.788
Recommend intention	Willingness to recommend animal welfare products: Absolutely not = 1, Rarely = 2, Possibly = 3, Probably = 4, Absolutely = 5	3.411	0.850
	Independent variables and control variables		
AW knowledge	Scores of animal welfare knowledge test	3.158	0.899
Product cognition	Mean scores of five items for the respondent's attitude towards animal welfare products	3.795	0.793
Empathy	Feelings every time a respondent sees animals being abused or suffering: Low = 1, Medium = 2, High = 3	2.177	0.710
Gender	Male = 1, Female = 0	0.361	0.480
Age	Age of the respondent	32.04	9.976
Dining scale	Number of people eating together in a family	3.853	1.463
Child	Whether there is a child under 18 years old dining together: Yes = 1, No = 0	1.518	0.500
Elderly	Whether there is an elderly person over 60 years old dining together: Yes = 1, No = 0	1.616	0.487

Table 5. *Cont.*

Variables	Definition and Assigned Values	Mean	Standard Deviation
Income	Average household income per month, <6000 yuan = 1, 6000–12,000 yuan = 2, 12,000–18,000 yuan = 3, 18,000–24,000 yuan = 4, 24,000–30,000 yuan = 5, >30,000 yuan = 6	2.842	1.466
Education	Assigned values according to different educational levels: Primary school = 6, Middle school = 9, High school (Technical secondary or higher vocational school) = 12, Junior college = 14, Undergraduate = 16, Graduate or above = 19	15.32	2.440
Urban	Urban resident: Yes = 1, No = 0	0.849	0.359
Pet experience	Having experience of raising pets: Yes = 1, No = 0	0.229	0.421
Animal-related work	Engaged in animal-related occupations: Yes = 1, No = 0	0.049	0.217
Ever heard of AW	Heard of animal welfare before the survey: Yes = 1, No = 0	0.794	0.405
First-tier city	Living in Guangzhou or Shenzhen: Yes = 1, No = 0	0.726	0.446

3.3. Estimation Methods

Following the practices of Wykes et al. [58] and Preacher et al. [59], the proposed moderated mediation model can be tested by the stepwise method. In terms of the mediating effect test, the first step is to test whether the influence of independent variables on the dependent variable is significant, the second is to test whether the influence of independent variables on the mediating variable is significant, and the third is to test whether the influence of independent variables on the dependent variable is significantly reduced or even disappeared after controlling the mediating variable. The moderating effect is tested by constructing the interactive term between the independent variable and the moderating variable, and the moderating effect is judged by observing the significance level of the interaction. According to the theoretical hypothesis of this paper, the following moderated mediation model can be constructed:

$$BI_i = \alpha_{10} + \alpha_{11}K_i + \alpha_{12}X + \varepsilon_1 \quad (1)$$

$$Awp_i = \alpha_{20} + \alpha_{21}K_i + \alpha_{22}X + \varepsilon_2 \quad (2)$$

$$BI_i = \alpha_{30} + \alpha_{31}K_i + \alpha_{32}Awp_i + \alpha_{33}X + \varepsilon_3 \quad (3)$$

$$BI_i = \alpha_{40} + \alpha_{41}K_i + \alpha_{42}Awp_i + \alpha_{43}Emp_i + \alpha_{44}Awp_i \times Emp_i + \alpha_{45}X + \varepsilon_4 \quad (4)$$

In Equations (1)–(4): BI_i represents consumers' behavioral intentions, K_i represents animal welfare knowledge, Awp_i represents cognition of animal welfare products, Emp_i represents animal empathy, and X represents a series of control variables mentioned above; α_{10}, α_{20}, α_{30}, α_{40} are the corresponding constant terms; ε_1, ε_2, ε_3, ε_4 are the corresponding random error terms, which are assumed to be normal distribution; the subscript i denotes the ith respondent. Coefficient α_{11} in Equation (1) denotes the total effect of animal welfare knowledge on consumers' behavioral intentions; coefficient α_{21} in Equation (2) denotes the impact of animal welfare knowledge on product cognition; coefficients α_{31}, α_{41} in Equations (3) and (4) denote the direct effect of animal welfare knowledge on consumers' behavioral intentions, and coefficients α_{32}, α_{42} denote the direct effect of product cognition on consumers' behavioral intentions. $\alpha_{21} \times \alpha_{32}$, . which can be obtained by bringing Equation (2) into Equation (3), showing the indirect effect of animal welfare knowledge on consumers' behavioral intentions, namely the impact of animal welfare knowledge on consumers' behavioral intentions through product cognition. Coefficient α_{43} in Equation (4) represents the direct effect of the moderating variable on consumers' behavioral intentions.

$\alpha_{42} + \alpha_{44}Emp_i$ means the mediated effect of product cognition moderated by Emp_i on consumers' behavioral intentions.

4. Empirical Results and Analysis

4.1. Total Effect and Robustness Test

Table 6 reports the regression results of Equation (1). The OLS estimation results in columns (1) and (2) show that animal welfare knowledge has a significant positive impact on consumers' behavioral intentions. Increasing animal welfare knowledge is conducive to improving consumers' purchase and recommend intentions. In terms of control variables, women are more likely to recommend animal welfare products to others, which is consistent with the fact that women are more willing to share life experiences with others; young people in first-tier cities with better family economic conditions are more likely to accept animal welfare products; respondents with pet experiences prefer animal welfare products to those without pet experiences, and those that never heard of animal welfare are more willing to buy and recommend animal welfare products.

Table 6. Total effects of animal welfare knowledge on consumer's behavioral intention.

Variable	(1)	(2)	(3)	(4)
	OLS	OLS	Ordered Probit	Ordered Probit
	Purchase Intention	Recommend Intention	Purchase Intention	Recommend Intention
AW knowledge	0.103 ***	0.151 ***	0.144 ***	0.195 ***
	(0.025)	(0.025)	(0.035)	(0.032)
Gender	−0.027	−0.106 **	−0.039	−0.138 **
	(0.042)	(0.046)	(0.061)	(0.059)
Age	0.010 ***	0.007 ***	0.016 ***	0.009 ***
	(0.003)	(0.003)	(0.004)	(0.003)
Education	−0.003	−0.010	−0.005	−0.014
	(0.010)	(0.011)	(0.014)	(0.014)
Urban	0.035	0.044	0.065	0.059
	(0.058)	(0.061)	(0.083)	(0.079)
Income	0.048 ***	0.038 **	0.068 ***	0.050 **
	(0.016)	(0.017)	(0.023)	(0.022)
Dinning scale	0.016	0.011	0.025	0.014
	(0.019)	(0.019)	(0.026)	(0.025)
Child	−0.014	−0.048	−0.024	−0.063
	(0.048)	(0.051)	(0.068)	(0.066)
Elderly	0.060	−0.027	0.089	−0.037
	(0.048)	(0.051)	(0.068)	(0.067)
Pet experience	0.106 **	0.133 **	0.158 **	0.175 ***
	(0.048)	(0.052)	(0.069)	(0.068)
Animal-related work	0.111	0.112	0.165	0.149
	(0.101)	(0.114)	(0.143)	(0.147)
Ever heard of AW	−0.101 **	−0.099 **	−0.145 **	−0.128 **
	(0.041)	(0.044)	(0.059)	(0.057)
First-tier city	0.096 **	0.066	0.147 **	0.085
	(0.048)	(0.050)	(0.068)	(0.065)
Constant	2.216 ***	2.800 ***		
	(0.287)	(0.309)		
Observation	1499	1499	1499	1499
R-squared/Pseudo R2	0.055	0.057	0.026	0.024
Wald chi2			81.86	91.43
Log pseudo-likelihood			−1646.082	−1821.981

*** and ** are statistically significant at 1% and 5% levels, respectively. Numbers in parentheses are robust standard errors.

Some previous studies have shown that statistical results share a very similar significance level between ordinal and cardinal numbers [60]; the ordered Probit model is

employed to estimate the impact of consumer welfare knowledge on consumers' behavioral intentions. The ordered Probit model regression results in columns (3) and (4) of Table 6 are entirely consistent with the OLS regression results in the significance level and symbolic direction.

4.2. Mediating Effect of Product Cognition and Robustness Test

Considering that animal welfare knowledge has a significant effect on consumers' behavioral intentions, we further explore product cognition's mediating role. The stepwise regression method was used to estimate Equations (1)–(3), respectively, and robust standard errors were obtained. The estimation results are shown in Table 7. Column (1) and column (4), respectively, indicate the total effect of animal welfare knowledge on consumers' purchase intentions and recommend intentions. Column (2) shows that animal welfare knowledge can significantly improve the levels of product cognition. Column (3) shows the direct effect of animal welfare knowledge and product cognition on consumers' purchase intentions. The estimated coefficient of animal welfare knowledge variable was 0.077, which was significant at the 1% statistical level, indicating that the direct effect of animal welfare knowledge on purchase intention was 7.7%. The direct effect of product cognition on purchase intention was 0.263, significant at the 1% statistical level. When multiplying it with the animal welfare knowledge coefficient in column (2), we obtained the indirect effect of animal welfare knowledge on purchase intention (0.026), accounting for 25.24% of the total effect, which means that the mediating effect of animal welfare knowledge on purchase intention was about 25% by improving product cognition. Similarly, according to columns (2), (4), and (5) in Table 7, the mediating effect of animal welfare knowledge on recommend intention by increasing product cognition was about 21%.

Table 7. Mediating effects of product cognition.

Variables	(1)	(2)	(3)	(4)	(5)
	Purchase Intention	**Product Cognition**	**Purchase Intention**	**Recommend Intention**	**Recommend Intention**
AW Knowledge	0.103 ***	0.098 ***	0.077 ***	0.151 ***	0.119 ***
	(0.025)	(0.023)	(0.024)	(0.025)	(0.024)
Product Cognition			0.263 ***		0.330 ***
			(0.035)		(0.036)
Control variables	controlled	controlled	controlled	controlled	controlled
Constant	2.216 ***	3.069 ***	1.408 ***	2.800 ***	1.788 ***
	(0.287)	(0.281)	(0.299)	(0.309)	(0.306)
Observation	1499	1499	1499	1499	1499
R-squared	0.055	0.046	0.121	0.057	0.147

*** is statistically significant at 1% level. Numbers in parentheses are robust standard errors. Due to space limitations, only brief results are represented.

Significance of indirect effects was estimated by the Sobel test and the bootstrap test. The Sobel test statistic Z for the purchase intention model was 4.113, and for the recommend intention model, 4.199. The associated p-values were both significant at the level of 1%, indicating significant mediation. Following the bootstrapping method of Preacher and Hayes [61] (setting 1000 iterations), results of the bootstrap test are shown in Table 8. The confidence intervals of both indirect and direct effects after bias correction did not include 0, indicating that there was indeed a transmission mechanism from animal welfare knowledge to purchase or recommend intention through improving product cognition. Both tests demonstrated that the stepwise regression method has a high degree of robustness for estimating the mediation effect.

Table 8. Bootstrap test results for mediating effect.

Dependent Variables	Bootstrap Test	Coefficient	Deviation	Standard Deviation	95% C.I.	Bias-Corrected C.I.
Purchase intention	indirect effect	0.027	−0.000	0.007	[0.015,0.042]	[0.016,0.045]
	direct effect	0.077	−0.000	0.024	[0.032,0.124]	[0.033,0.124]
Recommend intention	indirect effect	0.034	−0.000	0.008	[0.019,0.051]	[0.019,0.052]
	direct effect	0.117	−0.000	0.025	[0.070,0.167]	[0.069,0.166]

4.3. Moderating Effect of Empathy and Robustness Test

To investigate the moderating role of empathy in the link between product cognition and consumers' behavioral intentions, we constructed an interactive term between empathy and product cognition. Equation (4) was estimated using the OLS approach. The estimation results are shown in Table 9. The regression coefficient of the interactive term in column (2) was negative and significant at the level of 10%, showing that empathy may negatively regulate the positive impact of product cognition on purchase intention and recommend intention.

Table 9. Moderating effects of empathy.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Purchase Intention			Recommend Intention		
	All Sample	Weak Empathy Group	Strong Empathy Group	All Sample	Weak Empathy Group	Strong Empathy Group
AW Knowledge	0.062 **	0.088 ***	0.022	0.097 ***	0.122 ***	0.082
	(0.024)	(0.027)	(0.051)	(0.023)	(0.025)	(0.055)
Product Cognition	0.433 ***	0.320 ***	0.153 ***	0.499 ***	0.372 ***	0.232 ***
	(0.108)	(0.041)	(0.059)	(0.110)	(0.039)	(0.062)
Empathy	0.448 **			0.519 ***		
	(0.190)			(0.195)		
Product Cognition × Empathy	−0.083 *			−0.086 *		
	(0.048)			(0.049)		
Control Variables	controlled	controlled	controlled	controlled	controlled	controlled
Constant	0.551	0.892 ***	2.560 ***	0.854 *	1.473 ***	2.635 ***
	(0.503)	(0.345)	(0.571)	(0.515)	(0.347)	(0.595)
Observation	1499	965	534	1499	965	534
R-squared	0.139	0.166	0.066	0.177	0.195	0.091

***, ** and * are statistically significant at 1%, 5% and 10% levels, respectively. Numbers in parentheses are robust standard errors. Due to space limitations, only brief results are represented.

As mentioned above, the classification of the empathy variable may have an impact on the results. To check the robustness of the results and provide further insight into the relationship, all samples were divided into a strong empathy group and weak empathy group according to the mean of empathy. Subsequently, categorical analysis was conducted to compare the performance of the two groups (strong empathy vs. week empathy). The regression results in Table 9 show that the correlation coefficient of product cognition on purchase intention decreased from 0.320 in column (2) to 0.153 in column (3), which was significant at the level of 1%, indicating that the positive impact of product cognition on purchase intention decreases when empathy gains strength.

Figure 3 presents a more intuitive comparison of the regression results. It demonstrates that the purchase intention of the strong empathy group was stronger than that of the weak empathy group, which conformed to the expectation that empathy helps to promote animal welfare product consumption. The negative moderating effect of empathy was mainly manifested in the slope for the strong empathy group, which was smaller than that of the weak empathy group; that is, the impact of consumers' product cognition on purchase intention in the strong empathy group was smaller than that in the weak empathy group,

which was also in line with our expectations. The reason may be that empathy may be an important factor in motivating consumers to buy animal welfare products.

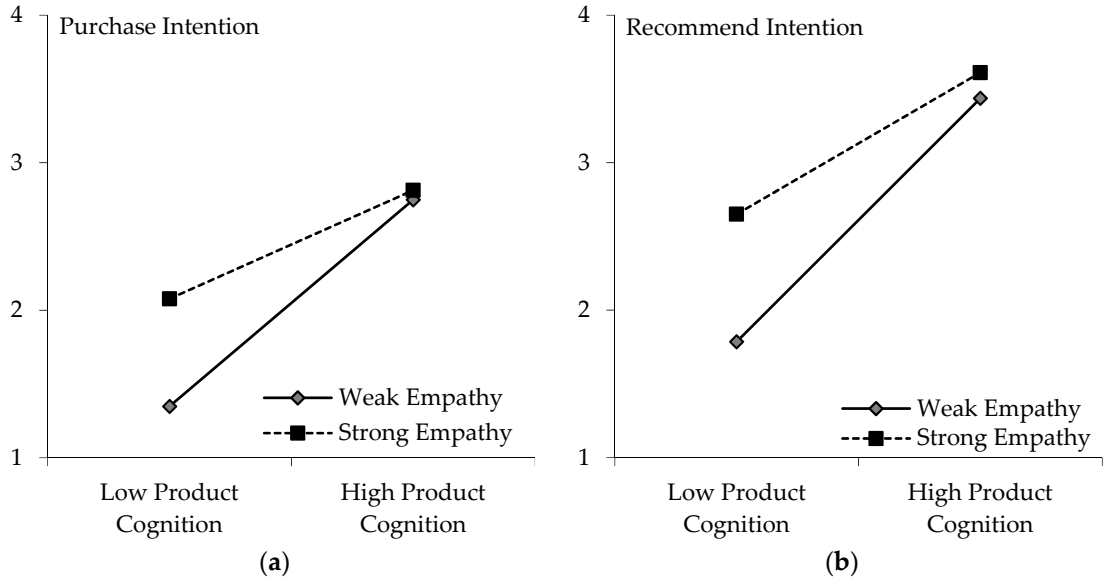

Figure 3. Effect of Empathy on Product Cognition Affecting Consumers' Behavioral Intentions. (**a**) Purchase Intention, (**b**) Recommend Intention.

Animal welfare products are considered to possess both quality and ethical attributes. The strong purchase intention of the strong empathy group may be mainly due to their strong empathy for animals. In this regard, consumers' purchase intentions would only be improved slightly even when the quality attributes of animal welfare products are identified. It is worth noting that animal welfare knowledge here did not have a significant impact on purchase intention for the strong empathy group. From another perspective, this may explain that consumers' behavioral intentions regarding animal welfare products in the strong empathy group mainly depended on their animal ethics. For consumers with weak empathy, their purchase intentions for animal welfare products may be mainly due to quality attributes such as taste, health, quality, safety or other considerations. Improving their cognitive level of animal welfare products may be conducive for them to accept animal welfare products.

According to the results in columns (5) and (6) in Table 9, empathy moderates the effect of product cognition on recommend intention, similarly to the moderating effect of empathy on product cognition affecting purchase intention. Figure 3 also intuitively demonstrates that people's recommend intentions for animal welfare products were stronger than their purchase intentions.

4.4. Further Discussions

This study investigated the relationship between animal welfare knowledge and consumers' behavioral intentions with respect to animal welfare products with the mediating role of product cognition and the moderating role of empathy. Consumers' perceptions and demands for farm animal welfare products determine the market outlook for animal husbandry producers to improve farm animal welfare and reflect public opinions and demands for the government to formulate laws, regulations and policies related to farm animal welfare.

This study found several interesting results. Animal welfare knowledge has a positive impact on consumers' behavioral intentions, and increasing animal welfare knowledge may help improve consumers' intentions to buy or promote animal welfare products. Our results were consistent with the findings in developing countries that consumers with

positive attitudes towards animal welfare are willing to pay more for animal-friendly products [62–64]. Carnovale et al. [56] found that consumers with higher levels of animal welfare knowledge had higher purchase intentions for animal welfare products in China. In the past, it was generally believed that animal welfare was a matter for developed countries. However, the findings of this study show that that is not entirely the case. As a largest developing country, China has become an affluent society in a general sense since 2020, and people's living standards have improved significantly. The demand for healthier, safer, higher-quality meat that meets their ethical requirements has been increasing. Therefore, a key issue going forward will be how to guide the public to fully understand animal welfare through publicity and promotional activities.

Furthermore, product cognition has a mediating effect on the link between animal welfare knowledge and consumers' behavioral intentions. This finding indicates that increasing animal welfare knowledge helps to increase consumers' product cognition. That is, consumers may link animal welfare knowledge with product cognition and make their purchase decisions. When acquiring knowledge about animal welfare, consumers may perceive and evaluate products with animal welfare attributes as of high quality because animal welfare products are generally known as high-end products with higher quality in nutrition, health, safety and taste than traditional products [5,18,65]. Hence, consumers may purchase more animal welfare products. Our findings support those of Jiang et al. [66], who suggested that positive animal welfare information made participants feel satisfied, healthy and happy, and consumers with higher product consumption showed a higher level of approval for animal welfare products. Consumers who often buy animal welfare products have more animal welfare knowledge and better product cognition. In addition to promoting animal welfare, it is necessary to achieve reasonable market segmentation and provide a more differentiated system for those who are interested in animal welfare, want higher standards of animal-derived products, and consider animal welfare in the search for information [67,68].

Finally, empathy plays a moderating role in the indirect effect of animal welfare knowledge on consumers' behavioral intentions via product cognition. This finding suggests that consumers with strong empathy may integrate their concern for animals into their purchase decisions. The motive of perceptual consumption, or a type of moral consumption, may reduce the impact of product cognition on purchase or recommend intentions. Consumers with weak empathy are less affected by animal ethics. Instead, they mainly use animal welfare knowledge available to make purchase decisions by rationally evaluating product quality. Overall, consumers with strong empathy are more likely to purchase animal welfare products than consumers with weak empathy under the same conditions, possibly due to the dual influence of product cognition and animal ethics. The moderating effect of empathy on product cognition affecting consumers' behavioral intentions confirms the ecological ethics of harmonious development between human and animals, and the existence of moral purchase behavior of consumers [69,70]. According to non-anthropocentrism, animals as the subject of life can feel pain and enjoy happiness. Freeing animals from unnecessary pain has become one of the motivations for consumers to consume animal welfare products. Therefore, promoting farm animal welfare not only fits the ethical perception of consumers but also has a functional impact on improving food safety [71]. However, consumers have to accept a higher price for the improvement of animal welfare, which to some extent inhibits consumer demand. Still, it is a fact that consumers can obtain additional benefits, such as health, deliciousness, safety, and even moral sentiment based on ecological ethics during animal welfare product consumption.

5. Conclusions and Implications

China is the most populated country in the world. Until now, people did not know much about animal welfare. Improving the level of animal welfare knowledge will help to cultivate market demand for farm animal welfare products and promote the high-quality development of animal husbandry. Based on the survey data of 1499 food consumers in

Guangdong Province, China, this paper revealed the influence and orientation of animal welfare knowledge on consumers' behavioral intentions by introducing product cognition and empathy.

The results from the moderated mediation model make three points. Firstly, the level of animal welfare knowledge has a significant positive impact on consumers' behavioral intentions. Secondly, product cognition significantly increases consumers' behavioral intentions and plays an intermediary role in the impact of animal welfare knowledge on consumers' behavioral intentions. Thirdly, empathy has a significant positive effect on consumers' behavioral intentions, and plays a negative moderating role through the indirect effect of animal welfare knowledge on consumers' behavioral intentions via product cognition.

There are several policy implications to be drawn from the above findings. First, China needs to create a good institutional environment for animal welfare development in a planned way. In any case, improving animal welfare levels and product safety is an inevitable trend. Animal welfare will be an important attribute of high-end food in the future and an important factor restricting the high-quality development of animal husbandry. As farm animal welfare products are typical trust products, the formation of an effective market for these products requires that the government or third-party institutions establish regulatory measures to ensure the quality of farm animal welfare products. It is necessary for China to gradually establish and improve regulatory measures for the animal products market, strengthen the formulation and evaluation of animal welfare standards, and guide the meat production chain to improve its facilities, equipment and management, so as to meet the requirements of more sensitive markets.

Second, universal education pertaining to animal science is especially important. A growing interest in animal welfare can be attributed to urbanization, social education and economic development, as well as the influence of media and civil society organizations. Improving the level of animal welfare knowledge and awareness of animal welfare products helps to solve the problem of information asymmetry between consumers and producers. The Chinese government and related institutions can strengthen education in ecological ethics and animal welfare ideology by means of media, organizations, education and training in order to provide consumers with more information that they can use in the decision-making process.

Third, the precise positioning of people with high consumption tendencies is required. With China's economy and society entering a transition period, people's eating habits and food consumption patterns have diversified. Consumers are no longer limited to the issue of nutritional intake in the selection of animal-derived food, but have begun to pay more attention to taste, safety, health, and even ethical and environmental requirements. Consumers are the end receivers of animal-derived products, and their needs are dominant factors significantly affecting the development of farm animal welfare. If governments and enterprises perceive changes in consumer needs and that trend over time, they may find more new growth points and tap into new business opportunities. Enterprise marketing personnel can communicate with different customer groups according to the animal welfare characteristics of meat products to better meet the needs of customers and improve market share.

The present study has some limitations that deserve comment. Firstly, the selection of research samples was limited by social constraints, research costs and other practical factors. In the future, the number of samples and the coverage of respondents need to be expanded to further test the stability and universality of our findings. Secondly, this paper measured consumers' behavior by behavioral intentions, and there was still a gap between intention and behavior. Therefore, future research on animal welfare product consumption can focus on consumers' actual purchase behavior regarding animal welfare-related attribute products. Finally, this study controlled many factors such as personal and family characteristics, animal contact experience, level of city, etc. to explore the mechanism of animal welfare knowledge and product cognition affecting consumers'

behavioral intentions. The study was limited to cross-sectional data, and longitudinal design could better clarify consumers' behavioral intentions and their influencing factors.

Author Contributions: Conceptualization, Y.L.; methodology, Y.L.; software, Y.L.; validation, W.C.; formal analysis, Y.L.; investigation, G.H.; resources, W.C. and H.W.; writing—original draft preparation, Y.L.; writing—review and editing, G.H. and H.L.; visualization, G.H.; supervision, G.L.; project administration, W.C. and G.L.; funding acquisition, H.W. and H.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by MOE (Ministry of Education in China) Youth Foundation Project of Humanities and Social Sciences (18YJC790079).

Institutional Review Board Statement: The ethical approval was obtained by College of Veterinary Medicine, South China Agriculture University (20200101).

Informed Consent Statement: Not applicable.

Data Availability Statement: All study data used for analysis are available upon request.

Conflicts of Interest: The authors declare no conflict of interest.

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Consumer Preferences for Animal Welfare in China: Optimization of Pork Production-Marketing Chains

Yaoming Liang [1,2,†], Yu Cheng [3,†], Yanjie Xu [1], Gengrong Hua [4], Zijian Zheng [1], Hui Li [1,5,6,*] and Li Han [5,*]

[1] College of Economics & Management, South China Agricultural University, No. 483 Wushan Road, Tianhe District, Guangzhou 510642, China
[2] College of Veterinary Medicine, South China Agricultural University, Guangzhou 510642, China
[3] School of Sociology and Anthropology, Sun Yat-sen University, 135 Xingang Road, Haizhu District, Guangzhou 510275, China
[4] Faculty of Social Sciences, University of Macau, Avenida da Universidade, Taipa, Macau 999078, China
[5] College of Public Management, South China Agricultural University, Guangzhou 510642, China
[6] College of Natural Resources and Environment, South China Agricultural University, Guangzhou 510642, China
* Correspondence: smarthuili@scau.edu.cn (H.L.); lynn_han1216@scau.edu.cn (L.H.)
† These authors contributed equally to this work.

Simple Summary: In this study, consumer preferences for pork produced using animal-welfare-enhancing farming strategies were assessed. In China, the demand for animal-friendly products is increasing, but so far, studies on consumer preferences for animal welfare farming attributes are limited. The objective of this study was to analyze consumer preferences for pork based on four animal welfare farming attributes, namely feed nutrition, living environment, health care, and activity space. The study employed a choice experiment approach. The survey covered 1274 pork consumers in Guangdong province, China. Our empirical results suggest that Chinese consumers were willing to pay an additional 2.359–10.477 CNY/500 g (5.27–23.39%) for animal welfare pork. Furthermore, there was significant heterogeneity in consumer preferences. China is the world's largest producer and consumer of pork. Since the outbreaks of African swine fever in 2018, China's pork imports have been constantly on the rise. The results can contribute to the optimization of pork production structures and marketing plans for stakeholders and can assist with the timely development of international competition strategies for animal-derived trade products.

Abstract: Consumption demands for pork produced by farms that employ strategies to improve animal welfare ("animal welfare pork") will be an important indicator for predicting domestic pig feeding standards and pork industry development. This paper analyzes consumer preferences for animal welfare pork based on the choice experiment data of 1274 pork consumers in Guangdong province, China. The results show that consumers had a significant preference for animal welfare pork and that they were willing to pay a premium of 2.359–10.477 CNY/500 g (5.27–23.39%) on average. There is heterogeneity in consumer preferences regarding age, education level, and income. Producers of animal-derived products can not only adjust the mix of production conditions to improve pig welfare and innovate contractual arrangements for industry chain stakeholder groups, but they can also develop differentiated marketing strategies for animal welfare products to meet consumer demands for animal welfare.

Keywords: animal welfare; consumer preferences; willingness to pay; choice experiment

Citation: Liang, Y.; Cheng, Y.; Xu, Y.; Hua, G.; Zheng, Z.; Li, H.; Han, L. Consumer Preferences for Animal Welfare in China: Optimization of Pork Production-Marketing Chains. *Animals* **2022**, *12*, 3051. https://doi.org/10.3390/ani12213051

Academic Editor: Sergio Ghidini

Received: 16 September 2022
Accepted: 4 November 2022
Published: 6 November 2022

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1. Introduction

There is a large international debate regarding the welfare of animals raised for food [1]. Many scholars consider animal welfare to be a positive attribute of food [2]. According to the Terrestrial Code of World Organisation For Animal Health (WOAH), animal welfare refers to: "the physical and mental state of an animal in relation to the conditions in which it lives and dies''. It is a branch of science and looks at these measurable states in almost all areas of our interaction with animals, including areas of agriculture, entertainment, companionship, research, and others [3]. Studies have shown that animal welfare can not only have a positive impact on the growth and health of farm animals [4,5], thereby improving the quality of animal-derived products, but that it also helps meet ethical and moral requirements of the public. If the living environment can be modified according to the physiological and behavioral habits of different animals, consideration of the concept of animal welfare will undoubtedly reduce animals' stress; improve their immunity, fitness, and health; and reduce the use of pesticides, feed additives, and veterinary drugs that pose serious health hazards to consumers. Improving animal welfare may become an important issue in the breeding industry.

China is a major producer and consumer of pork worldwide, and pig rearing is the backbone of the domestic livestock industry (pork production in China has reached 52.96 million tons in 2020, accounting for more than 59.6% of meat production according to the 2021 China Statistical Yearbook). With the optimization of industrial structures, farms that produce fewer than 500 pigs per year decreased from 82.2 million in 2007 to 20.6 million in 2020, while farms that produce more than 50,000 pigs per year increased from 50 in 2007 to 554 in 2020 (Figure 1). The issue of animal-derived food safety and farm animal welfare caused by intensive pig farming has become an urgent concern. In May 2014, China introduced the Farm Animal Welfare Requirements for Pigs, the first farm animal welfare standard concerning advanced foreign farm animal welfare concepts concerning the existing domestic scientific, technological, and socio-economic conditions. According to the requirements, the whole process of animal welfare management regarding pigs' breeding, transport, slaughter, and processing is to be regulated as it relates to aspects such as feed and drinking water, farming environment, farm management, health plans, transportation, slaughter, splitting and processing, records and traceability, etc. This increases the possibility of exploring issues related to pig welfare in China.

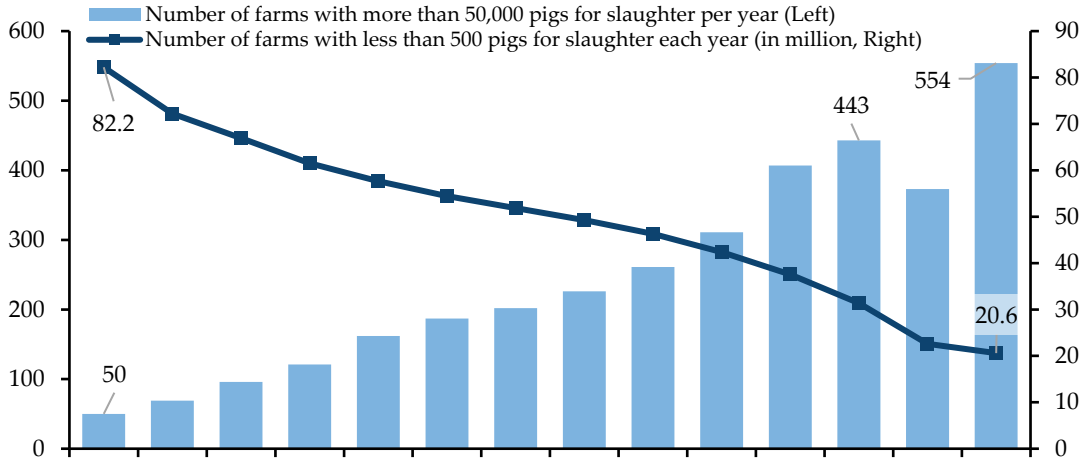

Figure 1. Number of Pig Farms in China from 2007 to 2020. (Source: China Animal Husbandry and Veterinary Yearbook.).

The future of agriculture depends in large part on consumer demand. It is critical for public health departments and animal-derived product marketers to understand consumer preferences and willingness to pay (WTP) for animal welfare. According to the results of a survey conducted by You et al. (2014) among 6006 consumers in 29 provincial administrative regions in China (excluding Tibet, Hainan, Taiwan, Hong Kong, and Macau), 54.5% of the respondents were willing to pay a higher price for animal welfare pork at least to some extent [6]. Wang and Gu (2014) found that consumers in Jiangsu province were willing to pay an average of over 16.2% of the base price for animal-friendly pork before being given information about the association between animal welfare and meat quality, and they were willing to pay over 21.3% of the base price after being given information about the association [7]. At present, most of the studies on Chinese consumer preferences for farm animal welfare still remain at the level of descriptive statistical analysis. Only a few studies, such as Wu et al. (2014) [8] and Xu et al. (2019) [9], focus on empirical methods. Additionally, studies on consumer preferences for animal welfare breeding attributes are uncommon in China.

This paper focuses on how much of a premium consumers are willing to pay for animal welfare pork in China. The study mainly covers the following aspects. First, the paper incorporates a limited choice experiment examining consumer preferences for animal welfare pork based on four attributes: feed nutrition, living environment, health care, and activity space. Second, it helps the stakeholders better understand the heterogeneity in Chinese consumer preferences for animal welfare farming methods, and it provides theoretical support for the formulation of farm-animal-management-related policies and marketing strategies for livestock products in China. This not only helps domestic stakeholders grasp the dynamic consumer preferences and optimize production structures and marketing plans, but it also improves the world's understanding of China's huge animal-derived food consumption market and the development of international competition strategies for agricultural trade products.

The structure of this paper is as follows. The choice experiment and survey design, estimation methods, and sample data are explained in Section 2. Empirical results are analyzed in Section 3. Discussions and policy implications are considered in Section 4. Finally, conclusions are presented in Section 5.

2. Research Methodology

2.1. Choice Experiment Design

In China, consumers do not know much about animal welfare, and there are no products with animal welfare labels on the market. Consumers tend to choose animal foods to meet their consumption needs by considering the manner, conditions, and environment in which animals are raised (e.g., whether they have a healthy diet, a good living environment, scientific health care, and adequate space to move around). Due to the lack of a real market, consumer-preference-assessment methods based on actual market prices are not suitable for evaluating consumer demand for non-market product attributes. However, hypothetical choice experiments can be advantageous in such cases and are thus widely used in this regard [10]. In particular, choice experiments have been widely used to measure consumer preferences for food with certain attributes, e.g., Wu et al. (2016), Ortega et al. (2017), Wang et al. (2018). Kallas et al. (2019), Czine et al. (2020), Huang et al. (2022), Lin-Schilstra et al. (2022) [11–17].

Pig welfare products can be seen as a collection of different welfare attributes from which consumers can obtain utility. Choice experiments enable evaluation of multiple attributes by replicating real life shopping scenarios [18]. Using this approach to determine consumers' willingness to pay has become a better way of assessing consumer demand and animal welfare preferences [19]. It provides important information to policymakers or marketers who are preparing and implementing such certification systems and promoting them widely [20]. Such information would be useful for stakeholders in the supply

chain for designing production processes and developing marketing strategies based on these production attributes, and it would be valuable for developing appropriate marketing communication tools [21].

In order to meet social concerns about the welfare quality of animal food and the related market demand, and to promote access to products that meet specific animal welfare standards, the EU published a welfare quality assessment scheme in 2009 for three categories of farm animals: pigs, cattle, and poultry. The standards of animal welfare practices are assessed in four areas: good feeding, good housing, good health, and appropriate behavior. Accordingly, we designed the choice experiment of animal welfare consumption preference with reference to the above four aspects. Specifically, we are more concerned about such aspects as feed nutrition, living environment, health care, and activity space, which seem to be the more prominent problems in China's pig industry [22–24].

It is worth noting that providing activity space and outdoor access are the two most important attributes necessary to obtain an acceptable level of welfare, as this prevents injuries and suffering [25]. Most consumers share this concern and cite the permission of outdoor access as a very important characteristic of pig welfare [26]. In terms of activity space, this paper refers to the welfare levels set up by Denver et al. (2017) [27], in which outdoor access is considered in addition to increased activity space. Therefore, the activity space attribute is defined in three levels, while the other three attributes are defined in two levels.

The price consists of four levels. The reference is based on the average market price of lean pork loin in large, medium, and small supermarkets as well as wet markets and online fresh food platforms (JD Fresh, Suning Commerce and Fresh Hema) in Guangzhou city (the capital city of Guangdong province) in February 2020. The pricing strategy of product marketing was also considered (e.g., any price ending with the number "8" is considered as a lucky number to Chinese consumers, as "8" has a similar pronunciation with "fa", the Chinese character of "wealth"). The animal welfare attributes and their levels in the choice experiment are shown in Table 1.

Table 1. Farm animal welfare attributes and their levels in the choice experiment.

Attribute	Level	Description
Feed nutrition	Common feed	The current national standards for nutrient content are met.
	Fermented feed	The current national standards for nutrient content are met. In addition, the feed is enriched with probiotics (which help intestinal digestion and reduce food residue).
Living environment	Standard environment	The air, ventilation, and other environmental parameters of the pig house are in line with the national standards.
	Recreational environment	The air, ventilation, and other environmental parameters of the pig house are in line with the national standards. In addition, toys, music, and other recreational facilities are provided.
Health care	Basic care	Basic, necessary epidemic diagnosis and treatment are provided.
	Optimal care	Measures such as frequent disinfection and disease monitoring are taken. Veterinarians provide a daily inspection and a timely diagnosis and treatment of sick or injured pigs. Pain-free surgery is given to avoid pain unrelated to the disease.
Activity space	Standard space	Indoor space in accordance with the national standard is at least 0.8–1.2 m^2 of bedding area per pig.
	100% more space	According to the national standard, 100% more indoor space takes up at least 1.6–2.4 m^2 of bedding area per pig.
	100% more space and outdoor access	100% more indoor space takes up at least 1.6–2.4 m^2 of bedding area per pig. In addition, access to outdoor pasture is provided.

Attribute	Level	Description
Price	44.8, 54.8, 64.8, 74.8	These are the prices at which the respondents usually bought fresh lean pork in supermarkets or wet markets (unit: CNY/500 g).

In this paper, 24 choice sets were designed to estimate consumers' utility of animal welfare pork based on a D-optimal fractional causal analysis experimental design using the Ngene 1.2.1 software package (www.choice-metrics.com, accessed on 16 September 2022). The 24 choice sets were divided into four groups and each respondent was randomized to complete one of the groups for a total of 6 choice sets. In this way, respondents may have the ability to complete the entire choice experiment within a reasonable time frame. It is generally accepted that providing an "opt-out" or "no purchase" option in the choice set more closely resembles the real decision scenario [28]. Therefore, each choice set includes the following three options with different animal welfare farming attributes: Pork A, Pork B, and neither. Figure 2. illustrates one of these choice sets.

Product Description		
	Pork A	**Pork B**
Health Care	Basic care	Optimal care
Feed Nutrition	Common feed	Fermented feed
Living Environment	Standard environment	Recreational environment
Activity Space	100% more space and outdoor access	Standard space
Retail Price	54.8 (CNY / 500 g)	64.8 (CNY / 500 g)
I will buy:	A. Pork A	B. Pork B C. None of these pork

Figure 2. Sample of a choice set.

2.2. Survey Design

Targeting pork buyers is a key part of the survey because targeting ordinary consumers may lead to bias in estimation caused by sample selection. Guangdong province was selected as the survey area for the following reasons. First, Guangdong's economic and social development level is among the highest in the country, with the GDP reaching about 1.92 trillion USD (Exchange rate: 1 USD/CNY 6.1798, December 31, 2021 (CFETS).) in 2021 and ranking first for 33 consecutive years in China. Second, Guangdong, adjacent to Hong Kong and Macau, is a major province of foreign trade, where people may be more likely to accept the concept of animal welfare. Third, there is a common belief that "people in Guangdong know about food" in China. Furthermore, consumers aged 16 and above were targeted as respondents in the survey, as China implements a nine-year compulsory education system, and 16 years old is usually the corresponding age for an individual to complete their compulsory education. Some previous research has included the 16-year-old group in survey subjects when assessing the purchasing of household food items, including Liu & Niyongira (2017), Liang et al. (2023) [29,30].

In developing countries, new ideas such as concern for animal welfare are generally easily accepted among young people with higher levels of education and better economic incomes [31,32]. In today's new media era, this group has access to a large amount of in-

formation via smartphones. Since a face-to-face survey method would substantially increase the cost of the survey and could lead to bias caused by limited consumer cognitive resources (time and energy) at the time of the survey, and because of the impact of the global COVID-19 pandemic, the data for this paper were obtained through an online survey.

The definitions of farm animal welfare and its products were clearly given in the guidelines of the questionnaire. The choice experiment was conducted immediately after respondents answered some basic questions about their perception of farm animal welfare and its products. In the survey, they were presented with a "cheap talk script" about the choice experiment designed to reduce their hypothetical bias [33,34]. The term "cheap talk" is borrowed from experimental economics, where it refers to communication between players prior to execution of an experiment. Here, a cheap talk script refers to open communication between the experimenter and the respondents about things to consider when responding to a subsequent question. The cheap talk script was followed by a description of the information about animal welfare farming attributes.

To ensure randomization of the survey, respondents were assigned to different groups of purchase scenarios based on the parity of the last two digits of their cell phone number (two odd numbers, two even numbers, odd followed by even, even followed by odd). They were only able to see one choice scenario at a time in order to exclude interference from other choice scenarios. They spent at least 15 s in each choice scenario to ensure an acceptable quality of data. In addition, the order of the six choice scenarios faced by each respondent was randomized to exclude any order effects on the estimated results. The choice experiment was followed by a survey on respondents' pork consumption habits and basic personal information. The questionnaire would be completed in about 15 min.

To reach statistical significance and satisfy the rank condition of the choice experiment, we adopted a protocol generally used in choice experiments design [35–37] to determine the minimum sample size:

$$\mathrm{N} \geq 500 \times \left(\frac{\mathrm{L}}{\mathrm{A} \times \mathrm{C}}\right) = 500 \times \left(\frac{4}{3 \times 6}\right) = 111.111$$

Here, N is the number of the sample; L is the largest number of levels of any of the attributes; A is the number of choice options in a choice set; and C is the number of choice sets faced by each respondent. Given that we divided the 24 choice sets into four groups, the minimum sample size for this choice experiment would be 112.

2.3. Estimation Methods and Econometric Models

This paper uses a random utility model to analyze consumer preferences. The choice experiment is based on the following assumption: individual n obtains utility by choosing option i from a finite set of alternative options J of choice set C under scenario t. In the random utility model, utility consists of a deterministic component V_{nit} that depends on the attributes of the options and a random component ε_{nit}, i.e.,

$$U = V_{nit} + \varepsilon_{nit} \quad (1)$$

Thus, if $U_{nit} > U_{njt}\ \forall j \neq i$, then individual n will choose option i. Consequently, the probability that individual n will choose option i is

$$P_{nit} = Prob(V_{nit} + \varepsilon_{nit} > V_{njt} + \varepsilon_{njt}\ ;\ \forall j \in C, \forall j \neq i). \quad (2)$$

Given the underlying distribution of the error term, the final form of the logit selection probability can be expressed as:

$$P_{nit} = \frac{exp(V_{nit})}{\sum_j exp(V_{njt})} \quad (3)$$

While traditional logit models assume that consumers are homogeneous, the random parameter logit (RPL) model relaxes the constraints of traditional logit models by allowing random variation in in-sample preferences according to a specified distribution [38]. Accordingly, the RPL model can be used to measure heterogeneity in consumer preferences for animal welfare farming attributes. Based on the RPL model, the deterministic component of utility V_{njt} in the random utility model takes the following form:

$$V_{njt} = \beta' \chi_{nit} \quad (4)$$

where β is a vector of random parameters with their own mean and variance indicating individual preferences and χ_{nit} is a vector of all attributes in the *i*th choice. According to Train (2003) [39], the probability that individual n will choose option i from the choice set *C* under scenario t is:

$$P_{nit} = \int \frac{exp(V_{nit})}{\sum_j exp(V_{njt})} f(\beta) d\beta \quad (5)$$

where the random parameter $f(\,)$ of the distribution is specified. If the parameter is fixed to β_c (non-random), the distribution fails, i.e., $f(\beta_c) \to \infty$, otherwise $f(\beta) = 0$.

Considering that utility is non-basic in nature and that the estimated model coefficients cannot be interpreted in economic terms, the willingness to pay of consumers is estimated as:

$$WTP = \frac{-\beta_k}{\beta_p} \quad (6)$$

where β_k is the estimated coefficient of the *k*th attribute and β_p is the estimated price coefficient. A 95% confidence interval was created using a parametric bootstrap procedure as suggested by Krinsky and Robb (1986) [40]. Specifically, a multivariate normal distribution was created by parameterizing the coefficients and variance terms estimated using the RPL model, from which 1000 observations were extracted.

2.4. Sample Source and Data Description

This survey was anonymous and ethical approval was granted by College of Veterinary Medicine, South China Agricultural University. A pre-survey was conducted in February 2020. We rephrased the questionnaire to make it more concise and easier to understand, removed survey questions inconsistent with the local situation, and added some more valuable questions based on the feedback and suggestions from 90 sample consumers.

Thereafter, a formal investigation was conducted in March 2020 via the paid online platform provider Wenjuanxing, which is a professional online survey platform in China that focuses on providing users with services such as powerful, user-friendly online questionnaire design, data collection, custom reports, and survey result analysis. The platform recruits and maintains a group of consumers who participate in surveys from time to time with small incentives. Participants will randomly receive email invitations and URLs directing them to the survey, and they subsequently receive rewards in the form of credits that can be converted to vouchers for shopping. Participation in each investigation is voluntary. The sample service of Wenjuanxing provides strict quality-control mechanisms, including sample quality control, filler control, filling process control, the whole tracking effect, etc., to ensure recovery of true and valid response data.

Finally, a total of 1637 questionnaires were collected, and 1274 respondents completed the entire survey. This produced a sample of 7644 choices (1274 respondents × 6 choice sets). The choice experiments included a significant number of pork consumers, which allowed us to investigate consumption preference and heterogeneity. All statistical analyses were carried out using the software package Stata 16.0 (Stata Corp. 2019, Stata Statistical Software: Release 16, StataCorp LLC, College Station, TX, USA).

The demographic characteristics of the sample consumers in Table 2 show that the proportion of females (62.48%) is significantly higher than that of males (37.52%), which is consistent with the fact that more women are responsible for taking care of the family's food. The average age of the respondents is 32.2 years old, and more than 50% have a university degree or higher, indicating that the sampled consumers are younger and more highly educated. Nearly 70% of the surveyed households have a monthly income between 6000 and 24,000 CNY. Nearly 50% of the households have children eating with them. Nearly 40% of the households have elderly people eating with them.

Table 2. Some socio-demographic characteristics of respondents (n = 1274).

Socio-Demographics		Socio-Demographics	
Gender (%)		Monthly household income (%)	
Male	37.52	<6000 CNY	17.03
Female	62.48	6000–12,000 CNY	33.28
Age (in years) Mean (s.e.)	32.25 (9.998)	12,000–18,000 CNY	20.88
Education level (%)		18,000–24,000 CNY	13.34
Primary school and below	0.55	24,000–30,000 CNY	8.01
Junior high school	5.18	>30,000	7.46
High school/technical secondary school)	10.08	Number of dining members (%)	
College/higher vocational	16.64	≤2	17.04
Undergraduate	54.00	3	24.88
Postgraduate and above	13.58 [1]	4	26.14
Eat with children under 18 years old (%)	49.69	5	21.11
Eat with the elderly above 60 years old (%)	39.87	≥6	10.83

[1] Note: Percentages may total >100% because of rounding.

3. Results

3.1. Consumer Preferences for Welfare Attributes of Fattening Pigs

As shown in Table 3, there is a significant preference for animal welfare pork. Consumers have the highest preference for the attribute of providing 100% more space and outdoor access. They are willing to pay a premium of 10.477 CNY/500 g (23.39%) compared to that of providing indoor rearing space in accordance with the national standard. However, their willingness to pay for 100% more rearing space is relatively low (a premium of 2.359 CNY/500 g or 5.27%), which suggests that Chinese consumers prefer the farming method of "free range" over simply increasing indoor rearing space. The premiums for the attributes of optimal care and fermented feed are 6.689 and 5.893 CNY/500 g, respectively. The premium is the lowest (2.560 CNY/500 g) for the attribute of providing recreational facilities such as toys and music instead of merely providing a ventilated, clean, and odor-free living environment.

Table 3. Random parameter logit results of consumer preferences for animal welfare pork.

Variables	Mean	Standard Deviation	Willingness to Pay	Willingness to Pay (%)
Fermented feed	0.380 ***	0.372 ***	5.893	13.15
	(0.033)	(0.075)	[4.912,6.874]	
100% more space	0.152 ***	−0.027	2.359	5.27
	(0.041)	(0.102)	[1.100,3.618]	
Increase 100% space and outdoor access	0.676 ***	−0.229	10.477	23.39
	(0.045)	(0.154)	[9.114,11.839]	
Optimal care	0.431 ***	0.434 ***	6.689	14.93
	(0.034)	(0.067)	[5.640,7.737]	

Recreational environment	0.165 ***	0.754 ***	2.560	5.71
	(0.036)	(0.056)	[1.455,3.666]	
Would not buy	−6.770 ***	2.849 ***		
	(0.234)	(0.169)		
Price	−0.064 ***			
	(0.002)			
Number of observations	22,932			
LR chi2	848.02			
Log likelihood	−5684.849			
AIC	11395.7			

*** indicates statistical significance at the 1% level. The numbers in parentheses are standard errors, and the numbers in brackets are 95% confidence intervals. Willingness to pay (%) calculates the proportion of payment premiums obtained through the RPL model, i.e., the ratio of WTP to the base price (44.8 CNY/500 g) in the choice set, so as to facilitate comparison of the proportion of price premiums between different products in the existing literature.

Table 3 also shows that the standard deviation coefficients of all three variables (fermented feed, optimal care, and recreational environment) are significant at the 1% level except the "activity space" variable. It also indicates the heterogeneity of consumer preferences for pig welfare farming attributes. Specifically, consumer preferences for the recreational environment attribute are the most varied, with a standard deviation coefficient of 0.754, followed by the optimal care attribute (0.434) and the fermented feed attribute (0.372). This suggests that heterogeneity should be considered in studying consumers' preferences for animal welfare farming attributes, and the hypothesis of using the RPL model to analyze consumer preferences for animal welfare is confirmed.

3.2. Heterogeneity Analysis of Consumer Preferences

As mentioned previously, there is heterogeneity in consumer preferences for animal welfare pork. It is practically relevant for pork producers and marketers to visualize consumer preferences for farm animal welfare through demographic characteristics. The random utility model shows the difference in utility brought to consumers by different product options rather than the absolute value of utility brought by a single product. Hence, the effect of individual consumer characteristics on utility is usually omitted directly in the expression of the function because individual characteristics do not vary with product options [39]. A common approach is to set interaction terms between consumer socio-demographic characteristics and product attribute levels in the model to analyze the effect of consumer characteristics on consumer preferences or willingness to pay, as done in Wu et al. (2014) and Wu et al. (2016). Following this approach, we formed interaction terms to examine how demographic variables affect consumption preferences related to animal welfare.

According to the age distribution, the sample can be divided mainly into three groups: ≤25 years, 26–35 years, and ≥36 years. The proportions in these groups are 33.12%, 36.74%, 30.14%, respectively. Some of these age nodes can be found in the existing literature, such as Lim et al. (2013), Wu et al. (2015), Han et al. (2015), and Denver et al. (2017) [41, 8, 42, 27]. Education levels of primary school and below; junior high school; high school/technical secondary school; college/higher vocational; and undergraduate, postgraduate, and above correspond to 6, 3, 3, 3, 4, and 3 years of education, respectively. Furthermore, we divided the sample into high-income and low-income categories based on income distribution, which accounted for 50.31% and 49.69% of respondents, respectively. In summary, the above socio-demographic variables can be classified as follows:

Gender: female, male;
Age: low age (≤25), middle age (26–35), and advanced age (≥36);
Education: high education (≥16 years) and low education (<16 years);

Income: high income (≥12,000 CNY) and low income (<12,000 CNY).

Accordingly, they formed interaction terms with each attribute variable of pig welfare, and RPL model regression estimation was conducted separately. Strictly speaking, the experimental design has to be adjusted after the introduction of the interaction effect, and the design scheme that only considers the main effect will lead to inefficient estimation [21]. In this paper, the interaction effects between attributes were not considered in the experimental design. In addition, we considered only one interaction term of consumer characteristics when conducting the RPL model estimation in order to avoid adding too many independent variables and over-parameterization caused by crossover between all of the individual characteristic terms and attribute terms [43]. Fortunately, the significance and sign of each welfare attribute may largely be consistent with those of the baseline model in the estimated model with the introduction of the interaction term.

It can be seen from Table 4 that, except for gender, age, education level, and income, all variables significantly affect consumer preferences regarding pig welfare farming attributes, albeit to varying degrees. Compared with consumers in the low age group (25 years old and below), consumers in the advanced age group (36 years old and above) are more concerned about the expansion of activity space and outdoor access (an interaction coefficient of 0.202), while consumers in the middle age group (25–35 years old) are less concerned about optimal care for pigs. The coefficients of interaction between the variables of being highly educated and preferring fermented feed as well as between being highly educated and preferring optimal care are significantly positive (0.196, 0.126). This indicates that consumer preferences for fermented feed and optimal care can be improved with increased education. In addition, the interaction coefficient between the higher income and fermented feed variables is significantly positive (0.253), which indicates that the two variables are associated. Increasing consumer income level is linked to higher consumer preferences for the fermented feed attribute.

Table 4. Random parameter logit results with socio-demographics interaction terms.

Variables	With Gender Interaction	With Age Interaction		With Education Interaction	With Income Interaction
Price	−0.064 ***	−0.065 ***		−0.065 ***	−0.065 ***
	(0.002)	(0.002)		(0.002)	(0.002)
Fermented feed	0.393 ***	0.347 ***		0.246 ***	0.252 ***
	(0.052)	(0.055)		(0.055)	(0.044)
100% more space	0.142 **	0.146 **		0.106	0.121 **
	(0.067)	(0.071)		(0.070)	(0.057)
100% more space and outdoor access	0.603 ***	0.572 ***		0.602 ***	0.618 ***
	(0.070)	(0.074)		(0.074)	(0.061)
Optimal care	0.440 ***	0.512 ***		0.344 ***	0.386 ***
	(0.053)	(0.057)		(0.056)	(0.046)
Entertainment environment	0.166 ***	0.240 ***		0.174 ***	0.114 **
	(0.059)	(0.063)		(0.062)	(0.050)
No purchase	−6.768 ***	−6.773 ***		−6.776 ***	−6.745 ***
	(0.234)	(0.234)		(0.236)	(0.232)
Interaction items between attributes and socio-demographics	Female	Middle Age (26–35)	Advanced Age (≥36)	High Education (≥16)	High Income (≥12,000)
Fermented feed ×	−0.021	0.088	0.002	0.196 ***	0.253 ***
	(0.065)	(0.075)	(0.079)	(0.067)	(0.063)
100% more space ×	0.016	−0.026	0.044	0.063	0.060

	(0.083)	(0.098)	(0.100)	(0.086)	(0.081)
100% more space and outdoor access ×	0.117	0.105	0.202 *	0.109	0.116
	(0.086)	(0.100)	(0.105)	(0.088)	(0.083)
Optimal care ×	−0.015	−0.134 *	−0.103	0.126 *	0.086
	(0.066)	(0.077)	(0.080)	(0.068)	(0.064)
Recreational environment ×	−0.001	−0.095	−0.128	−0.017	0.102
	(0.074)	(0.086)	(0.090)	(0.076)	(0.072)
Number of observations	22,932	22,932		22,932	22,932
Wald chi2	−5683.6497	−5678.736		−5678.379	−5673.9201
Log likelihood	847.75	847.31		846.94	831.47
AIC	11,403.3	11,403.47		11,392.76	11,383.84

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The numbers in parentheses are standard errors. The standard deviation of random parameters for each attribute variable is not reported in this paper due to space limitations.

3.3. Personality Portrait Analysis of Consumers

It can be helpful for marketers to more intuitively understand the preferences of consumers for pig welfare farming attributes and to identify which groups to target for sales. In general, there are more female respondents in charge of family food shopping. It can be assumed that the consumers were female, and education level and income can be assumed to be positive correlates, i.e., higher education level would result in higher income (see Lim et al., 2013 [41]). In this paper, a total of six specific types of consumers were selected based on four socio-demographic characteristics of respondents: gender, age, education level, and income. The relative preferences of these six types of consumers with different socio-demographic attributes for each attribute of pig welfare (Table 5) were calculated and comparatively analyzed.

Table 5. Random parameter logit results of consumer preferences by six groups.

Variables	Lower Education (<16 Years), Lower Income (<12,000 CNY)			Higher Education (≥16 Years), Higher Income (≥12,000 CNY)		
	Low Age (≥25)	**Middle Age (26–35)**	**Advanced Age (≥36)**	**Low Age (≥25)**	**Middle Age (26–35)**	**Advanced Age (≥36)**
Price	−0.178 ***	−0.052 ***	−0.035 ***	−0.139 ***	−0.071 ***	−0.059 ***
	(0.037)	(0.013)	(0.007)	(0.016)	(0.007)	(0.011)
Fermented feed	0.518	0.346 *	0.095	0.865 ***	0.512 ***	0.692 ***
	(0.520)	(0.194)	(0.116)	(0.212)	(0.116)	(0.163)
100% more space	−0.571	−0.058	0.239 *	−0.008	0.154	0.440 **
	(0.426)	(0.344)	(0.136)	(0.208)	(0.128)	(0.180)
100% more space and outdoor access	0.366	0.377	0.669 ***	0.773 ***	0.836 ***	1.175 ***
	(0.451)	(0.302)	(0.151)	(0.231)	(0.148)	(0.239)
Optimal care	0.026	0.710 ***	0.359 ***	0.900 ***	0.513 ***	0.685 ***
	(0.374)	(0.235)	(0.108)	(0.209)	(0.107)	(0.156)
Recreational environment	0.198	0.123	−0.052	0.263	0.096	0.399 **
	(0.491)	(0.220)	(0.123)	(0.189)	(0.109)	(0.189)
Would not buy	−12.425 ***	−5.041 ***	−5.732 ***	−11.567 ***	−8.231 ***	−7.541 ***
	(2.499)	(1.105)	(0.885)	(1.337)	(1.005)	(1.533)
Number of observations	522	738	1836	1638	2664	1332
Wald chi2	44.53	51.88	94.72	68.89	91.25	59.63

Variables	Lower Education (<16 Years), Lower Income (<12,000 CNY)			Higher Education (≥16 Years), Higher Income (≥12,000 CNY)		
	Low Age (≥25)	Middle Age (26–35)	Advanced Age (≥36)	Low Age (≥25)	Middle Age (26–35)	Advanced Age (≥36)
Log likelihood	−116.292	−196.791	−487.112	−335.2545	−616.9963	−299.408
AIC	258.584	419.582	1000.223	696.509	1259.993	624.8168

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The numbers in parentheses are standard errors. The standard deviation of random parameters for each attribute variable is not reported in this paper due to space limitations.

The results in Table 5 show that consumer preferences for animal welfare pork change with age. For female consumers in the low age group with low education and low income, their preference for pigs' welfare is not significant. In the middle age group, those with low education and income have a significant preference for the attributes of optimal care and fermented feed (utility coefficients are 0.710 and 0.346, respectively). In the advanced age group, those with low education and income still have a significant preference for the optimal care attribute (0.359), although the degree of preference is reduced. The preference for the activity space attribute also becomes significant, especially for the outdoor access attribute, whose coefficient is the largest (0.669). It is clear that female consumers with low education, low income, and low age primarily pay attention to animal welfare attributes related to food safety and health (i.e., optimal care and fermented feed), while concern for attributes related to food quality (i.e., activity space) increases with age.

If factors such as education and income limit consumers' actual purchases of animal welfare products, then a comparison of consumer preferences between low-education, low-income groups and high-education, high-income groups in the different age categories may help confirm this hypothesis. Table 5 also shows that the preferences of the high-education and high-income group for animal welfare pork are more or less consistent in different age groups. The utility coefficients for optimal care, fermented feed, and 100% more space and outdoor access are all significant at the 1% level, but the priorities of attributes are varied. This is somewhat consistent with the preferences of low-education, low-income people in the middle and old age groups, while the preferences of the high-educated and high-income group are stronger. Consumers in the high-education, high-income, and high age group are also concerned with the recreational environment (with the coefficient of 0.399), an animal welfare farming attribute that meets the needs of animal mental health.

It is worth noting that consumers in the low-education, low-income group, and middle age group prefer the optimal care attribute more, which seems to contradict the results in Table 4 that indicate that low-aged consumers care more about the optimal care attribute than middle-aged consumers. This may be due to the fact that the sample size of the high-education and high-income group (64.54%) is larger than that of low-education and low-income group (35.46%). Nevertheless, this illustrates the heterogeneity of consumer preferences for pork with animal welfare farming attributes. It suggests that more empirical research should be carried out regarding consumers with different characteristics.

The WTPs of the above six groups for animal welfare pork were calculated and presented in Table 5. In order to describe their characteristics more intuitively, we further assumed that the low-education and low-income group received 9 years of education and 6000 CNY per month on average while the high-education and high-income group received 16 years of education and 24,000 CNY per month.

Table 6 shows the payment premium of female consumers with different educational background, income, and age characteristics. For the low-education and low-income group, the premiums paid by middle-aged consumers for fermented feed and optimal care are 6.677 and 13.715 CNY/500 g, respectively. The premiums paid by advanced-age consumers for the attributes of 100% more space, 100% more space and outdoor access, and optimal care are 6.909, 19.335, and 10.391 CNY/500 g, respectively.

Table 6. Estimates of consumers' willingness to pay by six groups.

	Fermented Feed	100% More Space	100% More Space and Outdoor Access	Optimal Care	Recreational Environment
			Lower income, lower education		
			Income = 6000 CNY, education = 9 years		
Age = 22.379	2.906	−3.202	2.053	0.144	1.112
	[−2.419, 8.230]	[−7.772, 1.369]	[−2.896, 7.003]	[−3.971, 4.259]	[−4.205, 6.430]
Age = 32.250	6.677 *	−1.122	7.276	13.715 ***	2.375
	[−0.686, 14.040]	[−14.066, 11.823]	[−4.772, 19,325]	[4.447, 22.984]	[−6.085, 10.836]
Age = 45.216	2.743	6.909 *	19.335 ***	10.391 ***	−1.503
	[−3.832, 9.318]	[−0.975, 14.792]	[9.510, 29.161]	[3.430, 17.351]	[−8.438, 5.433]
			Higher income, higher education		
			Income=24,000 CNY, education = 16 years		
Age = 22.379	6.204 ***	−0.056	5.541 ***	6.454 ***	1.889
	[3.643, 8.764]	[−2.971, 2.860]	[2.498, 8.584]	[3.636, 9.272]	[−0.715, 4.493]
Age = 32.250	7.730 ***	2.175	11.792 ***	7.240 ***	1.35
	[4.052, 10.408]	[−1.387, 5.737]	[7.815, 15.769]	[4.355, 10.125]	[−1.668, 4.367]
Age = 45.216	11.780 ***	7.499 **	20.002 ***	11.671 ***	6.801 **
	[6.465, 17.095]	[1.261, 13.737]	[11.671, 28.333]	[5.565, 17.777]	[0.553, 13.049]

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The numbers in brackets are 95% confidence intervals.

The WTPs in Table 6 also show that highly educated and high-income consumers may generally have a significant payment premium for animal welfare farming attributes. Among them, the low-age consumers are willing to pay the highest premium for the optimal care attribute, reaching 6.454 CNY/500 g. The middle-age and advanced-age consumers are willing to pay the highest premium for the 100% more space and outdoor access attribute, reaching 11.792 CNY/500 g and 20.002 CNY/500 g, respectively. Those in the advanced-age group are also willing to pay a premium of 6.801 CNY/500 g for the entertainment environment attribute. As we expected, highly educated and high-income consumers are the focus of animal welfare marketing.

4. Discussions and Policy Implications

4.1. Discussions

This study empirically analyzes consumer preferences for pigs' welfare farming attributes in terms of feed nutrition, living environment, health care, and activity space. In general, consumers have a significant preference for these attributes and are willing to pay a premium of 2.359–10.477 CNY/500 g (5.27–23.39%). Among them, the premium for the attribute of 100% more space and outdoor access is the highest, reaching 10.477 CNY/500 g (23.39%). These results are generally consistent with other domestic studies. For example, Wang and Wu (2013) [44] examined the consumption preferences of urban residents in Changchun, Beijing, Hangzhou, Hohhot, and Chengdu, China, and found that consumers were willing to pay 2.814 CNY/500 g (11.73%) more for animal welfare pork.

However, the premium paid by Chinese consumers may be lower than that of Western developed countries. Liljenstolpe (2008) showed in a study with a choice experiment that Swedish consumers were willing to pay a 32% premium for outdoor-raised pork [45]. Denver et al. (2017) classified pig welfare as standard, medium, and high based on rearing space, i.e., rearing space stipulated by current legislation (at least 0.65 m^2 per fattening pig), 30% more space (at least 0.85 m^2), and 100% more space (at least 1.3 m^2), respectively [27]. Their study showed that Danish consumers were willing to pay a 17–75% premium

for medium-level animal welfare pork over standard animal welfare pork while willing to pay a 14% premium for high-level over medium-level animal welfare pork.

Although there is a gap between consumers' recognition of animal welfare and their actual purchasing behavior, providing information on animal welfare certification may become an important strategy to meet the differentiated needs of Chinese consumers. Currently, the packaging of fresh meat products in supermarkets, farmers' markets, and the three online fresh food platforms—JD Fresh, Suning Commerce and Fresh Hema—mainly involves information about animal species, parts of the meat, origin, and brand. There is lack of information regarding the farming methods with which the animals are raised. Consumers have to buy meat products based on experience, i.e., relying on personal observations of meat color, texture, etc. Our study found that consumers were willing to pay a significant premium for animal welfare pork. Policymakers and production suppliers may be able to further increase consumer confidence and product premiums by releasing information on the details of good production processes for meat products.

How can consumers be provided with better information for making these decisions? Information regarding animal welfare pork is well trusted by the populace [11]. Information regarding animal welfare attributes can be a useful tool to indicate the high-quality nature of the product if it is available to consumers through markings on the packaging [46]. Many studies have shown that product labeling is an effective tool to ensure that food products meet the individual needs of consumers, e.g., as in Gracia et al. (2011) and Kehlbacher et al. (2012) [47,48]. Therefore, product labeling is increasingly becoming an important regulatory strategy in the EU, especially as it relates to food safety issues [49]. Mandatory labeling, on the other hand, may lead to a negative selection of products with low animal husbandry standards, thus reducing consumers' choices. However, mandatory or enhanced legislation can improve consumer welfare by increasing the private value of animal welfare meat products [50].

An additional question is how to increase the market supply of animal welfare products. Many studies on willingness to pay for animal welfare have suggested potential strategies for improving the market supply of animal welfare products. However, there are still relatively few animal welfare products in the market, with the exception of a small number of countries such as Switzerland, the UK, and the Netherlands. This suggests that stakeholders in the food supply chain are very important for the improvement of animal welfare.

As pointed out by Thorslund et al. (2017), many steps have to be taken to improve farm animal welfare [51]. First, agribusinesses must be willing and able to produce to higher welfare standards. Second, there must be economic incentives to enable firms to gain, or at least not lose, revenue through animal welfare farming. Third, other entities such as slaughterhouses and meat processors must be willing to sell special products with animal welfare labels. Furthermore, retailers must be willing to market and sell the products. Lastly, consumers must be willing to buy the product at a premium price. In any case, the supply of animal welfare products requires changes in the governance structure between agricultural and production organizations in the food value chain. For example, the issue of animal welfare has to permeate the entire value chain when it cannot be solved at the end-handling stage, which in turn necessitates changes in the relationships between value chain members. In addition, new forms of contractual arrangements between farms and processors need to be established when animal welfare farming methods have been differentiated at the farm (rearing) stage.

Farmers or animal breeding enterprises are the most important stakeholder group for the improvement of animal welfare. Another reason for the low market share of farm animal welfare products may be that producers have doubts about animal welfare. Although many of them have positive attitudes toward farm animal welfare, previous studies have shown that only a minority of farmers recognize the need to improve the level of animal welfare in livestock production systems [25,52]. Practically, production system ad-

justments may entail high economic risks for producers, i.e., the cost of investment in improving animal welfare may not be matched by a return and selling the product at a higher price may itself be a big problem [53–55]. It has also been shown that farmers' attitudes are closely related to their behavior of improving animal welfare [56,57]. Future investigation of farmers' attitudes toward animal welfare farming is essential to understand their actual willingness to participate in improving animal welfare and to increase the market supply of animal welfare products in China.

4.2. Policy Implications

China is the world's largest producer and consumer of meat. The present study potentially contributes not only to promoting the high-quality development of animal husbandry, but also to promoting the transformation and upgrading of consumption structure. The following suggestions can be made for meat production suppliers.

The first suggestion is to adjust the mix of improved animal welfare production conditions. In developing product differentiation policies to address the issue of public claims for animal welfare, animal welfare preference must be correlated with production costs. For producers, the benefit–cost ratio of improving breeding conditions may vary greatly. Producers may gradually improve the animal production environment and adjust animal feeding methods according to the differences in consumers' concerns about animal welfare and their preferences for different welfare breeding conditions. In addition, they may choose to prioritize animal welfare improvements by considering the farm's own advantageous conditions.

The second suggestion is to establish innovative contractual arrangements between industry chain stakeholder groups. Farmers or enterprises are often bound by contracts at the downstream production stage. It is necessary to involve the slaughter and processing industries in the development of animal welfare standards so that farmers or enterprises have the opportunity to operate under higher animal welfare standards. Additionally, compliance with higher animal welfare standards is a long-term capital investment, and producers may be able to leverage the financial guarantees provided by the downstream industry both to gain the opportunity to produce a high-quality product and to escape the financial pressures of improving animal welfare on their farms by increasing the profitability of their animal products.

The third suggestion is to develop marketing strategies to differentiate animal welfare products. Achieving better economic outcomes has always been the main motivation for farmers to improve animal welfare. Manufacturers need to provide sufficient product information to guide consumers to take responsibility and purchase animal welfare products rather than just treating animal welfare as a problem that needs to be addressed through regulation. In addition, the consumers who buy animal welfare products are not homogeneous. It is important to consider the heterogeneity in consumer preferences during the market launch process, to segment the product market, and to improve the valuation of and demand for animal products with higher-than-average welfare production conditions from different consumer groups so as to obtain the best cost-benefit ratio.

5. Conclusions

The issue of animal welfare is still not commonly recognized and there are currently no farm animal welfare-certified products in China. However, the Chinese government has recently launched programs to improve animal welfare. For example, China approved the establishment of the Animal Welfare International Cooperation Committee of the China Association for the Promotion of International Cooperation in Agriculture in 2013. Since then, more regulations and policies have been introduced, such as Farm Animal Welfare Requirements for Pigs (2014), Meat Sheep (2015), Chicken (2017), Laying Hen (2017), Cashmere Goat (2020), and Cows (2021). The process of promoting animal welfare development in China is gradually accelerating. Soon, a widening range of animal-friendly products will be available to meet the consumer demand in China.

Improving animal welfare may lead to increased production costs. If consumers have a willingness to pay for farm animal welfare, it will help strengthen the determination and confidence of producers to improve animal welfare. In this regard, this paper examined the consumer preferences for animal welfare pork using data from a choice experiment with 1274 pork consumers in Guangdong province. The results showed that consumers had a significant payment premium of 2.359–10.477 CNY/500g (5.27–23.39%) for pork with different animal welfare characteristics. Products with the "100% more space and outdoor access" animal welfare attribute are the most valued, followed by "optimal care", "fermented feed", "recreational environment", and "100% more space" attributes. The study found no significant gender differences in consumer preferences, but age, education, and income all had varying degrees of influence on animal welfare pork consumption preference. The empirical findings are useful to both industry practitioners and decision-makers in promoting the transition to more sustainable animal welfare farming practices in society.

Our study has some limitations, which should be addressed by future research. Our survey was conducted at the beginning of the global COVID-19 outbreak in 2020, when quarantine and isolation rules were implemented in China. Further research is needed to determine whether people's consumption habits for products with animal welfare attributes could change before and after the pandemic. Additionally, despite the fact that the scope of our study is limited to China, these results may produce useful pieces of information that might help developing countries creating policies to improve animal welfare and enhance their competitiveness in international trade of livestock products.

Author Contributions: Y.L.: conceptualization, formal analysis, software, methodology, original draft, review and editing; Y.C.: resources, review and editing, project administration, funding acquisition; Y.X.: validation, investigation; G.H.: visualization, original draft; Z.Z.: investigation, review and editing; H.L.: supervision, project administration; L.H.: resources, funding acquisition. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the project "China's Experience and Global Sharing in the Building of a Community of Common Health for Mankind" (20&ZD122).

Institutional Review Board Statement: Ethical approval was obtained by College of Veterinary Medicine, South China Agricultural University (20200101).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: All study data used for analysis are available upon request.

Acknowledgments: We are thankful to Hao Wang and Qinying He, South China Agricultural University for fruitful discussions during the making of this paper and to Xin Chen, New York City College of Technology, CUNY and Jon Zou for the help with language polishing.

Conflicts of Interest: The authors declare no conflicts of interest.

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Optimal decisions of a retailer-owned dual-channel supply chain with demand disruptions under different power structures

Song Huang, Shuting Chen and Hui Li*

College of Economics and Management,
South China Agricultural University,
Guangzhou 510642, China
Email: hshust@163.com
Email: dagui_g@163.com
Email: smarthuili@163.com
*Corresponding author

Abstract: This paper studies the optimal restoration policy when a retailer-owned dual-channel supply chain experiences unexpected demand disruptions. We study three different supply chain power structures: the manufacturer Stackelberg (MS) game, the retailer Stackelberg (RS) game and the vertical Nash (VN) game. By defining a virtual production cost function, we establish an easy way to restore the supply chain's performance. We find that the original wholesale price is robust with demand disruptions if the disruption is mild and the disruption costs are borne by the retailer. In the VN market, the optimal adjusted wholesale price when the disruption costs are borne by the manufacturer is higher than that when the disruption costs are borne by the retailer, if and only if the demand disruption is negative. Moreover, the supply chain power structures have no impact on the robustness of the original production quantity in the decentralised dual-channel supply chain.

Keywords: dual-channel supply chain; disruption management; power structures; game theory.

Reference to this paper should be made as follows: Huang, S., Chen, S. and Li, H. (2018) 'Optimal decisions of a retailer-owned dual-channel supply chain with demand disruptions under different power structures', *Int. J. Wireless and Mobile Computing*, Vol. 14, No. 3, pp.277–287.

Biographical notes: Song Huang received his PhD degree in Management Science and Engineering from Huazhong University of Science and Technology, Wuhan, China. He is currently an Associate Professor at the College of Economics and Management, South China Agricultural University, Guangzhou, China. His research interests include supply chain management and incentives in operations management.

Shuting Chen is currently a Master student at the College of Economics and Management, South China Agricultural University, Guangzhou, China. Her research interest is dual-channel supply chain management.

Hui Li received her Master degree in Operations Management, University of Greenwich, London, United Kingdom. She is currently a Lecturer at the College of Economics and Management, South China Agricultural University, Guangzhou, China. Her research interest is supply chain management.

1 Introduction

With the development of internet, a large number of traditional retailers have opened online channels. The volume of online channel transactions is continuously booming. It is reported that China's online retail transactions are estimated at 2.75 trillion Yuan in 2015, compared with 1.22 trillion Yuan in 2012 (Bloomberg News, 2013). Alibaba Group Holding Ltd., the largest electronic commerce transaction platform in China, reported a blockbuster of $14.3 billion in sales during China's Singles' Day online shopping festival in 2015 (Wong, 2015).

Though a large number of traditional retailers choose to add online channels to their traditional retail channels, there also exists another trend that some giant online retailers are now opening brick-and-mortar stores to transfer part of their online business offline. For example, Dell, famous for its pure direct sales channel, began to sell products in retail

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stores (Ames, 2007). Amazon, the largest internet-based retailer with 20 years of online book-selling experience, opened the first brick-and-mortar store in 2015 (Halzack, 2015). The above practices show that retailers are now taking initiatives to refigure their marketing channels and operating both online and offline channels. And this retailer-owned dual-channel differs from the traditional dual channel in that the online channel is operated by the manufacturer in the latter case.

Globalisation brings both opportunity and risk to the supply chain operations. For example, unexpected natural disasters, new technology adoption, and customers' preference change, all probably lead to dramatic demand disruptions to supply chain operations. For example, the strongest earthquake in Japan in 2011 causes concerns with food exports, and the demand for the Megmilk Snow Brand Co.'s products experienced dramatic demand increase (Chan and Leung, 2011). Hendricks and Singhal (2005) find that when facing disruptive events, listed companies usually suffered as large as 10% of decline in market capitalisation. When a decentralised dual-channel supply chain experiences demand disruptions, it is more complicated to restore the supply chain efficiency, as the wholesale price and the channel sales prices are usually determined by the manufacturer and the retailer, respectively. Though there is already some literature on the demand disruption management in a dual-channel supply chain with the manufacturer operating the online channel (Huang et al., 2012; Zhang et al., 2015), there is little research on the demand disruption management of the retailer-owned dual-channel supply chain, especially when the manufacturer and the retailer have different decision powers. A natural question arises on what is the optimal production restoration policy when a retailer-owned dual-channel supply chain experiences demand disruptions? What's the impact of the supply chain power structures on the optimal restoration policy?

To address these questions, we consider a retailer-owned dual-channel supply chain with one manufacturer and one retailer similar to Chen et al. (2016). A manufacturer sells the products to a retailer, who then serves end customers through both the online electronic channel and the offline retail channel. We consider two consecutive periods. In the first period, a production plan is made based on the estimated demand before the realised demand is known. In the second period, some unexpected events occur and a demand disruption is detected. Both firms need to adjust their decisions in response to the demand disruptions. We consider three supply chain power structures: the manufacturer Stackelberg game (MS), the retailer Stackelberg game (RS), and the vertical Nash (VN) game. By defining a virtual production cost function, we obtain the optimal pricing and production quantity adjustment policies under these different supply chain power structures.

We have made some interesting observations. First, the original production quantities are robust with demand disruptions under different supply chain power structures. In addition, the manufacturer's original optimal wholesale price is also robust with demand disruptions as long as the disruption costs are borne by the retailer. Second, in the MS and RS markets, the supply chain power structures have no impacts on the optimal adjusted channel prices, and the optimal adjusted wholesale prices depend on which party bears the disruption costs. In the VN market, the optimal adjusted wholesale price when the disruption costs are borne by the manufacturer is higher than that when the disruption costs are borne by the retailer, if and only if the demand disruption is negative. At last, the decentralised dual-channel supply chain has the same robustness as the centralised dual-channel supply chain, which is in sharp contrast with Huang et al. (2012).

Our work falls into the stream of dual-channel supply chain management. There is substantial literature on channel entry and competition (Chiang et al., 2003; Tsay and Agrawal, 2004; Arya et al., 2007; Kurata et al., 2007; Huang and Swaminathan, 2009; Cai, 2010), supply chain coordination (Chen et al., 2012; Xu et al., 2014), information sharing (Yue and Liu, 2006; Yan and Pei, 2011; Lei et al., 2014), information asymmetry (Mukhopadhyay et al., 2008; Li et al., 2014, 2015; Cao et al., 2013), pricing and leadtime decisions (Hua et al., 2010; Xu et al., 2012), and pricing and service decisions (Chen et al., 2008; Dan et al., 2012). The above papers all study the dual-channel supply with the manufacturer operating the online channel. Recently, Chen et al. (2016) consider a dual-channel supply chain with the retailer operating both the online and offline channels. This paper studies a dual-channel supply chain similar to Chen et al. (2016) but with a different motivation. We intend to study how to restore the supply chain efficiency with demand disruptions under different supply chain power structures.

Our work is also related to supply chain disruption management. In this stream of research, Qi et al. (2004) study the disruption management in a one-manufacturer-one-retailer supply chain. Following Qi et al. (2004), some researchers extend their model into different scenarios, for example, Huang et al. (2006), Xiao et al. (2007), Xiao and Qi (2008), Chen and Xiao (2009), Lei et al. (2012), Huang et al. (2012), Cao et al. (2015), and Zhang et al. (2015). In particular, our work is mostly related to Huang et al. (2012), Cao (2014), and Zhang et al. (2015). Huang et al. (2012) study the pricing and production decision in a dual-channel supply chain with demand disruptions. Cao (2014) and Zhang et al. (2015) further study the coordination contracts when a dual-channel supply chain experiences demand disruptions. Our work differs from the above literature in the following aspects. First, we analyse the retailer-owned dual-channel supply chain. Second, we investigate the optimal production restoration policies under different supply chain power structures. Third, we establish a virtual production cost function to characterise the optimal restoration policy.

The rest of the paper is organised as follows. Section 2 presents the model setup and baseline case. Section 3 analyses the optimal decisions in the manufacturer Stackelberg market with demand disruptions. Section 4 analyses the optimal decisions in the retailer Stackelberg market with demand disruptions. The optimal decisions in the vertical Nash market

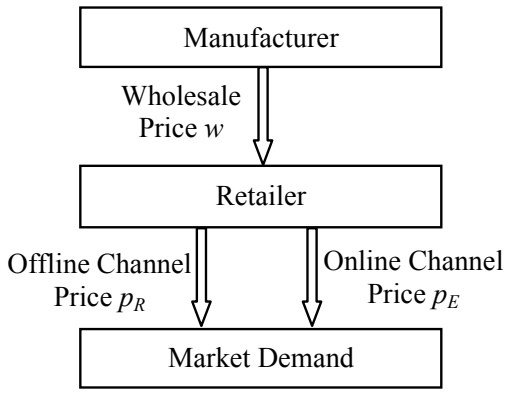
with demand disruptions are studied in Section 5. Section 6 analyses some results and Section 7 concludes.

2 Model setup and baseline case

2.1 Model setup

The dual-channel supply chain considered in this paper is similar to Chen et al. (2016). There are two selling channels: one is the traditional offline retail channel, and the other is the online electronic channel, which is depicted in Figure 1. The manufacturer sells the product at wholesale price w to the retailer, who then serves end customers through both the offline retail channel at p_R, and the online electronic channel at p_E. We assume that the demands in the two channels are linear in self-price and cross-price elasticity. This assumption is very common in operations literature (Raju and Roy, 2000; Yue and Liu, 2006; Kurata et al., 2007; Huang and Swaminathan, 2009; Hua et al., 2010). For analytical simplicity, we further assume that the self-price elasticity and the cross-price elasticity are symmetric (Zhang et al., 2012; Chen et al., 2016).

Figure 1 The retailer-owned dual-channel supply chain (Chen et al., 2016)



The demands in the offline retail channel and the online electronic channel are given by

$$D_R(p_R,p_E)=(1-\rho)a-\alpha p_R+\beta p_E, \quad (1)$$

$$D_E(p_R,p_E)=\rho a-\alpha p_E+\beta p_R, \quad (2)$$

where the subscripts R and E denote the offline retail channel and the online electronic channel, respectively. The supply chain's total demand $D_{SC}(p_R,p_E)=D_R(p_R,p_E)+D_E(p_R,p_E)$, where the subscript SC denotes the supply chain. The demand functions in Equations (1) and (2) indicate that demands in the two channels both depend on the offline retail channel price p_R and the online electronic channel price p_E. The parameter a represents the estimated market potential. The parameter ρ captures customers' preference for the online electronic channel. The parameter α and β are the coefficients of the self-price elasticity of its own channel and the coefficient of the cross-price elasticity of the opposite channel. Following Hua et al. (2010) and Huang et al. (2012), assume $\alpha>\beta$, which indicates that price elasticity of the own channel is greater than the cross-price elasticity of the opposite channel. The unit production cost is c. Building upon the above notations and assumptions, the profit functions of the retailer, the manufacturer and the dual-channel supply chain are respectively given by

$$\pi_R(p_R,p_E)=(p_R-w)D_R(p_R,p_E)+(p_E-w)D_E(p_R,p_E), \quad (3)$$

$$\pi_M(w)=(w-c)D_R(p_R,p_E)+(w-c)D_E(p_R,p_E), \quad (4)$$

$$\pi_{SC}(p_R,p_E)=(p_R-c)D_R(p_R,p_E)+(p_E-c)D_E(p_R,p_E). \quad (5)$$

Similar to Huang et al. (2012), we consider the disruption model in two consecutive periods. In the first period, an original production plan is made based on the estimated market potential a; thus, the original optimal production plan can only be made based on the estimated demand a. In the second period, a demand disruption Δa is observed and the realised demand is found to be $a+\Delta a$. Once a disruption Δa is detected, some possible deviation costs occur. Let μ_1 and μ_2 denote the unit underage cost and unit overage cost, respectively. In order to avoid triviality, we further assume that $\max\{\mu_1,\mu_2\}\le c$, which is similar to Qi et al. (2004).

Let $\bar{p}_R$ and $\bar{p}_E$ denote the adjusted prices when a demand disruption is observed. Throughout the paper, we use the upper bar to denote the case of demand disruptions. Therefore, the demands in these two channels, and the supply chain's total demand, are formulated as follows

$$\bar{D}_R(\bar{p}_R,\bar{p}_E)=(1-\rho)(a+\Delta a)-\alpha\bar{p}_R+\beta\bar{p}_E, \quad (6)$$

$$\bar{D}_E(\bar{p}_R,\bar{p}_E)=\rho(a+\Delta a)-\alpha\bar{p}_E+\beta\bar{p}_R, \quad (7)$$

$$\bar{D}_{SC}(\bar{p}_R,\bar{p}_E)=(a+\Delta a)-(\alpha-\beta)(\bar{p}_R+\bar{p}_E). \quad (8)$$

2.2 Baseline case: centralised supply chain

As the benchmark, we first analyse the optimal decisions with demand disruptions in the centralised supply chain. Denote the original optimal production quantity as Q^*. To avoid triviality, we assume that $a+\Delta a>0$ always holds to ensure that both channel demands are nonnegative. If a demand disruption Δa occurs, there will be possible disruption costs emerging form supply and demand mismatch. To be specific, if the demand exceeds the original production plan, then another production may be launched to increase the supply, otherwise, some material may be disposed.

The supply chain's total profit under demand disruptions can be formulated as

$$\begin{aligned}\bar{\pi}_{SC}(\bar{p}_R,\bar{p}_E)=&(\bar{p}_R-c)\bar{D}_R(\bar{p}_R,\bar{p}_E)+(\bar{p}_E-c)\bar{D}_E(\bar{p}_R,\bar{p}_E)\\&-\mu_1(\bar{D}_{SC}-Q^*)^+-\mu_2(Q^*-\bar{D}_{SC})^+,\end{aligned} \quad (9)$$

where $a^+=\max\{a,0\}$. In equation (9), the first term denotes the profit in the offline retail channel, the second term denotes the profit in the online electronic channel, the third term denotes the possible underage cost and the fourth term denotes the possible overage cost. Note that overage cost and underage cost cannot happen simultaneously.

For ease of exposition, we define two thresholds for the demand disruption Δa: $\overline{\Delta a} \equiv 2(\alpha-\beta)\mu_1$ and $\underline{\Delta a} \equiv -2(\alpha-\beta)\mu_2$. We also define the following critical virtual production cost function as

$$VC(\Delta a) \equiv \begin{cases} -\mu_2 & \text{if } \Delta a < \underline{\Delta a}, \\ \dfrac{\Delta a}{2(\alpha-\beta)} & \text{if } \underline{\Delta a} \le \Delta a \le \overline{\Delta a}, \\ \mu_1 & \text{if } \Delta a > \overline{\Delta a}, \end{cases} \tag{10}$$

which will be used throughout the paper. The function $VC(\Delta a)$ is a mapping from the demand disruption Δa to a cost-related term. In other words, for any given demand disruption Δa, there always exists a corresponding virtual unit production cost $VC(\Delta a)$. We can interpret $VC(\Delta a)$ as the cost-related parameter corresponding to the demand disruption Δa. This interpretation will help describe the market characteristics.

The following Lemma 1 characterises the optimal pricing decisions for the centralised retailer-owned dual-channel supply chain with demand disruptions. This result, presented in Huang et al. (2012) in the dual-channel supply chain with the manufacturer operating the online channel, still holds in our framework. We rewrite it by utilising the virtual unit production cost function $VC(\Delta a)$ defined in (10) and list it here to make the paper self-contained. Note that $p_R^* = \overline{p}_R^*|_{\Delta a=0}$, $p_E^* = \overline{p}_E^*|_{\Delta a=0}$, and $Q^* = \overline{Q}^*|_{\Delta a=0}$, we omit the details here for simplicity.

Lemma 1: *In the centralised dual-channel supply chain with demand disruptions, the optimal pricing decisions and the supply chain's optimal production quantity are*

$$\begin{cases} \overline{p}_R^* = \dfrac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)}(a+\Delta a) + \dfrac{1}{2}\big(c+VC(\Delta a)\big), \\ \overline{p}_E^* = \dfrac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)}(a+\Delta a) + \dfrac{1}{2}\big(c+VC(\Delta a)\big), \\ \overline{Q}^* = \dfrac{1}{2}\Big[(a+\Delta a) - 2(\alpha-\beta)\big(c+VC(\Delta a)\big)\Big]. \end{cases}$$

And the supply chain's optimal profit is

$$\begin{aligned} \overline{\pi}_{SC}^* = {} & \frac{\alpha\rho^2 + 2\beta\rho(1-\rho) + \alpha(1-\rho)^2}{4(\alpha^2-\beta^2)}(a+\Delta a)^2 \\ & - \frac{1}{2}(a+\Delta a)\big(c+VC(\Delta a)\big) \\ & + \frac{\alpha-\beta}{2}\big(c+VC(\Delta a)\big)^2 + \frac{\big(a-2(\alpha-\beta)c\big)}{2}VC(\Delta a) \end{aligned}.$$

3 Manufacturer Stackelberg (MS) game

Similar to Zhang et al. (2012) and Chen et al. (2016), we consider three supply chain power structures, i.e., the manufacturer Stackelberg game, the retailer Stackelberg game and the vertical Nash game. In this section, we consider the manufacturer Stackelberg market. The sequence of the events is as follows: First, the manufacturer announces the wholesale price w; then the retailer announces the offline retail channel price p_R and the online electronic channel price p_E; finally, customer demand is resolved and the profits are realised accordingly. Following Chen et al. (2016), when there is no demand disruptions, the optimal production quantity $Q^{MS} = [a-2(\alpha-\beta)c]/4$.

With demand disruptions, the retailer's profit function is determined by

$$\begin{aligned} \overline{\pi}_R^{MS}(\overline{p}_R, \overline{p}_E) = {} & (\overline{p}_R - \overline{w})\big[(1-\rho)(a+\Delta a) - \alpha\overline{p}_R + \beta\overline{p}_E\big] \\ & + (\overline{p}_E - \overline{w})\big[\rho(a+\Delta a) - \alpha\overline{p}_E + \beta\overline{p}_R\big] \end{aligned} \tag{11}$$

And the manufacturer's profit function is determined by

$$\begin{aligned} \overline{\pi}_M^{MS}(\overline{w}) = {} & (\overline{w}-c)\big[(a+\Delta a) - (\alpha-\beta)(\overline{p}_R + \overline{p}_E)\big] \\ & - \mu_1(\overline{D}_{SC} - Q^{MS})^+ - \mu_2(Q^{MS} - \overline{D}_{SC})^+ \end{aligned}, \tag{12}$$

where the first term is the manufacturer's profit from both the offline retail channel and online electronic channel, the second term is the possible underage cost and the third term denotes the possible overage cost.

Proposition 1: *In the MS decentralised retailer-owned dual-channel supply chain with demand disruptions, the optimal pricing decisions are*

$$\begin{cases} \overline{p}_R^{MS} = \left(\dfrac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)} + \dfrac{1}{8(\alpha-\beta)}\right)(a+\Delta a) + \dfrac{1}{4}\big(c+VC(\Delta a)\big), \\ \overline{p}_E^{MS} = \left(\dfrac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)} + \dfrac{1}{8(\alpha-\beta)}\right)(a+\Delta a) + \dfrac{1}{4}\big(c+VC(\Delta a)\big), \\ \overline{w}^{MS} = \dfrac{1}{4(\alpha-\beta)}(a+\Delta a) + \dfrac{1}{2}\big(c+VC(\Delta a)\big). \end{cases}$$

The optimal production quantity $\overline{Q}^{MS} = \frac{1}{4}\big[(a+\Delta a) - 2(\alpha-\beta)\big(c+VC(\Delta a)\big)\big]$.

Proposition 1 gives the optimal prices adjustment policy in the MS decentralised dual-channel supply chain. If there is a demand disruption, both the manufacturer and the retailer need to adjust their respective pricing decisions. And the adjusted optimal price is the original price plus a new term, which can be interpreted as the optimal price in a new market with market demand Δa and unit production cost $VC(\Delta a)$. The adjusted optimal production quantity is the original production quantity plus an additional optimal production quantity for the market with market demand Δa and production cost $VC(\Delta a)$. Proposition 1 also implies that the original production quantity has some robustness with demand disruptions in the MS market. The manufacturer needs to adjust the production quantity if and only if the demand disruption Δa is very high or low, i.e., $\Delta a < \underline{\Delta a}$ or $\Delta a > \overline{\Delta a}$. When $\Delta a \in [\underline{\Delta a}, \overline{\Delta a}]$, $\overline{Q}^{MS} = Q^{MS}$.

Under the optimal pricing decisions defined in Proposition 1, the manufacturer's optimal profit, the retailer's optimal profit, and the supply chain's optimal profit are

$$\begin{aligned} \overline{\pi}_M^{MS} = {} & \frac{1}{6(\alpha-\beta)}\Big[(a+\Delta a) - 2(\alpha-\beta)\big(c+VC(\Delta a)\big)\Big]^2 \\ & + \frac{1}{4}\big(a-2(\alpha-\beta)c\big)VC(\Delta a), \end{aligned}$$

$$\bar{\pi}_R^{MS} = \left(\frac{\alpha\rho^2 + 2\beta\rho(1-\rho) + \alpha(1-\rho)^2}{4(\alpha^2-\beta^2)} - \frac{3}{32(\alpha-\beta)}\right)(a+\Delta a)^2 - \frac{1}{8}(a+\Delta a)\left(c+VC(\Delta a)\right) + \frac{\alpha-\beta}{8}\left(c+VC(\Delta a)\right)^2,$$

$$\bar{\pi}_{SC}^{MS} = \left(\frac{\alpha\rho^2 + 2\beta\rho(1-\rho) + \alpha(1-\rho)^2}{4(\alpha^2-\beta^2)} - \frac{1}{32(\alpha-\beta)}\right)(a+\Delta a)^2 - \frac{3}{8}(a+\Delta a)\left(c+VC(\Delta a)\right) + \frac{3(\alpha-\beta)}{8}\left(c+VC(\Delta a)\right)^2 + \frac{\left(a-2(\alpha-\beta)c\right)}{4}VC(\Delta a).$$

4 Retailer Stackelberg (RS) game

In the RS market, the retailer acts as the Stackelberg leader and the manufacturer the Stackelberg follower. The sequence of the events is as follows. First, the retailer announces both the offline retail channel price p_R and the online electronic channel price p_E. Then the manufacturer announces the wholesale price w. Finally, customer demand is resolved and the profits are realised. Following Chen et al. (2016), when there is no demand disruptions, the optimal production quantity $Q^{RS} = [a-2(\alpha-\beta)c]/4$.

We next consider the scenario when there is demand disruption in the decentralised RS market. Assume that the disruption costs are borne by the party who is in the dominant position, which is in essence similar to Qi et al. (2004) and Huang et al. (2012). In the RS market when there is a demand disruption, we assume that the disruption costs are borne by the retailer. This assumption is reasonable because the manufacturer is in the follower position and only needs to follow the retailer's ordering quantity decisions. Following Zhang et al. (2012) and Chen et al. (2016), we assume that with demand disruptions, the marginal profit for the offline retail channel is $\bar{m}_R = \bar{p}_R - \bar{w}$ and the marginal profit for the online electronic channel is $\bar{m}_E = \bar{p}_E - \bar{w}$.

The manufacturer's profit function is determined by

$$\begin{aligned}\bar{\pi}_M^{RS}(\bar{w}) &= (\bar{w}-c)\left[(a+\Delta a)-(\alpha-\beta)(\bar{p}_R+\bar{p}_E)\right] \\ &= (\bar{w}-c)\left[(a+\Delta a)-(\alpha-\beta)(\bar{m}_R+\bar{m}_E+2\bar{w})\right].\end{aligned} \tag{13}$$

And the retailer's profit function is determined by

$$\begin{aligned}\bar{\pi}_R^{RS}(\bar{p}_R,\bar{p}_E) &= (\bar{p}_R-\bar{w})\left[(1-\rho)(a+\Delta a)-\alpha\bar{p}_R+\beta\bar{p}_E\right] \\ &\quad +(\bar{p}_E-\bar{w})\left[\rho(a+\Delta a)-\alpha\bar{p}_E+\beta\bar{p}_R\right] \\ &\quad -\mu_1(\bar{D}_{SC}-Q^{RS})^+ - \mu_2(Q^{RS}-\bar{D}_{SC})^+,\end{aligned} \tag{14}$$

where the first term is the retailer's profit from the offline retail channel, the second term is the profit from the online electronic channel, the third term is the possible underage cost, and the fourth term is the possible overage cost.

Proposition 2: *In the RS decentralised retailer-owned dual-channel supply chain with demand disruptions, the optimal pricing decisions are*

$$\begin{cases}\bar{p}_R^{RS} = \left(\dfrac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)} + \dfrac{1}{8(\alpha-\beta)}\right)(a+\Delta a) + \dfrac{1}{4}\left(c+VC(\Delta a)\right), \\ \bar{p}_E^{RS} = \left(\dfrac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)} + \dfrac{1}{8(\alpha-\beta)}\right)(a+\Delta a) + \dfrac{1}{4}\left(c+VC(\Delta a)\right), \\ \bar{w}^{RS} = \dfrac{1}{8(\alpha-\beta)}(a+\Delta a) + \dfrac{3}{4}\left(c-\dfrac{1}{3}VC(\Delta a)\right).\end{cases}$$

The optimal production quantity $\bar{Q}^{RS} = \frac{1}{4}\left[(a+\Delta a)-2(\alpha-\beta)\left(c+VC(\Delta a)\right)\right]$.

Similar to subsection 3.2, we find that in the decentralised RS market if there is a demand disruption, the retailer has to adjust the offline retail channel price and online electronic channel price simultaneously. From the point of view of the retailer, she is now facing a combination of two different markets. One is the original real market with market demand a and unit production cost c, and the other is a new virtual market with market demand Δa and unit production cost $VC(\Delta a)$. From the point of view of the manufacturer, he is now also facing a combination of two different markets. One is the original real market with market demand a and unit production cost c, and the other is a new virtual market with market demand Δa and unit production cost $-VC(\Delta a)/3$. Therefore, when the disruption costs are borne by the retailer, the virtual unit production cost for the new market is different for the manufacturer and the retailer. And this is in sharp contrast with the result in Proposition 2.

Specifically, if the disruption costs are borne by the retailer, the manufacturer's original wholesale price is also robust with respect to demand disruptions if and only if $\Delta a \in [\underline{\Delta a}, \overline{\Delta a}]$. Comparing Proposition 1 and Proposition 2, we find that the robustness of the original wholesale price is different. When there is a mild demand disruption, if the disruption costs are borne by the retailer, the retailer can adjust the online and offline prices simultaneously to eliminate the impact of the demand disruption. Therefore, the impact of the demand disruption will not be conveyed to the upstream manufacturer through the wholesale price. By contrast, if the disruption costs are borne by the manufacturer, the retailer has to change the wholesale price to convey the demand disruption effect to the downstream retailer. Besides, the two supply chain power structures, i.e., MS and RS, have no impact on the retailer's adjusted optimal channel sales prices. However, they do have significant impacts on the manufacturer's optimal adjusted wholesale prices.

Under the optimal pricing decisions defined in Proposition 2, the manufacturer's optimal profit, the retailer's optimal profit, and the supply chain's optimal profit are

$$\bar{\pi}_M^{RS} = \frac{1}{32(\alpha-\beta)}\left[(a+\Delta a)-2(\alpha-\beta)\left(c+VC(\Delta a)\right)\right]^2,$$

$$\bar{\pi}_R^{RS}=\left(\frac{\alpha\rho^2+2\beta\rho(1-\rho)+\alpha(1-\rho)^2}{4(\alpha^2-\beta^2)}-\frac{1}{16(\alpha-\beta)}\right)(a+\Delta a)^2 -\frac{1}{4}(a+\Delta a)\big(c+VC(\Delta a)\big)+\frac{\alpha-\beta}{4}\big(c+VC(\Delta a)\big)^2 +\frac{\big(a-2(\alpha-\beta)c\big)}{4}VC(\Delta a),$$

$$\bar{\pi}_{SC}^{RS}=\left(\frac{\alpha\rho^2+2\beta\rho(1-\rho)+\alpha(1-\rho)^2}{4(\alpha^2-\beta^2)}-\frac{1}{32(\alpha-\beta)}\right)(a+\Delta a)^2 -\frac{3}{8}(a+\Delta a)\big(c+VC(\Delta a)\big)+\frac{3(\alpha-\beta)}{8}\big(c+VC(\Delta a)\big)^2 +\frac{\big(a-2(\alpha-\beta)c\big)}{4}VC(\Delta a).$$

5 Vertical Nash (VN) game

In the VN market, the manufacturer and the retailer are in the identical power positions and move simultaneously. The sequence of the events is as follows. The retailer announces the offline retail channel price p_R and the online electronic channel price p_E, meanwhile, the manufacturer announces the wholesale price w; then customer demand is resolved and the profits are realised according to the announced prices.

We first analyse the scenario of no demand disruptions in subsection 5.1, and then analyse the scenario of demand disruptions in subsection 5.2. Since both parties have identical power, we consider two simple scenarios: the first scenario is that the disruption costs are borne by the manufacturer alone, and the second scenario is that the disruption costs are borne by the retailer alone. Though there does exists other possible disruption costs undertaking arrangement, for example, both parties can negotiate to share the disruption costs, we limit our attention to these two simple cases, partially because it is tractable to obtain analytical results and is sufficient to characterise the impacts of supply chain power structures. Following Chen et al. (2016), when there is no demand disruptions, the optimal production quantity $Q^{VN}=[a-2(\alpha-\beta)c]/3$. Similarly, we assume that with demand disruptions, the marginal profit for the offline channel is $\bar{m}_R=\bar{p}_R-\bar{w}$ and the marginal profit for the online channel is $\bar{m}_E=\bar{p}_E-\bar{w}$.

5.1 The disruption costs are borne by the manufacturer

When the disruption costs are borne by the manufacturer, the manufacturer's profit function is determined by

$$\begin{aligned}\bar{\pi}_{M(1)}^{VN}(\bar{w}_{(1)})&=(\bar{w}_{(1)}-c)\Big[(a+\Delta a)-(\alpha-\beta)(\bar{p}_{R(1)}+\bar{p}_{E(1)})\Big]\\&\quad-\mu_1(\bar{D}_{SC}-Q^{VN})^+-\mu_2(Q^{VN}-\bar{D}_{SC})^+\\&=(\bar{w}_{(1)}-c)\Big[(a+\Delta a)-(\alpha-\beta)(\bar{m}_{R(1)}+\bar{m}_{E(1)}+2\bar{w}_{(1)})\Big]\\&\quad-\mu_1(\bar{D}_{SC}-Q^{VN})^+-\mu_2(Q^{VN}-\bar{D}_{SC})^+,\end{aligned}\tag{15}$$

where the subscript (1) denotes the first scenario, i.e., the disruption costs are borne by the manufacturer. And the retailer's profit function is determined by

$$\begin{aligned}\bar{\pi}_{R(1)}^{VN}(\bar{p}_{R(1)},\bar{p}_{E(1)})&=(\bar{p}_{R(1)}-\bar{w}_{(1)})\Big[(1-\rho)(a+\Delta a)-\alpha\bar{p}_{R(1)}+\beta\bar{p}_{E(1)}\Big]\\&\quad+(\bar{p}_{E(1)}-\bar{w}_{(1)})\Big[\rho(a+\Delta a)-\alpha\bar{p}_{E(1)}+\beta\bar{p}_{R(1)}\Big].\end{aligned}\tag{16}$$

Proposition 3: *In the VN decentralised retailer-owned dual-channel supply chain with demand disruptions, if the disruption costs are borne by the manufacturer, then the optimal pricing decisions are*

$$\begin{cases}\bar{p}_{R(1)}^{VN}=\dfrac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{1}{12(\alpha-\beta)}(a+\Delta a)\\\qquad\qquad+\dfrac{1}{3}\big(c+VC(\Delta a)\big),\\\bar{p}_{E(1)}^{VN}=\dfrac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{1}{12(\alpha-\beta)}(a+\Delta a)\\\qquad\qquad+\dfrac{1}{3}\big(c+VC(\Delta a)\big),\\\bar{w}_{(1)}^{VN}=\dfrac{1}{6(\alpha-\beta)}(a+\Delta a)+\dfrac{2}{3}\big(c+VC(\Delta a)\big).\end{cases}$$

The optimal production quantity $\bar{Q}_{(1)}^{VN}=\frac{1}{3}\big[(a+\Delta a)-2(\alpha-\beta)\big(c+VC(\Delta a)\big)\big]$.

Proposition 3 presents the optimal prices adjustment policy in the VN decentralised dual-channel supply chain. Both the manufacturer and the retailer need to adjust their pricing decisions in the presence of demand disruptions. And the adjusted optimal price is the original price plus a new term, which can be interpreted as the optimal price in a new market with market demand Δa and production cost $VC(\Delta a)$. Proposition 3 also shows that the original production quantity has some robustness with demand disruptions. The manufacturer does not need to adjust the production quantity if the demand disruption is mild, i.e., $\Delta a\in[\underline{\Delta a},\overline{\Delta a}]$.

Under the optimal pricing decisions defined in Proposition 3, the manufacturer's optimal profit, the retailer's optimal profit, and the supply chain's optimal profit are

$$\bar{\pi}_{M(1)}^{VN}=\frac{1}{18(\alpha-\beta)}\Big[(a+\Delta a)-2(\alpha-\beta)\big(c+VC(\Delta a)\big)\Big]^2 +\frac{\big(a-2(\alpha-\beta)c\big)}{3}VC(\Delta a),$$

$$\bar{\pi}_{R(1)}^{VN}=\left(\frac{\alpha\rho^2+2\beta\rho(1-\rho)+\alpha(1-\rho)^2}{4(\alpha^2-\beta^2)}-\frac{5}{72(\alpha-\beta)}\right)(a+\Delta a)^2 -\frac{2}{9}(a+\Delta a)\big(c+VC(\Delta a)\big)+\frac{2(\alpha-\beta)}{9}\big(c+VC(\Delta a)\big)^2,$$

$$\bar{\pi}_{SC(1)}^{VN}=\left(\frac{\alpha\rho^2+2\beta\rho(1-\rho)+\alpha(1-\rho)^2}{4(\alpha^2-\beta^2)}-\frac{1}{72(\alpha-\beta)}\right)(a+\Delta a)^2 -\frac{4}{9}(a+\Delta a)\big(c+VC(\Delta a)\big)+\frac{4(\alpha-\beta)}{9}\big(c+VC(\Delta a)\big)^2 +\frac{\big(a-2(\alpha-\beta)c\big)}{3}VC(\Delta a).$$

5.2 The disruption costs are borne by the retailer

When the disruption costs are borne by the retailer, the manufacturer's profit function is determined by

$$\begin{aligned}\bar{\pi}_{M(2)}^{VN}(\bar{w})&=(\bar{w}_{(2)}-c)\Big[(a+\Delta a)-(\alpha-\beta)(\bar{p}_{R(2)}+\bar{p}_{E(2)})\Big]\\&=(\bar{w}_{(2)}-c)\Big[(a+\Delta a)-(\alpha-\beta)(\bar{m}_{R(2)}+\bar{m}_{E(2)}+2\bar{w}_{(2)})\Big],\end{aligned}\tag{17}$$

where the subscript (2) denotes the second scenario, i.e., the disruption costs are borne by the retailer. And the retailer's profit function is determined by

$$\begin{aligned}\bar{\pi}_{R(2)}^{VN}(\bar{p}_{R(2)},\bar{p}_{E(2)})&=(\bar{p}_{R(2)}-\bar{w}_{(2)})\Big[(1-\rho)(a+\Delta a)-\alpha\bar{p}_{R(2)}+\beta\bar{p}_{E(2)}\Big]\\&+(\bar{p}_{E(2)}-\bar{w}_{(2)})\Big[\rho(a+\Delta a)-\alpha\bar{p}_{E(2)}+\beta\bar{p}_{R(2)}\Big]\\&-\mu_1(\bar{D}_{SC}-Q^{N})^{+}-\mu_2(Q^{N}-\bar{D}_{SC})^{+}.\end{aligned}\tag{18}$$

Proposition 4: *In the VN decentralised retailer-owned dual-channel supply chain with demand disruptions, if the disruption costs are borne by the retailer, then the optimal pricing decisions are*

$$\begin{cases}\bar{p}_{R(2)}^{VN}=\dfrac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{1}{12(\alpha-\beta)}(a+\Delta a)+\dfrac{1}{3}\big(c+VC(\Delta a)\big),\\ \bar{p}_{E(2)}^{VN}=\dfrac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{1}{12(\alpha-\beta)}(a+\Delta a)+\dfrac{1}{3}\big(c+VC(\Delta a)\big),\\ \bar{w}_{(2)}^{VN}=\dfrac{1}{6(\alpha-\beta)}(a+\Delta a)+\dfrac{2}{3}\left(c-\dfrac{1}{2}VC(\Delta a)\right).\end{cases}$$

The optimal production quantity $\bar{Q}_{(2)}^{VN}=\frac{1}{3}\big[(a+\Delta a)-2(\alpha-\beta)\big(c+VC(\Delta a)\big)\big]$.

Proposition 3 and Proposition 4 show that no matter which party undertakes the possible disruption costs, the adjusted prices are the same for the retailer. When confronted with demand disruptions, the retailer faces a combination of two different markets. One is the original true market with market demand *a* and unit production cost *c*, and the other is a new virtual market with market demand Δa and unit production cost $VC(\Delta a)$. The optimal pricing decisions are just simply to add together the optimal prices for these two markets by assuming that there is no demand disruption.

However, from the perspective of the manufacturer, he is now also facing a combination of two different markets. One is the original true market with market demand *a* and unit production cost *c*, and the other is a new virtual market with market demand Δa and unit production cost $-VC(\Delta a)/2$. The optimal wholesale price is just simply to add together the optimal wholesale prices for these two markets. Therefore, when the disruption costs are borne by the retailer, the virtual production cost for the new market is different for the manufacturer and the retailer. And this is in sharp contrast with the results in Proposition 1 and Proposition 3. Similarly, if the disruption costs are borne by the retailer, then the manufacturer's original production quantity is also robust with respect to demand disruptions i.e., $\bar{Q}_{(2)}^{VN}=Q^{VN}$ if $\Delta a\in[\underline{\Delta a},\overline{\Delta a}]$.

Under the optimal pricing decisions defined in Proposition 4, the manufacturer's optimal profit, the retailer's optimal profit, and the supply chain's optimal profit are

$$\bar{\pi}_{M(2)}^{VN}=\frac{1}{18(\alpha-\beta)}\Big[(a+\Delta a)-2(\alpha-\beta)\big(c+VC(\Delta a)\big)\Big]^2,$$

$$\bar{\pi}_{R(2)}^{VN}=\left(\frac{\alpha\rho^2+2\beta\rho(1-\rho)+\alpha(1-\rho)^2}{4(\alpha^2-\beta^2)}-\frac{5}{72(\alpha-\beta)}\right)(a+\Delta a)^2 -\frac{2}{9}(a+\Delta a)\big(c+VC(\Delta a)\big)+\frac{2(\alpha-\beta)}{9}\big(c+VC(\Delta a)\big)^2 +\frac{\big(a-2(\alpha-\beta)c\big)}{3}VC(\Delta a),$$

$$\bar{\pi}_{SC(2)}^{VN}=\left(\frac{\alpha\rho^2+2\beta\rho(1-\rho)+\alpha(1-\rho)^2}{4(\alpha^2-\beta^2)}-\frac{1}{72(\alpha-\beta)}\right)(a+\Delta a)^2 -\frac{4}{9}(a+\Delta a)\big(c+VC(\Delta a)\big)+\frac{4(\alpha-\beta)}{9}\big(c+VC(\Delta a)\big)^2 +\frac{\big(a-2(\alpha-\beta)c\big)}{3}VC(\Delta a).$$

6 Analysis

In this section, we analyse the properties of the optimal adjusted prices and production quantities with demand disruptions in the retailer-owned dual-channel supply chain. We have the following observations.

Observation 1. In the VN market with demand disruptions, $\bar{w}_{(1)}^{VN}<\bar{w}_{(2)}^{VN}$ if and only if $\Delta a\le 0$.

Proposition 3 and Proposition 4 together imply that in the VN market, no matter which party bears the disruption costs, the retailer's optimal adjusted prices are the same. Even under different disruption costs undertaking arrangements, the retailer does not need to take these arrangements into account, because the disruption costs undertaking arrangements have no direct impact on the retailer's optimal adjusted prices. However, Observation 1 shows that the arrangement that the disruption costs are borne by which party does impact the manufacturer's optimal wholesale adjustment decision. Specifically, compared with the scenario where the disruption costs are borne by the

manufacturer, if the demand disruption is negative, then the manufacturer will offer higher wholesale price when the disruption costs are borne by the retailer. On the contrary, if the demand disruption is positive, then the manufacturer will offer lower wholesale price when the disruption costs are borne by the retailer.

Observation 2. The wholesale prices $\overline{w}^{RS}$ and $\overline{w}_{(2)}^{VN}$ are robust with demand disruptions if $\Delta a \in [\underline{\Delta a}, \overline{\Delta a}]$.

Observation 2 shows that the manufacturer's original wholesale price is robust if the demand disruption is mild and the disruption costs are borne by the retailer, which is in sharp contrast with Huang et al. (2012). The rational is that in the dual-channel supply chain where the retailer operates two channels. Once a demand disruption is observed, the retailer alone can take efficient pricing adjustment policy to tackle the disruptions, so that the impact of demand disruptions will not be conveyed to the manufacturer through the wholesale price. However, in the dual-channel supply in Huang et al. (2012), the manufacturer and the retailer operate the online channel and the offline channel separately. And once a demand disruption is observed, the manufacturer has to adjust the online channel price and wholesale price simultaneously.

Observation 3. The original production quantities have the same robustness with demand disruptions under different supply power structures, and they are the same as that in the centralised supply chain.

Observation 3 also reveals a different result compared with Huang et al. (2012). Their study finds that the robustness of the original production quantity depends on customers' preference to the online channel. However, in the retailer-owned dual-channel supply chain, the robustness of the original production quantity in the decentralised supply chain is the same as that in the centralised supply chain. The underlying reason is that in the traditional dual-channel supply chain with the manufacturer operating the online channel, the online electronic channel price and the offline retail channel price are controlled by the manufacturer and the retailer, respectively. However, in the retailer-owned dual-channel supply chain, these two prices are both controlled by the retailer. In other words, when facing demand disruptions, the retailer has two efficient restoration tools, online electronic channel price and offline retail price, to keep the original production quantity unaffected when the demand disruption is mild.

7 Conclusions

Many giant retailers are opening the online channels to offer more convenient purchase experiences to customers. Though this operation strategy helps the retailer reach more customers, it also increases the managerial difficulty when the market demand experiences demand disruptions. Once a demand disruption is observed, the retailer-owned dual-channel supply chain will make some adjustments to restore the supply chain performance. In this paper, from the supply chain power structures, we consider the optimal pricing and production quantity adjustment decisions under the manufacturer Stackelberg market, the retailer Stackelberg market and the vertical Nash market, respectively, when a demand disruption is observed.

We establish an easy way to adjust the prices and production quantity through defining a virtual production cost function. The adjusted optimal production quantity and prices can be interpreted as the original production quantity and prices plus an adjusted term, which can be treated as the optimal decisions in a virtual market with the demand disruption and the virtual production cost. We find that under different supply chain structures, the original production quantities all have some kind of robustness. In addition, the party who bears the possible demand disruption costs has significant impact on the optimal adjusted wholesale price. Specifically, if the possible disruption costs are borne by the retailer, the original wholesale price also has some robustness with demand disruption. However, if the possible demand disruption costs are borne by the manufacturer, the manufacturer will always adjusts his wholesale price once a demand disruption is detected.

There are also some limitations in our paper. First, we focus on the pricing and production adjustment policy and does not address the coordination issue with demand disruptions, since the coordination of the dual-channel supply chain with demand disruption is somewhat difficult (Cao, 2014; Zhang et al., 2015), especially when the different supply chain power structures are considered. Second, we do not consider the possible service or lead time decision in the retailer-owned dual-channel supply chain. In practice, the retailer can add retail service to increase the channel demands. These can be interesting work in the future.

Acknowledgements

The authors are grateful to the editor and referees for their constructive comments that led to this improved version. This work was supported in part by the National Natural Science Foundation of China under Grant 71772070 and 71301055.

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Appendix

Proof of Proposition 1: It is easy to verify that $\bar{\pi}_R^{MS}(\bar{p}_R, \bar{p}_E)$ is jointly concave in $\bar{p}_R$ and $\bar{p}_E$. Therefore, given the manufacturer's wholesale price $\bar{w}$, the retailer's optimal responsive pricing decisions are $\bar{p}_R(\bar{w}) = \frac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)}(a+\Delta a) + \frac{1}{2}\bar{w}$ and $\bar{p}_E(\bar{w}) = \frac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)}(a+\Delta a) + \frac{1}{2}\bar{w}$. Integrating with the manufacturer's profit function defined in (12), the manufacturer's optimisation problem can be rewritten as

$$\max \bar{\pi}_M^{MS}(\bar{w}) = \frac{1}{2}(\bar{w}-c)\left[(a+\Delta a)-2(\alpha-\beta)\bar{w}\right] - \mu_1(\bar{D}_{SC}-Q^{MS})^+ - \mu_2(Q^{MS}-\bar{D}_{SC})^+$$

We consider the above problem in two different cases:

1 If $\bar{D}_{SC} \geq Q^{MS}$, the actual demand exceeds the original planned production quantity, and there is possible underage cost. Then the manufacturer's problem can be simplified as

$$\max \bar{\pi}_M^{MS}(\bar{w}) = \frac{1}{2}(\bar{w}-c)\left[(a+\Delta a)-2(\alpha-\beta)\bar{w}\right] - \mu_1\left[\left(\frac{1}{2}(a+\Delta a)-(\alpha-\beta)\bar{w}\right) - \frac{1}{4}\left(a-2(\alpha-\beta)c\right)\right]$$

$$s.t.\ \frac{1}{2}(a+\Delta a)-(\alpha-\beta)\bar{w} \geq \frac{1}{4}\left(a-2(\alpha-\beta)c\right)$$

2 If $\bar{D}_{SC} \leq Q^{MS}$, the actual demand is less than the original planned production quantity, and there is possible overage cost. Then the manufacturer's problem can be simplified as

$$\max \bar{\pi}_M^{MS}(\bar{w}) = \frac{1}{2}(\bar{w}-c)\left[(a+\Delta a)-2(\alpha-\beta)\bar{w}\right] - \mu_2\left[\frac{1}{4}\left(a-2(\alpha-\beta)c\right) - \left(\frac{1}{2}(a+\Delta a)-(\alpha-\beta)\bar{w}\right)\right]$$

$$s.t.\ \frac{1}{2}(a+\Delta a)-(\alpha-\beta)\bar{w} \leq \frac{1}{4}\left(a-2(\alpha-\beta)c\right)$$

The objective function $\bar{\pi}_M^{MS}(\bar{w})$ is concave in $\bar{w}$ and the constraint is linear in $\bar{w}$, therefore, there is only one optimal solution to each of the above optimisation problem. Solving the above two optimisation problems, we can obtain the manufacturer's optimal wholesale price $\bar{w}^{MS}$. Substituting it to the retailer's optimal responsive pricing decisions, we can obtain $\bar{p}_R^{MS}$ and $\bar{p}_E^{MS}$.

Proof of Proposition 2: We derive the optimal pricing decisions by backward deduction. We first derive the manufacturer's optimal responsive pricing decision in the second period. From the analysis in subsection 4.1, the manufacturer's optimal responsive pricing decision is $\bar{w}(\bar{p}_R, \bar{p}_E) = \frac{1}{2(\alpha-\beta)}(a+\Delta a) - \frac{1}{2}(\bar{p}_R+\bar{p}_E) + c$. In the first period, after anticipating the manufacturer's optimal responsive pricing decision $\bar{w}(\bar{p}_R, \bar{p}_E)$, the retailer's optimal pricing decisions are the solutions to the following optimisation problem

$$\max \bar{\pi}_R^{RS}(\bar{p}_R, \bar{p}_E) = \left[\bar{p}_R - \frac{1}{2(\alpha-\beta)}(a+\Delta a) + \frac{1}{2}(\bar{p}_R+\bar{p}_E) - c\right]\left[(1-\rho)(a+\Delta a) - \alpha\bar{p}_R + \beta\bar{p}_E\right]$$

$$+\left[\bar{p}_E - \frac{1}{2(\alpha-\beta)}(a+\Delta a) + \frac{1}{2}(\bar{p}_R+\bar{p}_E) - c\right]\left[\rho(a+\Delta a) - \alpha\bar{p}_E + \beta\bar{p}_R\right] - \mu_1(\bar{D}_{SC}-Q^{RS})^+ - \mu_2(Q^{RS}-\bar{D}_{SC})^+$$

Solving the above two optimisation problems, we can obtain the retailer's optimal offline retail channel price $\bar{p}_R^{RS}$ and online electronic channel price $\bar{p}_E^{RS}$. Substituting them into the manufacturer's optimal responsive pricing decision $\bar{w}(\bar{p}_R, \bar{p}_E)$, we can obtain the manufacturer's optimal wholesale price $\bar{w}^{RS}$.

Proof of Proposition 3: In the VN market, both the manufacturer and the retailer move simultaneously. We first analyse the retailer's profit function. From (16) we know that the retailer's optimal response pricing decisions are given by $\bar{p}_{R(1)}(\bar{w}_{(1)}) = \frac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)}(a+\Delta a) + \frac{1}{2}\bar{w}_{(1)}$ and $\bar{p}_{E(1)}(\bar{w}_{(1)}) = \frac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)}(a+\Delta a) + \frac{1}{2}\bar{w}_{(1)}$. We then consider the following two cases: $\bar{D}_{SC} \geq Q^{VN}$ and $\bar{D}_{SC} \leq Q^{VN}$.

Solving the above two sub-problems, we can obtain the manufacturer's optimal responsive pricing decision

$$\overline{w}_{(1)}(\overline{p}_{R(1)},\overline{p}_{E(1)})=\begin{cases}\dfrac{a+\Delta a}{2(\alpha-\beta)}-\dfrac{1}{2}(\overline{p}_{R(1)}+\overline{p}_{E(1)})+c-\mu_2 & \text{if } \Delta a<(\alpha-\beta)(\overline{p}_{R(1)}+\overline{p}_{E(1)})-\dfrac{2}{3}\big(a+(\alpha-\beta)c\big)\\ \dfrac{a+\Delta a}{2(\alpha-\beta)}-\dfrac{1}{2}(\overline{p}_{R(1)}+\overline{p}_{E(1)})+c-\lambda & \text{if } \Delta a=(\alpha-\beta)(\overline{p}_{R(1)}+\overline{p}_{E(1)})-\dfrac{2}{3}\big(a+(\alpha-\beta)c\big)\\ \dfrac{a+\Delta a}{2(\alpha-\beta)}-\dfrac{1}{2}(\overline{p}_{R(1)}+\overline{p}_{E(1)})+c+\mu_1 & \text{if } \Delta a>(\alpha-\beta)(\overline{p}_{R(1)}+\overline{p}_{E(1)})-\dfrac{2}{3}\big(a+(\alpha-\beta)c\big)\end{cases}$$

where λ is the constant such that $\Delta a=(\alpha-\beta)\ \big[\overline{p}_{R(1)}(w_{(1)}(\lambda))+\overline{p}_{E(1)}(w_{(1)}(\lambda))\big]-\dfrac{2}{3}\big(a+(\alpha-\beta)c\big)$. Combine the manufacturer's optimal responsive pricing decision $\overline{w}_{(1)}(\overline{p}_{R(1)},\overline{p}_{E(1)})$ with the retailer's optimal response pricing decisions $\overline{p}_{R(1)}(\overline{w}_{(1)})$ and $\overline{p}_{E(1)}(\overline{w}_{(1)})$, we can obtain the retailer's optimal pricing decisions $\overline{p}_{R(1)}^{VN}$ and $\overline{p}_{E(1)}^{VN}$, as well as the manufacturer's optimal pricing decision $\overline{w}_{(1)}^{VN}$.

Proof of Proposition 4: In the VN market, both the manufacturer and the retailer move simultaneously because they have the same decision power. We first analyse the manufacturer's profit function. From (17) we know that the manufacturer's optimal responsive pricing decision is given by $\overline{w}_{(2)}(\overline{p}_{R(2)},\overline{p}_{E(2)})=\frac{a+\Delta a}{2(\alpha-\beta)}-\frac{1}{2}(\overline{p}_{R(2)}+\overline{p}_{E(2)})+c$. We then analyse the retailer's problems and consider the following two cases: $\overline{D}_{SC}\geq Q^{VN}$ and $\overline{D}_{SC}\leq Q^{VN}$, respectively.

Solving the above two sub-problems, we can obtain the retailer's optimal responsive pricing decisions are

$$\overline{p}_{R(2)}(\overline{w}_{(2)})=\begin{cases}\dfrac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{1}{2}(\overline{w}_{(2)}-\mu_2) & \text{if } \Delta a\leq 2(\alpha-\beta)(\overline{w}_{(2)}-\mu_2)+\dfrac{2}{3}[a-2(\alpha-\beta)c]\\ \dfrac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{(a+3\Delta a)+4(\alpha-\beta)c}{12(\alpha-\beta)} & \text{if } 2(\alpha-\beta)(\overline{w}_{(2)}-\mu_2)+\dfrac{2}{3}[a-2(\alpha-\beta)c]\leq \Delta a\\ & \leq 2(\alpha-\beta)(\overline{w}_{(2)}+\mu_1)+\dfrac{2}{3}[a-2(\alpha-\beta)c]\\ \dfrac{\alpha(1-\rho)+\beta\rho}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{1}{2}(\overline{w}_{(2)}+\mu_1) & \text{if } \Delta a\geq 2(\alpha-\beta)(\overline{w}_{(2)}+\mu_1)+\dfrac{2}{3}[a-2(\alpha-\beta)c]\end{cases}$$

$$\overline{p}_{E(2)}(\overline{w}_{(2)})=\begin{cases}\dfrac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{1}{2}(\overline{w}_{(2)}-\mu_2) & \text{if } \Delta a\leq 2(\alpha-\beta)(\overline{w}_{(2)}-\mu_2)+\dfrac{2}{3}[a-2(\alpha-\beta)c]\\ \dfrac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{(a+3\Delta a)+4(\alpha-\beta)c}{12(\alpha-\beta)} & \text{if } 2(\alpha-\beta)(\overline{w}_{(2)}-\mu_2)+\dfrac{2}{3}[a-2(\alpha-\beta)c]\leq \Delta a\\ & \leq 2(\alpha-\beta)(\overline{w}_{(2)}+\mu_1)+\dfrac{2}{3}[a-2(\alpha-\beta)c]\\ \dfrac{\alpha\rho+\beta(1-\rho)}{2(\alpha^2-\beta^2)}(a+\Delta a)+\dfrac{1}{2}(\overline{w}_{(2)}+\mu_1) & \text{if } \Delta a\geq 2(\alpha-\beta)(\overline{w}_{(2)}+\mu_1)+\dfrac{2}{3}[a-2(\alpha-\beta)c]\end{cases}$$

Combining the retailer's optimal responsive pricing decisions $\overline{p}_{R(2)}(\overline{w}_{(2)})$ and $\overline{p}_{E(2)}(\overline{w}_{(2)})$ with the manufacturer's optimal response pricing decision $\overline{w}_{(2)}(\overline{p}_{R(2)},\overline{p}_{E(2)})$, we can obtain the retailer's optimal pricing decisions $\overline{p}_{R(1)}^{VN}$ and $\overline{p}_{E(1)}^{VN}$, and the manufacturer's optimal pricing decision $\overline{w}_{(2)}^{VN}$.

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指导老师：李慧、左两军

证书编号：BIZ-202305-2204

高等学校国家级实验教学示范中心联席会

中国管理现代化研究会

2023 年 5 月 20 日

荣誉证书

华南农业大学

孙怡 高国铭 邓咏诗 纪海奋 朱勉茂

你（们）的作品《一诺（广州）食品安全科技有限公司》在第三届“嘉诚-高顿杯”粤港澳大湾区高校大学生物流设计大赛中荣获创业组：

特等奖

指导老师： 李慧、张光辉

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广东省本科高校物流管理与工程类专业教学指导委员会

广东省物流与供应链学会

广东省电子商务协会

二〇一九年四月

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李　慧老师：

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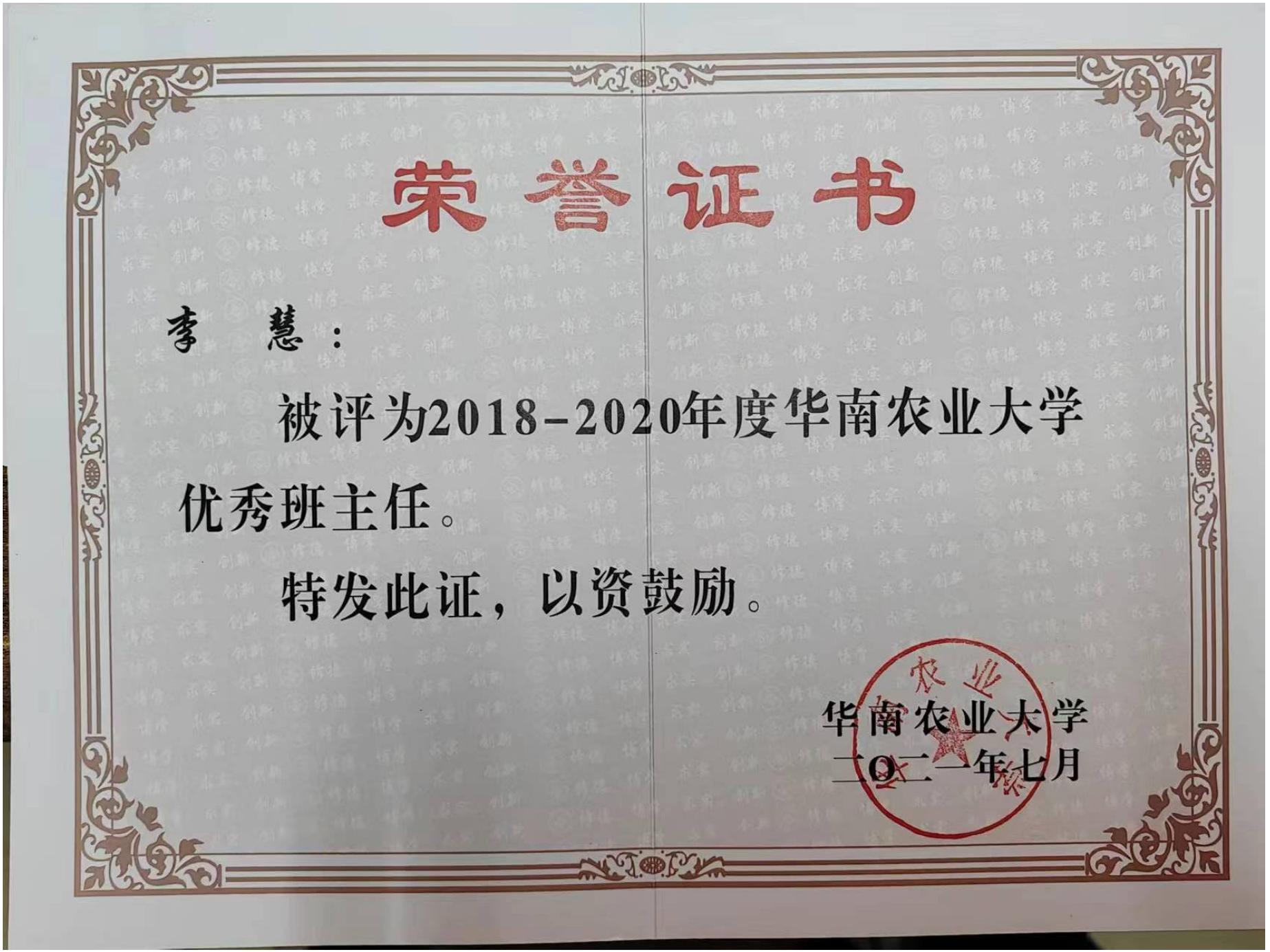
二〇一二年九月六日



荣誉证书

李　慧：

被评为2018-2020年度华南农业大学优秀班主任。

特发此证，以资鼓励。

华南农业大学

二〇二一年七月

荣誉证书

华南农业大学李慧老师：

您在第三届“嘉诚-高顿杯”粤港澳大湾区高校大学生物流设计大赛中荣获：

优秀指导老师

指导课题：《一诺（广州）食品安全科技有限公司》

特颁此证，以兹鼓励。

广东省本科高校物流管理与工程类专业教学指导委员会

广东省物流与供应链学会

广东省电子商务协会

二〇一九年四月

证　书

李　慧 同志：

你撰写的《激励高校女教师学术上持续发展的研究》荣获本会第三届优秀调研成果三等奖。

特发此证。

广东省教科文卫工会

二〇一四年三月

中共广东省委农村工作领导小组办公室

政策建议采纳证明

华南农业大学：

贵校李慧老师、罗明忠、章家恩、陈凤波老师提交的《关于推进我省水稻绿色生产的对策建议》对本单位推动农业绿色高质量发展具有指导价值，相关建议已被我部门采纳，（该报告受到教育部人文社科项目的支持“农业社会化服务改善我国小农发展空间的研究”-编号：18YJC790079）。

特此证明。

中共广东省委农办秘书处

2023年9月[illegible]日

广东水稻绿色生产的问题和对策建议

摘要：绿色生产是农业现代化的必由之路，是落实广东“1310”决策部署的内在要求。水稻绿色生产既有助于谷米提质，又有助于满足人民日益增长的对优美生态环境需要，助力生态可持续发展。根据华南农业大学课题组对我省13市38个行政村1100余个农户的入户跟踪调查显示，我省水稻生产未普遍推行绿色生产，仍处于粗放的石油农业阶段，究其主要原因是生产主体老龄化严重，绿色大米市场激励缺失。为此，应通过绿色化的机械服务迂回提升农户水稻绿色生产能力，通过种养结合的循环农业进行水稻生产绿色转型，通过树立绿色大米品牌利用市场溢价拉动绿色生产。

党的二十大报告明确指出，要“推动绿色发展，促进人与自然和谐共生”，必须全面贯彻落实“绿水青山就是金山银山”的绿色发展理念。在水稻生产中，就是要全力推进绿色生产，既要增产，又要保质，还要增绿。水稻高效绿色生产是深入推进绿美广东生态建设的重要抓手，是贯彻落实广东“1310”部署的内在要求。

当前，我省水稻占粮食播种面积和产量80%以上，生产主体仍为小农户。发展水稻绿色生产潜力大，任务重，难度高。为此，华南农业大学课题组从2021年开始，连续三年

对我省水稻种植面积较大的13个地级市的38个行政村的1100余个农户进行了入户跟踪专题调研，以摸清我省水稻生产的基本情况，诊断存在的问题，并提出相关建议。

一、我省农户水稻生产主要呈现三大特点

我省小农户仍主要以传统方式开展水稻生产，绿色转型任重道远。课题组问卷调查结果显示，7.3%的样本农户在水稻生产过程中采用“三控”（即控肥：控制总施氮量、分蘖肥推迟施用和前氮后移作穗肥;控苗：通过控肥，控制无效分蘖发生，降低高峰苗数，提高成穗率;控病虫:通过控肥、控苗，调优群体结构，减轻病虫害发生，减少农药施用量）施肥技术，4.4%的样本农户参与世界银行贷款农业面源污染项目，4.5%的样本农户施用有机肥，5.5%的样本农户施用生物农药，12.3%的样本农户使用物理防治，31.1%的样本农户参与统防统治，58.8%的样本农户秸秆还田或其他资源化回收。具体的：

一是农户水稻生产以高产为首要目标。农户追求水稻高产的重要手段是大量施用化肥，力求亩产最大化。广东2020年科学施肥意见为每造水稻推荐用氮肥最高限量值为15.3公斤/亩。课题组问卷调查结果显示，样本农户水稻生产的平均氮肥施用量为20.85公斤/亩，但仅5.7%的样本农户认为自己施用氮肥过量。农户一旦发现虫情，倾向于加大农药剂量，力求减产最小化。课题组问卷调查结果显示，44.0%的样本

农户自报告其农药施用量高于说明书标准。大量施用化肥导致水体功能富营养化，及土壤微生物被毒害。农田有害物质超标，将直接影响出产的农产品和当地饮用水的质量安全。

二是农户水稻生产所需劳动投入大幅度降低。传统水稻生产需要大量投入劳动力的耕田、插秧、收割环节，目前大部分已转由机械及新农技完成。课题组问卷调查结果显示，90.2%的田块使用机耕，85.3%的田块使用机收，未机耕机收的主要原因是机械不能到达及灾害性天气。播种的形式比较多样，42.1%的田块抛秧，9.4%的直播，6.9%的机插，仍有41.5%的田块由人工插秧。购买机械社会化服务和销售稻谷也非常便利，无需大量劳动力投入。课题组问卷调查结果显示，分别有 94.5%和 93.6%的样本农户认为机耕、机收服务容易获取，分别有 82.8%和 80.0%的样本农户满意所购买的机耕、机收服务；80.6%的样本农户生产水稻的主要目的是满足口粮，也就不存在销售问题；而在有稻谷销售的样本农户中，78.1%的样本农户由小商贩上门收购，也基本无需耗费精力。小农户水稻种植面积有限，相应的现金投入总额有限。

三是农户对生态环境保护态度积极。大多数农户关注本地生态环境，课题组问卷调查结果显示，63.1%的样本农户认为农业生态环境的改善“非常重要”，27.1%的样本农户认为“重要”。同时，农户在一定程度上践行水稻绿色生产，

67.3%的样本农户有意选择低毒低残留的农药，53.0%的样本农户对农药包装物进行了集中处理。

二、我省推动农户水稻绿色生产转型面临三大难题

为推进水稻绿色生产，近年来，全省自上而下采取了一系列化肥农药减量行动，其中包括亚洲最大、国内首个利用世界银行贷款，总投资 13.4 亿元的农业面源污染治理项目，实现提前 3 年完成化肥农药使用量零增长目标。根据课题组调研发现，进一步推动我省水稻生产绿色转型仍任重道远，至少面临农户绿色生产内在能力低下和绿色生产外部动力缺乏两个方面的三大难题。

难题之一：农村劳动力被城镇发达地区市场虹吸，水稻生产主体老能力弱。课题组问卷调查结果显示，仅 34.5%的样本农户家庭成员的收入来源于农业生产，绝大部分农户的主要家庭收入不来自水稻生产；水稻生产决策者的平均年龄为 61.42 岁，48.2%的水稻生产决策者为小学及以下学历，86.0%的水稻生产决策者为初中及以下学历。在农业劳动力数量不足，质量不佳的情况下，理性农户倾向于节约劳动力的耕作方式，比如“施肥一炮轰”，为了弥补非适时适机施肥，相应加大化肥投入量。而且，老龄农户更倾向延续传统的生产方式，对现代化的绿色生产技术的接受程度低，速度慢。针对我省近年大力推广的“三控”技术，课题组问卷调查结果显示，仅 7.1%的样本农户有听说过“三控”施肥技术。

水稻生产面临着绿色高效生产技术采纳率低的问题。

难题之二：水稻生产成本持续攀升而稻谷收购价多年未变，农户生产水稻收益下降。当前，水稻的亩均销售毛收入基本在千元左右，水稻收购价已多年未涨；而化肥、农药和谷种等生产投入品的价格高企。课题组问卷调查结果显示，2022 年部分农资价格比 2021 年上涨幅度高达 30%；2023 年春季虽有较大回落，但水稻的生产成本仍然是“地板”高企。在不考虑土地租赁费用、劳动力成本、自然灾害风险的条件下，水稻生产的亩均利润为 300-500 元，不能承受绿色转型的成本，理性农户不会主动从传统生产转换为绿色生产。水稻绿色生产面临着利薄而难以承受绿色转换成本的问题。

难题之三：绿色稻谷与普通稻谷的收购价无差别，农户开展绿色生产缺乏有效激励。当前，稻谷收购价格的差异主要基于品种差异而定，不考虑是否减少化肥用量、是否施用有机肥、是否减少农药用量、是否使用生物或物理防治等绿色生产技术，农户绿色生产成本未能在销售收入中体现。水稻绿色生产面临着无绿色收益、缺乏有效激励、鱼目混珠、优质不优价，甚至“劣币驱逐良币”的问题。

三、进一步推动水稻高效绿色生产转型的建议

绿色生产是我国农业现代化的大势所趋，是深入推进绿美广东生态建设的重要抓手。基于我省水稻绿色生产转型面临的难题，应从向农户迂回导入绿色生产能力和增强绿色生

产市场动力两方面入手，采取有效措施予以破解。

（一）全力推进农业生产社会服务绿色化，向农户迂回导入水稻绿色生产能力

推进绿色农业生产社会化服务，即通过机械装备绿色化、服务标准绿色化，迂回地实现农户水稻绿色生产。课题组问卷调查结果显示，我省社会化服务在水稻生产覆盖率高，其中机耕机收均超过85%，无人机植保从2021年的15.9%增加到2022年的21.1%。2023年中央一号文件将“农业绿色发展”写进“强化农业科技和装备支持”部分，为农业生产绿色转型指明了利用绿色装备科技的道路，我省应对以下水稻适用型绿色机械服务进行引导和支持。

第一，支持大马力耕整机，提高灭茬整地质量。旋耕深翻到20-30厘米，可使秸秆全部翻入地下，让秸秆与土壤充分混合，保证土壤墒情，增加土壤透气性，有利于秸秆腐化，防止秸秆富集于播种层，为下一季作物创造适播条件。

第二，继续推广无人机植保，实现植保专业化。无人机植保作业必须是持证专业飞手，他们能够短时间积累大量病虫害防控经验。对比面向农户培训，对飞手开展培训，效果好，受益广，效率高。飞手为农户“对症下药”，根据害虫不同习性特点，基于水稻品种及植株状态，制定从选药、配药到飞行路线、速度、高度，以及喷雾器械类型、型号和喷头选择的全套作业方案，实现科学选药，精准打药。专业的

无人机植保有能力在控制植保质量的前提下最小化农药施用量，保证对作物和生态环境的安全，实现绿色生产。

第三，支持秸秆处理设备成套化，为秸秆综合利用提供条件。收割作物留茬应小于10厘米，为下一造作物整田做好准备。对于沤烂还田的秸秆，收割机应装配秸秆粉碎刀片和抛撒装置，以便在收割过程中切碎秸秆，并均匀撒铺于田间；对于用作饲料、燃料、食用菌等作物覆盖的秸秆，可对收割机配套秸秆打捆装置，或使用捡拾打捆机处理收割后的秸秆，推动秸秆的资源化利用。

（二）大力发展种养结合循环模式实现农业生产内部生态平衡，增加农民收入

种养结合是种植业和养殖业紧密衔接的生态循环农业模式，兼顾了农业生产与生态保护。在模式内部，充分利用物质和能量在动植物间有机转换与高效利用，在直接减少生产资料投放的同时，农户还获得养殖收入。我省拥有桑基鱼塘、稻田综合种养、林下复合种养等种养结合的传统经验，为发展现代生态循环的绿色农业打下良好基础。

第一，因地制宜推广稻田综合种养。鸭稻共作、鱼稻共作模式的科学性和合理性在长期实践中得到验证，它既极大地降低了作物病虫害的发生，进而减少水稻种植的肥料和农药施用，又减少养殖饲料和兽药的投放，实现单片田地内部生态平衡，极大地降低了对农田附近生态环境的影响，而且

可实现“一田多收”。农户在增加稻鸭、稻鱼等销售收入的基础上，配之鸭稻、鱼稻的绿色溢价，还可增加稻谷销售的收入，实现多元增收。

第二，支持有条件地区散养牛羊，发展林下经济。在有足够放牧场地和林地的条件下，农户采用完全放养的模式，小规模散养牛羊，饲料成本低，牲口抗病能力强，肉质好，价格高，销路广。冬天及不适合放牧时，农户以水稻及其他作物秸秆进行喂养，牲口粪便为放牧地提供有机肥料，实现小范围内部生态平衡。对比规模养殖，小规模养殖本身是绿色生产，利用荒地和山坡的野草作为主要投入品，与种植业结合，以作物秸秆为辅助投入品。散养牛羊生产成本低，但周期长，农户是以时间换收益，销售压力低，适价而售，单位牛羊可获得相对较高收入。

（三）聚力整合塑造区域绿色大米品牌以畅通绿色稻米销售，启动绿色生产市场激励

国际有机联盟的数据显示，中国已成为全球第四大有机市场。按中国有机标准生产和认证，并进口的产品仅2019年就达到130亿元，说明中国国内生产未能满足自身市场需求。作为我国经济发展排头兵，识饮识食的广东人对高质量绿色大米具有相当需求。

第一，继续加大扶持丝苗米产业园的绿色品牌建设。我省已建成29家省级丝苗米现代农业产业园，打造了一批粤

字号丝苗米品牌。在此基础上，大米品牌建设应进一步突出“绿色”内涵，让更多消费者知晓、了解、认可、忠诚于广东绿色丝苗米。产业园核心企业要从选择绿色优质谷种，推广物理杀虫、生物农药防治、施用有机肥，到统一收割、包装、销售，以“公司+农户”的方式带动农户绿色生产。这样将既满足了消费者对绿色大米的需求，又发展了企业，也实现了农民增收，还保护了生态环境。

第二，进一步加大“三品一标”的宣传力度。“三品一标”是我国政府积极推进的优质农产品公共品牌，其实质是政府为优质农产品背书，因此平均到各企业的品牌成本低。一方面，政府要继续加大力度向广大消费者宣传“三品一标”，让消费者认识到具有“三品一标”的大米质量安全、口感好、营养价值高，对生态的可持续发展有重要意义。全力培育绿色消费习惯，使消费者逐渐接受绿色成本，为水稻生产绿色转型提供源动力。另一方面，政府要向企业宣传“三品一标”，让更多稻米加工企业参与其中，企业向谷米质量要利润。企业在申请大米“三品一标”的过程中，将梳理水稻生产流程，其中绿色技术是重要内容。“三品一标”水稻生产技术标准规范将推动农户绿色生产技术的应用，实现水稻生产绿色转型。

撰稿人：

李慧，华南农业大学经济管理学院、省哲学社会科学重点实验室--乡村振兴实验室讲师、资源环境学院博士研究生；

罗明忠，华南农业大学经济管理学院、省哲学社会科学重点实验室--乡村振兴实验室执行院长（主任）、教授；

章家恩，华南农业大学资源环境学院教授、博士生导师、华南农业大学现代生态农业与循环农业工程技术研究中心主任；

陈风波，华南农业大学经济管理学院副教授。

项目来源：

教育部人文社科青年基金项目“农业社会化服务改善我国小农发展空间的研究”（18YJC790079）；

广东省哲学社会科学规划项目“农户绿色生产自我实现机制研究：基于合约匹配视角”（GD23CYJ07）；

广东省现代农业产业技术体系创新团队建设项目（2021KJ105, 2022KJ105, 2023KJ105）；

广州市哲学社会科学发展“十四五”规划基金“粤港澳大湾区经济发达地区小农绿色生产的决定机制研究”（2023GZGJ05）。

贫困治理的广东路径：从精准扶贫到农业农村高质量发展

○刘义强（暨南大学国际关系学院教授）
○李　慧（华南农业大学经济管理学院讲师）
○本文责编／刘龙飞

刘义强

李慧

党的十八大以来，广东推进精准扶贫，形成全社会共同参与

党中央提出“确保到2020年所有　　展，贫困人口快速减少；1985年起，广