Received: 2 March 2022 | Accepted: 7 January 2024

DOI: 10.1111/1467-8489.12556

The Australian Journal of Agricultural and Resource Economics AARES

ORIGINAL ARTICLE

Purchasing habits, age effects and Chinese consumers' willingness to pay for chilled pork: Evidence from a random Nth-price auction experiment

Zhen Yan[1,2] | **Fei Han**[1] | **Holly Wang**[3] | **Yun Shen**[1] | **Jiehong Zhou**[1,2]

[1]China Academy for Rural Development, Zhejiang University, Hangzhou, China

[2]Laboratory of Agricultural & Rural Development and Intelligent Computing, School of Public Affairs, Zhejiang University, Hangzhou, China

[3]Center for Food and Agricultural Business, Purdue University, West Lafayette, Indiana, USA

Correspondence
Jiehong Zhou, Room 803, School of Public Affairs, Zhejiang University, No. 866 Yuhangtang Road, Zhejiang University, Hangzhou 310058, China.
Email: runzhou@zju.edu.cn

Funding information
National Natural Science Foundation of China, Grant/Award Number: 72073118; National Social Science Fund of China, Grant/Award Number: 19ZDA106; Key Research Projects of Humanities and Social Sciences under the 14th Five-Year Plan of the Ministry of Education, Grant/Award Number: 22JJD790079; Zhejiang Social Science Planning Office

Abstract

As concerns over African swine fever (ASF) in China continue, measures have been taken to regulate the inter-provincial transport of live hogs, yet entrenched non-chilled fresh pork consumption habits make it challenging to expand the chilled pork in the market. To address this issue, our study employed multiple rounds of random Nth-price auction experiments to measure participants' quality perceptions of, and willingness to pay (WTP) for chilled pork under different packaging, storage temperature and duration labels. By comparing the results with physicochemical lab testing outcomes, we confirmed the existence of a quality perception bias among the participants. Notably, consumers who regularly consume chilled meat demonstrated a higher average WTP, while consumers born in the 1980s exhibited significantly higher bids. Furthermore, access to emerging purchase channels positively influences consumer WTP for chilled meat, particularly through branded product purchasing experiences. Consequently, it is recommended that the public sector takes steps to balance the distribution of pork production capacity and supports the development of cold chain transportation technology to meet the growing demand for high-quality chilled pork, especially from younger consumers.

KEYWORDS

chilled pork ham, consumption habit, Nth-price auction experiment, physicochemical test, willingness to pay

JEL CLASSIFICATION

C92, Q13, Q16, Q28

1 | INTRODUCTION

China holds the position as the world's leading pork producer and consumer, with traditional 'backyard' farming practices contributing to more than 50% of the nation's hog production, as documented in the Ministry of Agriculture and Rural Affairs of China (MOARAC, 2018). However, the 2018 African swine fever (ASF) outbreak catalysed a swift nationwide spread of the disease, exacerbated by the transportation of infected live hogs. In response to this crisis and to safeguard pork supply, safety and quality, the MOARAC enacted stringent measures. These included curbing the inter-provincial transport of live hogs from ASF-afflicted regions and their neighbouring provinces (Delgado et al., 2021; Ma et al., 2021). A pivotal element of these measures was the introduction of the 'Transporting Pork' policy,[1] which mandated the movement of slaughtered hogs to markets via a cold chain. Such protocols are commonplace in developed nations, where hog production and slaughter occur on a large scale, and chilled pork is distributed via specialised logistics networks. These systems are critical for controlling the transmission of livestock diseases and maintaining the quality of meat products (McEwan et al., 2021; Timothee et al., 2017).

In December 2018, merely 3 months after its initiation, the 'Transporting Pork' policy was superseded by the dual strategy of the parallel control policy. This new framework permitted the direct transportation of live swine contingent upon stringent epidemic prevention protocols and regulatory oversight. While the original policy held promise for mitigating swine disease outbreaks, its execution was fraught with challenges, largely due to three reasons. First, many households in China favour non-chilled fresh pork and regard this as the benchmark for freshness, which has led to usual non-chilled fresh pork purchasing habits and dietary preferences (Bai et al., 2020; De Bruijna, 2011; Grubliauskiene et al., 2012; Wang, Chen, et al., 2018). Second, the traditional methods of assessing pork quality—through visual cues, its appearance, smell and tactile feedback—are built upon their experiences with non-chilled fresh pork (Wang, Chen, et al., 2018). Chilled pork products, often enclosed in modified atmosphere packaging (MAP) or vacuum packaging (VP), diverge from these customary assessment techniques, thus discouraging the purchase of pre-packaged, chilled fresh pork products (Zhou et al., 2010). Lastly, despite the emergence of the online fresh food retail sector that relies on cold chain logistics, the market share of pre-packed chilled pork products remains marginal at the present stage.

Based on our field research and review of the current literature, we have determined that the adoption of the chilled pork market remains limited, primarily due to the substantial initial investment costs, creating a barrier for small-scale producers (Wang, Chen, et al., 2018). The existing literature has identified consumer readiness to pay a premium for several safety and quality attributes of meat including freshness (Zhou et al., 2010), flavour (Muringai et al., 2017), specific colours (Lusk et al., 2018), texture (Koistinen et al., 2013), information regarding antibiotic use in pig rearing (Mckendree et al., 2013), traceability (Liu et al., 2019), local production (Byrd et al., 2018) and animal welfare (Lai et al., 2018). However, there remains a notable research gap concerning consumer preference for the packaging attributes of chilled pork (Zhang et al., 2019). Moreover, while some studies have investigated consumer perceptions of pork quality and their willingness to pay (WTP) for chilled versus non-chilled pork, such as Wang, Chen, et al. (2018), these studies have not concentrated on the willingness of consumers to pay for chilled pork under different packaging and storage conditions.

In addition, the variability in food consumption behaviours can also be attributed to purchasing habits and age-related effects (Teuber et al., 2016; Xiong et al., 2019). Consumers often

[1]MOARAC, Notice of MOARAC on Further Strengthening the Supervision of Trans-provincial Transfer of Live Hogs and Pork Products, 2018. http://www.moa.gov.cn/govpublic/SYJ/201809/t20180925_6158480.htm. Accessed by 7 July 2020.

persist in buying the same products due to established habits, reducing their propensity to respond to short-term price shifts (Dubra et al., 2019; Li & Dorfman, 2019). Age-related effects are closely related to the consumer lifecycle theory. For instance, younger consumers show greater openness to trialing novel products, such as chilled fresh pork, whereas older consumers, with more entrenched consumption practices, may display greater aversion to altering their purchasing behaviours (Wang, Gao, & Shen, 2018; Wu et al., 2016). To enrich the understanding of these factors, our study is designed to examine the influence of habitual purchasing and age-related effects on both consumer acceptance and their WTP for chilled pork. This angle is particularly relevant as prior research has largely neglected the exploration of these effects in the context of meat products. Our study seeks to provide new evidence on preferences for pork.

In the pursuit of understanding consumer WTPs for food products, a diverse set of methodologies has been explored. Some researchers have employed the contingent valuation method, although this approach is frequently criticised due to the potential for hypothetical bias and overestimation of the WTP, largely attributed to respondents' social desirability (Dahal et al., 2018; Wang & Ge, 2016). Alternatively, choice experiments have been harnessed to yield more precise WTP valuation, yet they are not exempt from hypothetical bias, particularly because of a lack of incentive compatibility for participants (Jiang et al., 2022; Liu et al., 2019; Ortega et al., 2011). The auction mechanism has been utilised to derive the maximum price consumers are willing to pay. This mechanism involves participants bidding their highest prices for an auctioned object (Morgan et al., 2020; Zhang et al., 2021), integrating open bidding formats such as British auctions, which feature ascending bids, and Dutch auctions, characterised by descending bids along with sealed bid designs such as first-price auctions, Vickrey auctions, also known as second-price auctions, and the Becker–DeGroot–Marschak (BDM) auctions, all underpinned by auction theory.

The random Nth-price auction mechanism is a method that synthesises the merits of the Vickrey and BDM auctions. Participants submit sealed bids that reflect their true WTP, and a transaction price is randomly selected from these submitted bids, ensuring an equal opportunity for all to win the auctioned item. This approach is lauded for its incentive compatibility, effectively mitigating issues such as dishonest bidding, the endowment effect and the learning effect (Lee et al., 2011; Shogren, Cho, et al., 2001; Shogren, Margolis, et al., 2001). Its application extends to the evaluation of environmental public goods and non-market goods value (Lee et al., 2011; McFadden & Huffman, 2017; Siang & Leng, 2015). Therefore, we have adopted the random Nth-price auction method in this study to determine the actual WTP of consumers for chilled pork. However, few previous studies examine chilled meat quality evaluation in conjunction with results from physicochemical testing.

In this study, we recruited 188 individuals to participate in a series of random Nth-price auction experiments designed to measure the participants' perception of quality and WTP for chilled pork under two commonly used meat packaging methods, namely MAP and VP, and various storage temperature and duration labels. By comparing the results from the physicochemical laboratory tests, we were able to confirm the presence of a perceptual quality bias among the participants. Moreover, we discerned the diversity in WTPs for chilled pork across distinct consumer demographics, specifically noting variations linked to age groups and pork consumption habits. Our study provides new evidence regarding the factors influencing consumer acceptance of chilled pork and their WTP, as well as highlighting the necessity of considering quality perception bias and the demographic and behavioural characteristics of consumers in related future research.

The contributions of our research to the existing literature are threefold. Firstly, we performed consumer sensory evaluations of chilled pork and established that there was a higher sensory evaluation of chilled meat when combined with the outcomes of physicochemical analyses. Secondly, we appraised consumer WTP for chilled pork preserved in typical packaging

formats under various preservation conditions, revealing a market preference and higher WTP for MAP, which did not align with the quality. Thirdly, we explored and separated the impact of different pork purchasing habits and age stages on consumer WTPs for chilled pork products, shedding light on the diverse preferences among consumers.

The following sections are organised as follows. Section 2 introduces the experiment design. Section 3 describes the data and estimation method. Section 4 presents the testing and estimation results. Finally, Section 5 concludes.

2 | EXPERIMENT DESIGN

2.1 | Auction experiment and bidding subject

The bidding subject was boneless pork from the hind leg, which is a popular cut in the Chinese market (Yan et al., 2019), and is processed with relatively advanced technologies for storage and transportation (Wu et al., 2016). To limit the influence of origin, manufacturer and other factors, all pieces of auctioned pork were provided by the same pork company and presented in two packaging methods: MAP and VP, each containing 250 g. The pork was stored under three distinct conditions to simulate various market scenarios: at 4°C for 12 h (4C12h) to represent chilled pork in local markets, at 4°C for 36 h (4C36h) to mimic inter-regional transport conditions for chilled pork and at 20°C for 12 h (20C12h) to reflect non-chilled pork available at local farmers' markets. Each storage condition had pork packaged in both MAP and VP, resulting in a total of six sample groups for the auction experiment.

2.2 | Participant recruitment and pork quality testing

The experimental study was conducted in Hangzhou, a metropolis and hub for domestic migration within China, making it an excellent case study location to analyse diverse consumer preferences for pork. In May 2019, we recruited a total of 210 individuals from seven residential communities adjacent to the Zijingang Campus, Zhejiang University, with 30 participants from each community. These participants were the primary pork purchasers within their households. Ultimately, we retained 188 eligible participants, achieving a qualification rate of 89.5%. Of these, 117 participants (62.2%) were female, which is representative of the gender distribution for primary food buyers in typical Chinese families.

Before each auction session, the pork ham, stored as previously described, were transported to the laboratory facilities at the College of Agriculture and Biotechnology, Zhejiang University. Here, various tests were carried out to assess the physicochemical attributes of the pork, such as the pH levels, luminosity measured in relative light units, bacterial colony count and quantification of total volatile basic nitrogen. This comprehensive analysis provides a data-backed framework to evaluate the quality of the pork samples presented in the auction.

2.3 | Auction experiment design

The auction experiment was conducted through a structured five-step process.

Step 1: Upon entering the experimental room, participants were randomly assigned an ID number and given an experiment guide manual (Appendix S1). They were then seated according to their ID number. An instructor explained the rules and procedures of the experiment, emphasising that participants should not exchange information with each other.

Before the formal experiment, a prior auction using candies was conducted to ensure that participants understood the procedures of the random Nth-price auction. Additionally, one experiment assistant briefly explained the differences between VP and MAP, and informed the participants of the average price of pork in local markets, which is 6.5 yuan per 250 g (1 Yuan = 0.21 AUD = 0.14 USD in early 2024).

Step 2: The auction of the pork meat without labels and packages (under storage condition of 4C12h) was conducted first. Before the formal auction, all participants were invited to evaluate the quality of the meat based on its appearance, smell and sense of touch, and grade it using a Likert scale ranging from 1 (terrible) to 5 (excellent). After evaluating the quality, participants submitted their bids using electronic devices. If they were unwilling to make a purchase, they could submit a bid price of zero.

Step 3: The researchers collected all the participants' bids using electronic terminals. After excluding zero bids, a computer program randomly selected the Nth-highest price, which was then set as the hammer price for the auction. Participants who bid higher than this price would win the lot. The hammer price and the winner IDs were announced by the experiment instructor. This procedure was followed in the second to fifth auctions as well.

Step 4: Following the same procedure of Steps 3 and 4, another four rounds of auctions were conducted for pork in VP/MAP labelled preservation information of 4C12h and 20C12h. Similarly, the same types of pork minus the packaging were provided to allow the participants to judge the quality of meat by its appearance, smell and sense of touch. To control the impact that sequence could have on results, the pork with the two packaging methods was presented in a random order in different experiment sessions. Specifically, in different experimental sessions, different kinds of pork are auctioned in random order, and the successful bidding prices of participants are not announced publicly until all rounds of auctions are completed, to eliminate the learning effects, namely the effect that the same person participates in multiple auctions and adapts her/his own biding decisions in later rounds based on other bidders' transaction prices learned from earlier rounds (Pownall & Wolk, 2013).

Step 5: After all rounds of the auction, the participants were asked to fill out a questionnaire about their pork consumption habits and behaviours, as well as the demographic characteristics of their families. Each participant was paid 35 yuan for their participation, which is equal to the average hourly private-sector wage in Hangzhou. This payment was deemed appropriate compensation for their time spent participating in the auction within 1 h, without being too high to influence overbidding or cause wealth effects. Finally, one round of the auctions was randomly selected, and successful bidders were required to pay for the pork at the Nth-highest price. In other words, the price of the pork was deducted from their payment as part of the experiment.

Our design adheres to rigorous experimental protocol, ensuring the collection of reliable data while providing adequate remuneration and maintaining ethical considerations.

3 | DATA AND ESTIMATION METHOD

3.1 | Variables selection and descriptive statistics

The variables setting and their descriptive statistics are shown in Table 1.

Consumer WTP for the pork ham was gauged using random Nth-price auctions and served as the study's primary dependent variable.

Independent variables account for factors potentially influencing WTP. First, the dependence on purchase habits for non-chilled pork (purchase_habit) is easily observed in Chinese

TABLE 1 Descriptive statistics of bids and demographic variables.

Variable	Description	Mean/Proposition	Median	Min	Max
WTP_{noinf}	Bids for unpackaged and unlabeled chilled and fresh pork	6.45 (2.50)	6.17	2.20	19.30
WTP_{4C12h}	Bids for labelled chilled and fresh pork (4°C12h)	7.37 (3.84)	6.90	3.10	23.10
WTP_{4C36h}	Bids for labelled chilled and fresh pork (4°C36h)	5.91 (4.34)	6.00	1.90	19.00
WTP_{20C12h}	Bids for fresh pork (20°C12h)	6.64 (3.32)	6.30	1.00	15.90
Purchase_habit	Pork meat consumption is: 1—mainly non-chilled fresh meat; (0—mainly chilled fresh meat)	86.0	1.00	0.00	1.00
Purchase_channel	Pork meat purchasing channel is: 1—supermarket, store, e-shop; (0—traditional farmers' market)	47.9	0.00	0.00	1.00
Purchase_brand	Pork meat bought: 1—with brand; (reference: 0—no brand)	46.0	0.00	0.00	1.00
Storage_method	Pork storage by: 1—refrigerated in the first day and frozen in the second day;	57.8	1.00	1.00	3.00
	2—always refrigerated; (reference: 3—always frozen)	12.3			
Age_group	1—1990s (20–29 years)	31.6	2.00	1.00	5.00
	2—1980s (30–39 years);	20.0			
	3—1970s (40–49 years);	26.5			
	4—1960s (50–59 years); (reference: 5—1950s [60 years] or above)	16.1			
Gender	1—female (reference: 0—male)	62.0	1.00	0.00	1.00
Education	1—under junior high school;	21.9	3.00	1.00	4.00
	2—senior high school;	18.7			
	3—college or university; (reference: 4—graduate or above)	25.8			
Family_income	Family monthly income: 1—higher than 10,000 yuan; (reference: 0—others)	49.0	0.50	0.00	1.00

Note: Numbers in cells of the first column are means for willingness to pay (WTP)s, and percentages for the other variables. Standard deviation values are in the brackets.

pork consumers' daily behaviours, which could potentially restrain participants' chilled fresh pork bids (Sun et al., 2017).

Second, chilled fresh pork is mostly available in supermarkets and meat specialty stores. To minimise purchase channel-related constraints on consumer consumption habits, regular purchase channel for pork (purchase_channel) was incorporated into our model.

Third, most branded pork, which is stored using chilling technologies, is perceived as higher quality by consumers. Notably, evidence suggests that people who habitually buy branded pork are more likely to accept chilled fresh pork (Zhang et al., 2019). Therefore, branded pork purchasing habits (purchase_habit) are pertinent for understanding consumers' perceptions of pork quality and their WTP.

Fourth, home storage methods such as chilling or freezing can influence consumer attitudes towards the freshness and storage duration of the pork, potentially impacting WTP for chilled fresh pork (Person et al., 2005). Thus, the pork storage method at home (storage_method) is also considered.

Control variables encompassed demographic characteristics, gender (gender), education level (education), age group (age_group) and monthly family income (family_income), all of which could sway the WTP for chilled pork.

3.2 | Estimation model

As there were instances of bid prices of zero,[2] the Tobit–Cragg model was employed to discern how social a psychological traits influenced participants' WTP outcomes (Bernini et al., 2020; Burke, 2009; Kleibergen & Paap, 2006). The model is suited for data sets with truncated, non-zero and positive bid values, improving upon the conventional Cragg model by accommodating a broader span of observations, including those with zero bids, thus enriching the regression analysis (Begum et al., 2012; Manyong et al., 2006; Sugimoto, 2019). Therefore, we employed the following Tobit–Cragg model for regression.

$$\begin{aligned} Y_{ij} = \; & a + b_{1j}\text{purchase\_habit}_i + b_{2j}\text{purchase}_{\text{channel}_i} \\ & + b_{3j}\text{purchase\_habit}_i \times \text{family}_{\text{income}_i} + b_{4j}\text{purchase}_{\text{habit}_i} \times \text{age}_i \\ & + b_{5j}\text{purchase\_channel}_i \times \text{purchase\_brand}_i + b_{6j}\text{purchase\_brand}_i \\ & + b_{7j}\text{storage\_method}_i + b_{8j}\boldsymbol{Z}_i + \alpha_i + \varepsilon_{ij}, \end{aligned}$$

where Y_{ij} is the ith consumer's bid price for jth chilled fresh pork, purchase_habit_i denotes whether the consumer retains the habit of purchasing non-chilled fresh pork and $\text{purchase\_channel}_i$ represents whether the ith consumer purchases pork via newly emerged channels such as supermarkets, specialty stores or the internet. Moreover, purchase_brand_i represents whether the ith consumer purchases branded pork regularly, storage_method_i denotes the normal way of preserving leftover pork at home and $\boldsymbol{Z_i}$ represents the collective individual characteristics, including gender, age group, education level and family income. The α_i captures the individual fixed effects, which are the effects of unobservable characteristics of different people on bid price, as well as to cope with the repeated observations issue, that is, multiple data points from the same person (Armstrong, 2013). In addition, three interaction terms were included in the analysis: (1) the cross-item of the non-chilled fresh pork purchasing habit and the family income ($\text{purchase\_habit}_i \times \text{family\_income}_i$), (2) the cross-item of the non-chilled pork purchasing habit and age groups ($\text{purchase\_habit}_i \times \text{age}_i$) and (3) the cross-item of a non-traditional purchase channel

[2]The pork stored for 36 h at low temperatures garnered a high frequency of zero bids, with many prices falling below three Yuan. To simplify the analysis, we merged the bids into several groups and found that approximately 21.5% of the bids were considered as zero.

and the experience of purchasing branded pork (purchase_channel$_i$×purchase_brand$_i$), to investigate the varied effects of this habits on the consumer's WTP for chilled fresh pork under different family incomes and age groups, as well as effects of different purchasing channels on WTP with or without brands.

4 | RESULTS

4.1 | Pork quality testing and perception results

Laboratory tests revealed that pork stored at a low temperature for 12 h retained the highest quality. However, an increase in both storage duration and temperature caused a rise in all measured physicochemical indicators, indicating a deterioration in meat quality. Notably, the quality of the pork sample stored at 20C12h was marginally better than that of the 4C36h sample. Additional testing on meat sample at 35C12h confirmed that elevated temperatures significantly compromised quality, to an extent where auction sale was not viable. Overall, it was found that VP or MAP had the ability to constrain the growth of bacterial colonies, while also delaying rancidity.

Participants' perceptions were quantified through their assessment of appearance, smell and texture of pork meat, as shown in Table 2. Within the low-temperature group, VP pork meat received notably higher scores than MAP pork meat. These evaluations are largely in line with the measure changes in meat quality indicators. Nonetheless, the relationship between participant assessments and quality indicators diminished as storage temperatures and periods increased, affecting both packaging types. Despite varied storage conditions, consumers consistently held a more positive opinion of VP pork compared with MAP pork.

Further statistical analysis indicated that there was no significant difference in consumers' sensory evaluation of chilled pork, regardless of whether they typically purchased non-chilled pork or not (Table 3). This finding holds true for consumers who usually purchase pork from different regular purchase channels as well (Table 4). Regarding age differences, participants born in the 1980s and 1990s did not exhibit significant variance in their perception of pork quality; however, among consumers born before 1980, there were notable perceptual perceptive differences (Table 5).

TABLE 2 Perception remarks on pork meat overall appearance.

Label	Variables	Mean (VP)	Mean (MAP)	ΔMean
4C12h	Appearance	4.059	3.754	−0.305*
	Smell	3.988	3.632	−0.356*
	Tenderness	4.047	3.596	−0.451**
4C36h	Appearance	3.852	3.684	−0.168
	Smell	3.365	2.965	−0.400
	Tenderness	3.353	3.140	−0.213
20C12h	Appearance	3.518	3.404	−0.114
	Smell	3.518	3.193	−0.325
	Tenderness	3.482	3.263	−0.219

Abbreviations: MAP, modified atmosphere packaging; VP, vacuum packaging.

*, ** and *** denote the levels of statistical significance at 10%, 5% and 1%, respectively.

TABLE 3 Quality perception of consumers with different non-chilled fresh consumption habit.

	By habit	Mean (VP)			Mean (MAP)		
Label	Variables	Purchase_ habit = 1	Purchase_ habit = 0	Diff.	Purchase_ habit = 1	Purchase_ habit = 0	Diff.
No-info	Total	3.879	3.583	−0.296	3.702	3.667	−0.035
4C12h	Appearance	4.125	4.000	−0.125	3.766	3.778	0.012
	Smell	4.089	3.909	−0.180	3.660	3.667	0.007
	Tenderness	4.054	4.091	0.037	3.596	3.667	0.071
4C36h	Appearance	3.571	3.273	−0.298	3.383	3.000	−0.383
	Smell	3.607	3.364	−0.243	2.979	2.889	−0.090
	Tenderness	3.518	3.364	−0.154	3.149	3.111	−0.038
20C12h	Appearance	3.589	2.909	−0.680**	3.404	3.444	0.040
	Smell	3.500	3.091	−0.409	3.170	3.222	0.052
	Tenderness	3.500	3.000	−0.500	3.255	3.333	0.078

Abbreviations: MAP, modified atmosphere packaging; VP, vacuum packaging.
*, ** and *** denote levels of statistical significance at 10%, 5% and 1%, respectively.

TABLE 4 Quality perception of consumers with different purchasing channels.

	Packaging	VP			MAP		
Label	Variables	Purchase_ channel = 1	Purchase_ channel = 0	Diff.	Purchase_ channel = 1	Purchase_ channel = 0	Diff.
No-info	Total	3.767-	3.854	0.087	3.733	3.630	−0.104
4C12h	Appearance	4.138	4.026	−0.112	3.833	3.667	−0.166
	Smell	4.138	3.949	−0.189	3.567	3.704	0.137
	Tenderness	4.103	3.974	−0.129	3.600	3.593	−0.007
4C36h	Appearance	3.586	3.436	−0.150	3.200	3.481	0.281
	Smell	3.621	3.487	−0.134	2.733	3.222	0.489*
	Tenderness	3.483	3.462	−0.021	3.000	3.296	0.296
20C12h	Appearance	3.241	3.615	0.374*	3.267	3.556	0.289
	Smell	3.172	3.59	0.418*	3.000	3.407	0.407
	Tenderness	3.172	3.564	0.392*	3.000	3.556	0.556*

Abbreviations: MAP, modified atmosphere packaging; VP, vacuum packaging.
*, ** and *** denote levels of statistical significance at 10%, 5% and 1%, respectively.

4.2 | Consumer bids for chilled pork

The distribution of consumer bids for chilled pork is depicted in Figure 1. After checking the bids of participants in different auctions, we find that there are no direct rules in bidding. As Figure 1a demonstrates, consumers' average WTP was higher for chilled fresh pork with a MAP than that with VP packages, while their WTP for chilled pork without label information about storage was in between those for 4C12h and 4C36h. This was followed by the WTP for packed non-chilled pork, with the average bid for unpackaged non-chilled pork in the farmers' markets being the lowest. The results suggest that the labels of chilled fresh pork can effectively increase the premium paid by consumers and better convey the manufacturers' quality information.

Compared with unpackaged chilled fresh pork, consumers were willing to pay a premium of 2.02% to 23.52% for the pork with storage information labels and packages on average. For

TABLE 5 Quality perception among age groups.

		VP					MAP				
Label	**Packaging variables**	**Age = 1**	**Age = 2**	**Age = 3**	**Age = 4**	**Age = 5**	**Age = 1**	**Age = 2**	**Age = 3**	**Age = 4**	**Age = 5**
No-info	Total	3.522	3.727	3.739	4.455**	4.250	3.867	3.818	3.462	3.429	4.250
4C12h	Appearance	4.043	3.909	4.048	4.600	4.750	3.867	3.818	3.692	3.714	3.500
	Smell	3.870	3.818	4.095	4.500	4.500	3.667	3.364	3.692	3.857	3.250
	Tenderness	4.087	3.636	3.952	4.600	4.500	3.800	3.364	3.692	3.571	3.250
4C36h	Appearance	3.174	3.455	3.571	3.600	4.250*	3.333	3.182	3.308	3.357	3.750
	Smell	3.348	3.636	3.381	3.400	4.250*	2.733	2.455	3.308*	3.071	3.750*
	Tenderness	3.304	3.273	3.476	3.500	4.250	2.933	2.818	3.231	3.357	3.750
20C12h	Appearance	3.304	3.000	3.429	4.100***	4.250**	3.667	2.818	3.000	3.643	4.500
	Smell	3.304	2.909	3.476	4.000**	4.000	3.000	2.455*	3.000*	3.786**	4.500**
	Tenderness	3.174	2.818	3.524	4.100	4.000	3.267	2.364*	3.000	3.857***	4.500**

Abbreviations: MAP, modified atmosphere packaging; VP, vacuum packaging.

*, ** and *** denote levels of statistical significance at 10%, 5% and 1% compared with the average level, respectively.

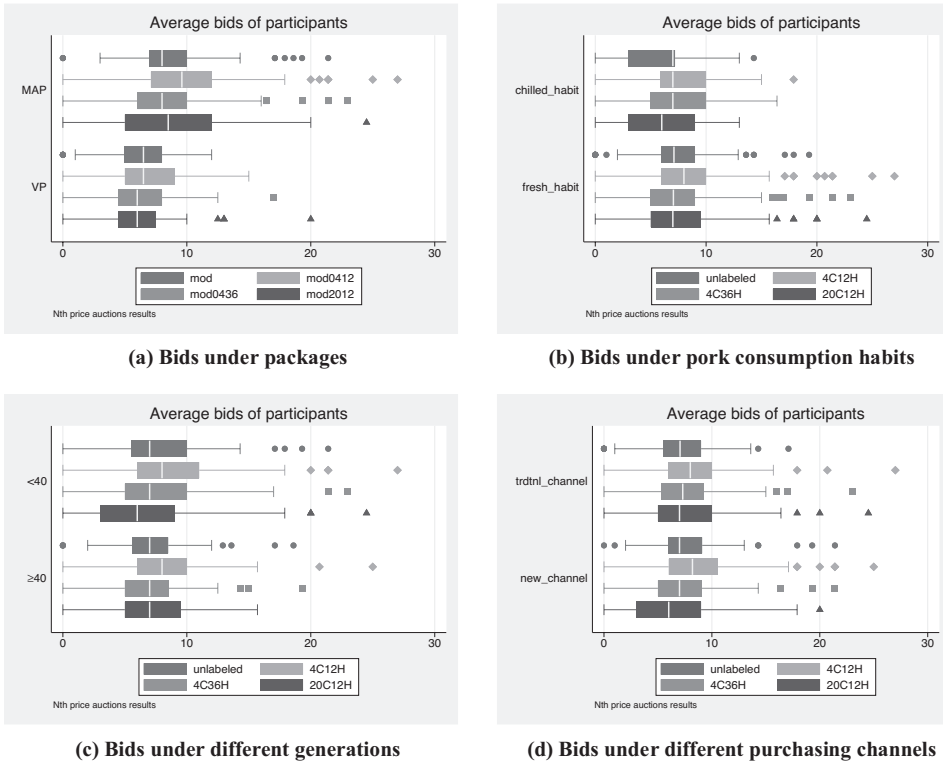

FIGURE 1 Bids under different (a) packages, (b) habits, (c) generations and (d) purchasing channels.

pork under the same storage conditions, participants paid a premium of 2.42–3.44 yuan/250 g for MAP pork over VP pork. The WTP for 4C12h pork was 1.00 yuan higher than that for 4C36h pork. The bid price box plots for VP and MAP generally overlap for pork under different storage conditions. Despite this, it seems that the bid prices for VP were lower and clustered more tightly. After conducting a *t*-test, we discovered that the bid price for MAP was higher than that of VP for 4C36h pork with a significance level of 5% ($p = 0.026$).

It is worth noting that participants who were over 40 years old (born before the 1980s) and those who habitually purchased non-chilled pork tended to offer a narrower range of prices for chilled fresh pork under different storage conditions (as can be seen in Figure 1b,c). This could be attributed to the fact that participants with different purchasing habits and channels tend to have different bidding ranges for the three types of chilled pork. Consumers who rely on non-traditional purchasing channels, such as supermarkets, fresh food chains and e-commerce, tend to have a narrower range of bids rather than relying on traditional purchasing channels such as farmers' markets. This may be because consumers aged over 40 are more familiar with purchasing non-chilled meat and are more sensitive to the price of pork (Wu et al., 2016). Furthermore, the price ranges between consumers over and under the age of 40 generally overlap each other. In fact, those who are below the age of 40 and actively seek out chilled fresh pork are less sensitive to its price, resulting in a wider range of acceptable prices.

Additionally, the research suggests that consumers purchasing pork through non-traditional channels possess a nuanced understanding of the pork pricing under varied storage conditions. This helps enable them to offer more consistent bid prices for chilled fresh pork (Figure 1d). Nevertheless, *t*-test indicated no significant differences at a 10% level in the mean bid prices when comparing age groups or people or purchasing habits.

4.3 | Estimation results

The study employed the Stata 15.1 software for statistical and regression analysis, using the Tobit–Cragg model. A bootstrap process was executed 500 times to obtain the estimated regression results, as presented in Table 6. The consistency of root mean square errors (RMSE) pre- and post-regression underscores the model's robustness. Given that each auction round featured different cuts of pork, it is concluded that the inter-dependence of bids across rounds does not detract from the efficiency of the regression outcomes. As depicted in Table 6, the propensity of consumers to buy non-chilled fresh pork negatively influenced their WTP for all three categories of chilled fresh pork, attaining significance levels of 1% (for both no-label and 4°C12h pork) and 5% (for 4°C36h pork). This result aligns with expectations, considering that the consumption patterns of non-chilled fresh pork in China may lead to a reduced average WTP.

TABLE 6 Regression results of the Tobit–Cragg model.

	(1)	(2)	(3)
Variables	**WTP_{noinf}**	**WTP_{4C12h}**	**WTP_{4C36h}**
Purchase_habit	−2.566***	−3.675***	−3.195**
	(0.926)	(1.037)	(1.339)
Purchase_channel	−0.242	0.499	−0.0276
	(0.570)	(0.638)	(0.866)
Purchase_habit × Family_income	0.495***	1.295***	1.764***
	(0.176)	(0.211)	(0.245)
Purchase_habit × Age_30s	0.645***	1.720**	1.703**
	(0.309)	(0.821)	(0.803)
Purchase_habit × Age_40s	−0.527**	−2.120**	−1.547**
	(0.643)	(0.930)	(0.742)
Purchase_habit × Age_50s	−0.422	−3.364**	−2.871***
	(0.901)	(1.316)	(0.960)
Purchase_habit × Age_60s	−1.447*	−2.637*	−3.377**
	(0.817)	(1.372)	(1.395)
Purchase_channel × Purchase_brand	1.195**	1.100*	1.481*
	(0.495)	(0.582)	(0.800)
Control variables			
Purchase_brand	Y	Y	Y
Storage_method	Y	Y	Y
Female	Y	Y	Y
Education	Y	Y	Y
Family_income	Y	Y	Y
Constant	1.237	0.00235	−1.273
	(1.186)	(1.308)	(1.737)
Observations	242	227	227
Fix effect of individuals controlled	Y	Y	Y
R-squared	0.213	0.303	0.415
Log likelihood	−591.349	−498.975	−476.354
LR $chi^2(22)$	81.63	Prob > chi^2	0.000

*, ** and *** denotes significance at 1%, 5% and 10% level. Standard deviations are in the brackets.

Building on the aforementioned analysis, prior researches have delved into how non-chilled pork consumption habits influence bid values for chilled pork (Liu et al., 2019; Wu et al., 2016; Yin et al., 2017). These studies illuminate a significant trend: As consumer incomes grow, the general farm product market struggles to satisfy the escalating quality and safety expectations of those who are prepared to pay higher prices for superior meat. A nuanced view of the data reveals the diminishing impact of habitual non-chilled pork purchases as family income surpasses the 10,000 yuan (Table 6). This pattern is likely reflective of individuals' propensity to embrace new living standards and consumption behaviours with increased financial means, thereby weakening the stronghold of previous purchasing traditions on their preference for chilled fresh pork.

The interplay between consumption habits and age uncovered that age exerts a differential influence on bidding prices for chilled fresh pork, a finding that deviates slightly from the existing literature positing that older consumers are more averse to paying premiums for chilled and frozen meats (Wang, Gao, & Shen, 2018). Across the study's demographic spectrum, all age groups except those born in the 1980s exhibited a reluctance towards labelled chilled fresh pork (12h/36h), aligning with the habit formation theories prevalent in food consumption and behavioural economics scholarship (List & Samek, 2015; Zhai et al., 2021). Given the proliferation of modern commercial outlets and supermarket in Chinese urban centres since the late 20th century, generations of the 1980s and 1990s have been conditioned to supermarkets shopping. Notably, it is predominantly those from generations preceding the 1980s who are inclined towards non-chilled pork and, in turn, demonstrate lower WTP for chilled alternatives.

Interestingly, no significant variance was observed in participants' WTP for chilled fresh pork when contrasting purchase channels, spanning online platform, department stores and supermarkets. This lack of variance may be attributed to a widespread deficiency in consumer knowledge regarding chilled fresh pork and a consequent inability to distinguish between chilled and non-chilled products within these retail contexts. However, an analysis considering the interaction between purchase channel preference and brand loyalty revealed nuanced insights. It appears that for consumers accustomed to purchasing branded pork, the influence of brand loyalty mitigates the significance of the purchase channel on WTP. The data indicate that individuals who routinely procure meat from entities such as farmers' markets, local butcher shops and direct from farmers are less influenced by the purchase channel on their WTP when they have a history of buying branded pork. For these consumers, particularly those employing non-traditional purchasing avenues, the act of buying branded meat positively impacts their WTP.

This observation appears to conflict with the previous literature that posits branding in agricultural products as an indicator of quality, with Chinese consumers reportedly willing to pay a premium for such branded items (Yan et al., 2019; Zhong et al., 2016). The contradiction could be rationalised by the moderating effect of positive experiences associated with the consumption of high-quality branded meat among satisfied consumers. Nonetheless, it is critical to recognise that the quality of meat can vary markedly among Chinese brands. Moreover, there exists the possibility that branded meat are not optimally stored in traditional retail outlets such as farmers' markets. Even well-established brands can be marred by subpar quality and safety standards (Ortega & Wolf, 2018; Zhou et al., 2010). Ultimately, consumer preferences are manifested in their purchasing choices. Given this concerns, certain consumers opt to reduce or even stop purchasing branded meat, favouring instead ordinary or imported meats obtained through traditional channels (Wang, Gao, & Shen, 2018).

Considering the mean values of other variables, it was discerned that participants older than 60, with a preference for non-chilled pork, and those who were not provided with storage information, exhibited a higher WTP (6.93 yuan/250 g as illustrated in Table 4, Column 2). Nonetheless, the disparity in WTP between this cohort and others was not statistically significant (1.54 yuan). In examining individuals familiar with purchasing chilled fresh pork, a pronounced divergence in the premiums offered across age groups was detected. Participants aged 30–39 proposed the highest price (8.05 yuan/250 g), which was 5.70 yuan more than the

20–29 age bracket, who were willing to pay only 2.35 yuan/250 g. In Model 2 of Table 6, it was noted that the 20–29 age group presented the highest price (8.51 yuan/250 g), while those aged 40–49 proposed the lowest rate. Nevertheless, the difference between these age groups was not statistically significant. Participants within the 50–59 age range offered a WTP of 3.78 yuan/250 g. The third category of chilled fresh pork typically attracted lower prices, with minimal variation in WTP apparent among the different age brackets.

As illustrated in Table 7, a horizontal comparison of the marginal effects of consumption habits across age groups, while controlling for purchase channels, was conducted. This

TABLE 7 Margin effect estimation.

	All means	pchnnl = 0	pchnnl = 1	Δpchnnl (%)
WTP_{noinf}				
Purchased channel: traditional farmers' market				
20–29 years	2.35	2.24	2.47	10.27
30–39 years	8.05	7.94	8.17	2.90
40–49 years	3.79	3.68	3.91	6.25
50–59 years	5.04	4.93	5.16	4.67
≥60 years	4.38	4.27	4.50	5.39
Purchased channel: supermarkets, specialised stores and online				
20–29 years	5.49	5.38	5.61	4.28
30–39 years	6.13	6.02	6.25	3.82
40–49 years	6.01	5.91	6.13	3.72
50–59 years	5.91	5.80	6.03	3.97
≥60 years	6.93	6.83	7.05	3.22
WTP_{4C12h}				
Purchased channel: traditional farmers' market				
20–29 years	4.18	3.49	4.93	41.26
30–39 years	9.68	8.99	10.44	16.13
40–49 years	1.12[a]	0.43	1.88	
50–59 years	4.25	3.56	5.00	40.45
≥60 years	3.78	3.10	4.54	46.45
Purchased channel: supermarkets, specialised stores and online				
20–29 years	8.51	7.82	9.27	18.54
30–39 years	6.79	6.10	7.55	23.77
40–49 years	6.39	5.70	7.15	25.44
50–59 years	5.15	4.46	5.91	32.51
≥60 years	5.87	5.19	6.63	27.75
WTP_{4C36h}				
Purchased channel: traditional farmers' market				
20–29 years	6.14	5.44	6.90	26.84
30–39 years	5.63	4.93	6.39	29.61
40–49 years	4.39	3.69	5.15	39.57
50–59 years	3.94	3.24	4.70	45.06
≥60 years	3.38	2.68	4.14	54.48

Note: The superscript means the marginal effect is not significant. Others values are all significant at the level of 1%.

comparison highlighted that in the absence of label information, the marginal cost benefit of improving consumer channels was inconspicuous. In the 30–39 age groups, with a habit of purchasing chilled fresh pork, the premium disparity was marginal, with prices of 8.05, 7.94 and 8.17 yuan/250 g, respectively, differing by only 0.23 yuan. Conversely, for the consumers within the same age bracket who consistently opted for chilled fresh pork identified by the 4C12h label, the highest bids were 9.68, 8.99 and 10.44 yuan/250 g, respectively, culminating in a premium of 1.45 yuan. Additionally, the WTP among consumers aged 20 ~ 29 years who customarily selected non-chilled pork stood at 8.51, 7.82 and 9.27 yuan/250 g, respectively, with an equivalent premium equalling 1.45 yuan.

5 | DISCUSSION

The auction outcomes for chilled pork imply that enterprises could augment their market valuation by curtailing the transportation span and minimising supply chain duration to enhance product freshness. As depicted in Figure 1, there is an inverse relationship between the storage duration of chilled pork and bid valuations, accentuating freshness as a pivotal factor within China's meat marketplace. There exists a potential gap in consumer cognition regarding the storage conditions and quality assessment of chilled fresh pork, which may lead to misperceptions. Implementing information labelling strategies can diminish this uncertainty and markedly amplify the product premium.

Our analysis indicates that the selection of retail avenues exerts no direct influence on the bid amounts for chilled meat. Nonetheless, the history of purchasing branded pork bolsters the constructive moderating role of alternative channels on the valuation of chilled meat. Moreover, the study elucidates an age-related divergence in WTP for chilled pork; elder demographics exhibit a reduced WTP, signalling notable age-specific predilections in a rapidly aging society such as China.

The research predominantly centres based on consumer perception bias, habitual purchasing patterns and age implications on WTPs for chilled pork, without delving into welfare assessment. Future research may benefit from incorporating welfare evaluations within this domain, as delineated by Small and Rosen (1981) and Hu et al. (2022).

6 | CONCLUSIONS

In the context of combating ASF, it is necessary to encourage consumers to transition from non-chilled to chilled pork consumption patterns. This study used random Nth-price auctions to investigate consumers' WTPs for chilled pork with two usual types of packaging and different preservation conditions, as well as the effects of consumption habits and age on WTP.

Findings reveal that, consumers give a higher sensory evaluation of chilled meat than non-chilled pork, which aligns with physicochemical testing's freshness ranking. However, consumers had a higher WTP for MAP even though VP pork has better quality. Providing accurate storage information encourages consumers to pay a higher premium for chilled fresh pork, with shorter storage time leading to higher bids. Consumption habits and age have an impact on their WTP for chilled meat. Older consumers, particularly those born before the 1980s, and those who are not accustomed to purchasing chilled meat are less likely to pay higher prices for it. Additionally, understanding consumer behaviour and demographic factors can help in developing targeted marketing strategies for chilled meat sellers.

From a practical standpoint, pork production entities should implement standardised labelling protocols for chilled pork to effectively communicate meat quality specifics. Companies

ought to consider adopting MAP initially and strategically target chilled pork offerings to younger consumers born post-1980s, who demonstrate greater familiarity with chilled meat acquisitions. To advance the adoption of chilled fresh technology, ameliorate food quality and curb the transmission of animal diseases, a collaborative effort among businesses, industry bodies and governmental agencies is recommended to bolster public cognizance. Such endeavours are vital to prime the populace for an expanding chilled fresh pork market in the forthcoming period.

ACKNOWLEDGEMENTS

We appreciate the support in lab experiments from Xiaoyu Han, Cangyu Jin, Hao Huang, Ke Wei, Yu Jin and other graduate students from Zhejiang University. We also gratefully thank the support from the National Natural Science Foundation of China (Grant no. 72073118), the major project of the National Social Science Found of China (Grant no. 19ZDA106) and the major project from Zhejiang Social Science Planning Office 'Comprehensive Formation of Green production and Lifestyle Research'; Key Research Projects of Humanities and Social Sciences under the 14th Five-Year Plan of the Ministry of Education (22JJD790079). We submitted the complete experimental design and survey procedure to the Interdisciplinary Center of Social Sciences (ICSS) at Zhejiang University and received ethics approval.

DATA AVAILABILITY STATEMENT

The data supporting this study's findings are available upon request from the corresponding author. These data are not publicly available due to privacy or ethical restrictions.

ORCID

Zhen Yan https://orcid.org/0000-0003-0091-6265
Fei Han https://orcid.org/0000-0001-8054-3432
Holly Wang https://orcid.org/0000-0001-6929-4201

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SUPPORTING INFORMATION

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How to cite this article: Yan, Z., Han, F., Wang, H., Shen, Y. & Zhou, J. (2024) Purchasing habits, age effects and Chinese consumers' willingness to pay for chilled pork: Evidence from a random Nth-price auction experiment. *Australian Journal of Agricultural and Resource Economics*, 68, 503–520. Available from: https://doi.org/10.1111/1467-8489.12556