Food Policy 123 (2024) 102602

Contents lists available at ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

Price response to government disclosure of food safety information in developing markets

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ARTICLE INFO

JEL codes:
I18
Q11
Q18

Keywords:
Food safety
Information disclosure
Wholesale market
Pork prices

ABSTRACT

This study investigates the impact of government disclosure of food safety information on market outcomes in a real and developing market setting. Prior research either relied on data from developed countries, or hypothetical and laboratory experiments to examine market responsiveness to food safety information. Using a panel dataset of weekly pork wholesale prices and pork sampling test result variables at the city level, we find lagged and negative price responses to government quality information disclosure in the Chinese pork wholesale markets. Average pork wholesale prices began to decrease by 5% two weeks after the information disclosure. The negative information effects on pork prices are largely driven by negative pork demand shocks in particular in the main pork consumption cities, and are more evident in the treated cities with higher internet penetration rates, incidence of foodborne illness, and food safety regulatory resources. Results of this study contribute to a better understanding of the nationwide information-based food quality regulation, and importantly, inform the efficacy of public information interventions that tackle food safety issues in other developing countries.

1. Introduction

Theoretical perspectives generally align on the effectiveness of providing quality information as a means to address food safety concerns. When food safety information is disclosed, consumers can distinguish between safe and unsafe products from various suppliers. Consequently, there may be an increase in the demand for safe food products and a decrease in the demand for unsafe ones, leading to higher market prices for safe products and lower prices for unsafe ones. However, for this information-based policy to work effectively, certain assumptions must hold. It is assumed that market buyers are sufficiently aware of disclosed food safety information and that they respond to it by exerting pressure that forces unsafe food products out of the market.

Empirical evidence, primarily from developed countries, supports the notion that the disclosure of food safety information reduces food consumption (Piggott and Marsh, 2004; Shimshack et al., 2007; Schlenker and Villas-Boas, 2009; Arnade et al., 2009). For instance, a detailed scanner-level dataset analysis by Toledo and Villas-Boas (2019) showed decreased sales of both affected and unaffected egg brands following three consecutive egg recalls in California. This, in turn, incentivizes higher compliance with safety standards among food suppliers (Jin and Leslie, 2003; Ollinger and Bovay, 2020; Zhou et al., 2022).

Despite these promising findings, limited research has explored how *developing markets* respond to food safety information disclosure. On one hand, food safety information in developed societies tends to gain greater visibility through a process of “social amplification” by which affected parties bring increased attention to the problem (Ortega and Tschirley, 2017; Hoffmann et al., 2019). Relative to food security, food safety has a lower priority in developing countries than in developed countries (Mohand et al., 2017). This implies potentially lower responsiveness to food safety information in a developing market context, regardless of its high prevalence of food safety events (Henson, 2003). On the other hand, disclosure of unsafe foods in developing markets may gain a stronger response as a result of collective reputation (Bai et al., 2021). In these markets, agricultural suppliers are often small-scale and primarily deal in homogeneous goods, making it challenging to trace food products back to individual traders or producers. Thus if one producer is revealed to supply unsafe foods, other suppliers in the same market may also suffer.

Moreover, prior studies exploring consumer preferences and valuation for safe foods in developing countries indicate that individuals express concern and are willing to pay additional prices for access to food safety information (Ehmke et al., 2008; Ortega et al., 2012;

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https://doi.org/10.1016/j.foodpol.2024.102602
Received 17 August 2022; Received in revised form 5 January 2024; Accepted 24 January 2024
Available online 3 February 2024
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Wongprawmas and Canavari, 2017; Liu et al., 2019; Wang et al., 2019). Although these studies imply strong responses to food safety information by developing markets, it is worth noting that these results were derived from hypothetical stated preference methods (Birol et al., 2010), which may be influenced by hypothetical bias (Penn and Hu, 2021) and demand effects (Carlsson et al., 2018).

This study presents a novel investigation of whether and to what extent markets respond to government disclosure of food safety information, in a *real* developing market setting. Governments play a key role in the provision of public goods including food quality information (Hamilton et al., 2003; Wu et al., 2016; Wu et al., 2022), and this role is particularly important for developing countries where food supply chains are characterized by a large number of small-scale and informal actors, with low traceability levels. As a practical application, we focus on China, the largest food market worldwide, which has been chosen carefully. China's food safety has been a prominent public issue (Alcorn and Ouyang, 2012; Wang et al., 2019; Yang et al., 2019; Liu et al., 2020). Government disclosure of food safety information in China in this study refers to a national policy instrument that mandates the central and local government regulatory agencies to make all the information about food sampling test records and outcomes public on a regular basis. Effective in 2014 as part of the China Food Safety Laws (Jin et al., 2021a), this policy disclosed over 638 million of food sampling test results in 2020, compared to 150 million in 2016 (SAMR, 2020), imposing significantly increased fiscal resources annually. Recent food scandals, including the one discovered in the largest pork processor in this country, Shuanghui,[1] however, may not fully convince the public that food safety in China has improved. This study evaluates the impact of government disclosure of food safety information in China on market outcomes, specifically, market prices, whose fluctuation influences the welfare of numerous agricultural producers, traders, and buyers.

With regard to the empirical strategy, we constructed a panel dataset of weekly pork wholesale prices and pork sampling test result variables[2] at the city level for the period between 2018 and 2020. Results from an event study approach reveal a lagged negative price response to government disclosure of pork safety information in Chinese agricultural wholesale markets. Average pork wholesale prices began to decrease by 5 % two weeks after the information disclosure. Besides, disclosure of unsafe pork products exerts some negative impacts on local beef prices and on neighboring cities' pork prices, especially when nearby cities are in the same province as treated cities. We also find that the negative information effects on pork prices are largely driven by negative pork demand shocks, in particular in the main pork consumption cities. Negative pork demand shocks and therefore pork price reduction is more evident in the treated cities with higher internet penetration rate, the incidence of foodborne illness, and food safety regulatory resource, which are used to proxy information accessibility and salience. We note that the estimated average information treatment effects are consistent with different model specifications such as different event windows and difference-in-difference specification. Results from this study contribute to a better understanding of the nationwide information-based food quality regulation, and importantly, inform the efficacy of public information interventions that tackle food safety issues in other developing markets.

Our research inquiry relates to several strands of the literature. First, we inform a stream of research investigating the effect of food safety information on market outcomes. Related work has dominantly focused on the U.S. and other developed contexts, and finds that food safety information may have industry-wide impacts on sales and prices depending on consumers' response to the information (Piggott and Marsh, 2004; Taylor et al., 2016; Shang and Tonsor, 2017). The food safety information is typically indexed by constructed media indices (Piggott and Marsh, 2004), and the presence and intensity of food recall (Lusk and Schroeder, 2002; Toledo and Villas-Boas, 2019; Neill and Chen, 2021) and food safety events (Shimshack et al., 2007; Arnade et al., 2009; Schlenker and Villas-Boas, 2009). This study complements the literature by studying the effects of food safety information in a different setting. We focus on the results of food safety sampling tests made public by the Chinese government regularly. Second, the study relates to the literature on the driving forces of food prices. Previous studies have examined the impacts of weather anomalies (Headey and Fan, 2008; Letta et al., 2022), increased transaction cost (Dillon and Barrett, 2016), trade restriction (Abbott, 2012), supply chain disruption (Ruan et al., 2021; Dietrich et al., 2022), biofuel production (Mitchell, 2008; Zilberman et al., 2013) and quality signals (Mérel et al., 2021) on food prices. This study highlights the impact of information disclosure on market outcomes.

2. Background and mechanism

2.1. China's pork wholesale market

This study examines market responsiveness to the disclosure of food safety information within the Chinese pork wholesale market. We focus on pork products for several reasons. First, meat is one of the most frequently tested agricultural products by the food safety regulation organizations in China, due to the abuse of additives and antibiotics in meat production. Second, pork, relative to other meat products, tends to receive more market attention when the safety test results are disclosed. This heightened attention stems from two facets. On one hand, recurring food safety scandals, including those involving China's largest pork firms, underscore the necessity of rigorous scrutiny (Wang et al., 2018). On the other hand, China boasts the title of being the world's largest pork producer (Carriquiry et al., 2019), with numerous hog producers whose livelihoods are closely intertwined with pork market dynamics. Pork also plays an important role in Chinese consumers' daily diet, evidenced by the fact that pork meat carries a substantial weight in the consumer price index calculation (Yu and Abler, 2014).

In emerging economies like China and India, wholesale markets play a pivotal role as intermediary components within agri-food value chains, making substantial contributions, accounting for approximately 30 to 40 percent of both value addition and associated costs (Reardon, 2015). Additionally, these wholesale markets have drawn attention as high-risk areas for food safety and adulteration within China's intricate food supply chains (Jin et al., 2021b).

This significance extends to pork wholesale markets, which occupy a critical position within China's meat supply chain. They serve as vital intermediaries that bridge the gap between producers and consumers, facilitating a vast volume of transactions. According to data provided by the Chinese Ministry of Agriculture and Rural Affairs in 2019, China's annual pig production reached an astonishing 541 million heads, with over half of these transactions taking place within wholesale markets. The prevalence of pork wholesale markets spans the entirety of China, as data from the Ministry of Agriculture and Rural Affairs in 2020 reveals a total of 23,770 such markets nationwide, covering all 31 provinces. The highest concentrations of these markets are observed in regions such as Jiangsu, Shandong, Henan, and Hebei.

In pork wholesale markets, participants encompass wholesalers, supermarkets, traditional wet markets, specialized pork stores, and institutional buyers such as schools, government agencies, and other organizations. Regarding pork supply, wholesalers primarily source their pork from designated pig slaughter and processing enterprises. Although China's pig slaughter and processing industry has become centralized, the challenge lies in tracing the pork's origins back to the numerous and scattered upstream pig producers. Indeed, the adoption of traceability systems in China's pork wholesale markets remains limited,

[1] https://www.scmp.com/news/people-culture/trending-china/article/3170567/china-food-scandal-meat-producer-exposed-using.

[2] We discussed in the background section reasons for choosing wholesale prices and pork products.

with less than one-third of these sellers implementing such systems (Jin et al., 2021b). In terms of pork demand, wet markets and supermarket chains emerge as the two main purchasers in pork wholesale markets. In China, approximately 70 % of the agricultural products in supermarkets and wet markets originate from wholesale markets (Yuan et al., 2021).

2.2. Food safety sampling tests

Food safety sampling tests serve as a pivotal tool for regulatory authorities to oversee food quality and safety. In China, both central and local governments meticulously devise plans for these inspections. The State Administration for Market Regulation (SAMR) annually formulates a Food Supervision Sampling Plan based on risk analysis and resident population. Provinces, cities, and counties also create their respective plans with varying food safety priorities. At the national level, SAMR focuses on inspecting large-scale supermarkets, agricultural markets, and key production firms nationwide. Provinces handle central-to-local transfers and provincial-level inspections, emphasizing large and medium-sized supermarkets, agricultural markets, production firms, and school campuses. City and county-level regulatory departments supervise small-scale supermarkets, agricultural wholesale markets, small food stores, and workshops.

Sampling inspections are divided into two categories: regular and special. Regular sampling involves inspections conducted according to the annual sampling inspection plans established at the beginning of each year. In contrast, special sampling goes beyond these plans and is typically carried out during holidays, for high-risk products, or in response to food safety incidents. Regular sampling involves a significantly larger quantity of tests compared to special sampling. Local regulatory departments are usually assigned regular and weekly sampling inspections for vegetables, fruits, livestock, and poultry meat.

In accordance with China's Food Safety Law and the Implementation Rules for National Agricultural Product Quality and Safety Supervision and Checks, when a food product, like pork with excessive chloramphenicol use, fails safety sampling tests, regulatory authorities are empowered to take certain actions on its supplier. These include the confiscation of illegal gains from food suppliers and the oversight of product recalls. Additionally, fines are levied, and in severe cases, business licenses may be revoked. However, an exception is made if the food supplier can demonstrate fulfillment of their obligations to inspect purchased products, provide substantial evidence indicating a lack of awareness regarding safety risks, and furnish traceability information for the products. Under these conditions, the penalty may be waived, and responsibility for the failed tests is typically shifted to the upstream supplier identified in the traceability information. Nevertheless, due to the limited adoption of traceability systems in China's agricultural supply chains, executing large-scale recalls of non-compliant food products is logistically challenging. Fines, thus, remain the prevalent punitive measure, and the specific penalty amounts may differ across regions.

2.3. Food safety information disclosure

Beyond food safety sampling tests, information disclosure serves as an additional regulatory mechanism utilized by the government to monitor and enforce food safety in China. According to the Regulations of the People's Republic of China on the Disclosure of Government Information and the Management Measures for Food Safety Sampling and Testing, it is imperative for food safety regulatory authorities to promptly disseminate information pertaining to food safety sampling. Presently, this dissemination occurs primarily through two channels: online and offline.

Firstly, the National Food Sampling Information Platform[3] is responsible for publicly disclosing comprehensive food sampling records and test results. Additionally, at the provincial, municipal levels, food safety regulatory authorities typically use their official websites to disseminate relevant sampling information, which includes details such as the sampling entity, sampled unit address, product's name and production date, producer's name and location, testing agency, test results, and instances of non-compliance. Recently, some local governments have expanded the dissemination of this information through their official social media accounts and news media outlets like Sohu and other self-media accounts, increasing accessibility. However, consumer engagement with this online channel remains limited, as noted by Zhou et al. (2022), primarily due to perceived complexity and insufficient publicity.

Secondly, wholesale markets prominently display food safety information within the physical market premises, providing a more convenient and broadly embraced method for accessing this information. Wholesale markets equipped with information disclosure facilities typically share details from their sampling test records. Information bulletins are typically positioned at the market entrance, ensuring visibility to all entering the market. These records typically include details such as the identification number of the trader in and/or outside the market, product name and test outcomes, etc. Thus, traders who fail in these tests may experience reputational damage due to the public disclosure of this information.

2.4. Potential mechanisms

Considering the background of food sampling tests and information disclosure, we propose that the public disclosure of pork safety information in cities where pork test failures are disclosed would lead to a reduction in pork prices, because of a decrease in pork demand in those cities. The drop in pork demand could be attributed to the fact that buyers avoid pork purchases once they become aware of pork products from a specific wholesaler being disclosed as non-compliant. This behavior would be exacerbated by the limited traceability of agricultural products in China, potentially leading consumers to abstain from buying pork from the entire wholesale market. The reason buyers avoid purchasing such pork is that those who shop in wholesale markets are typically retailers and food service businesses. If their pork is found and disclosed to be non-compliant in inspections, it could harm their reputation and consequently financial well-being.

However, it's worth noting that the impact of public disclosure of pork safety information on pork prices is expected to be smaller, compared to studies conducted in developed markets such as Dillaway et al. (2011). This is not surprising, given the nature of informational regulation and the characteristics of food supply chains in developing economies. First, the way that the food safety information is disclosed in our context differs from that in the previous studies, making our information less popularized for the market to react. Other than the official website and the offline disclosure, food sampling test outcomes and failures rarely got media coverage in China. In contrast, in the previous work focusing on developed markets, food safety information has been widely popularized by the media. This can be evidenced by the common use of media indices to proxy food safety information (Piggott and Marsh, 2004; Mazzocchi, 2006; Wang and Beville, 2017). In our case, the moderate information treatment effects would be driven by the unpopularized outcomes of food safety sampling tests, and wholesale markets may be less aware of the information even though they are available online. A recent survey based in Shanghai found that 52 % of food suppliers including wholesalers, processors, and retailers didn't know where to find food sampling test results, and the ratio increased to 80 % among household consumers (An, 2020).

Second, the food safety information we investigate, that is, the failure of pork safety sampling tests, delivers different content and therefore has different implications from those in the related literature. Most existing work on the US markets used food recalls (Lusk and Schroeder,

[3] Website: https://sac.nifdc.org.cn.

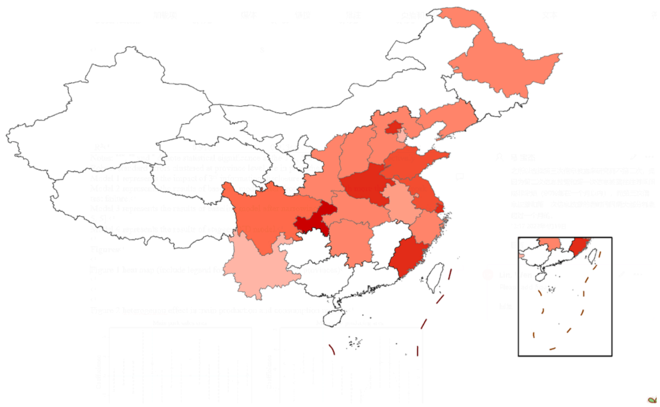

Fig. 1. Provinces in the treatment group.

2002; Neill and Chen, 2021) or food safety events (Arnade et al., 2009; Schlenker and Villas-Boas, 2009) as indicators of food safety related information, and almost at the same time the Center for Disease Control and Prevention identified and announced health risks associated with consuming these unsafe foods. For example, Toledo and Villas-Boas (2019) examined how contaminated egg recalls and related safety information (Salmonella infections) affect egg sales. In our case, the information reveals whether a pork product passed the safety tests and why it failed (if failed), without any follow-up information such as health consequences. This could make the information difficult for the public to interpret, hampering its dissemination.

Last and remarkably, the differences underlying food supply chains between developing and developed countries could also potentially contribute to the moderate treatment effect. Food suppliers in developed markets tend to be large-scale and concentrated which would lead to system-wide impacts (Ma and Lusk, 2021), while small-scale food supply chain actors dominate in developing countries. Approximately 75 % of agricultural products in China have been supplied by a large number of small-scale wholesale markets (Ren and An, 2010). Diseconomies of scale implies that a low traceability adoption rate in China's agricultural supply chain. A prior survey on Chinese agricultural traders suggests only 30 % have adopted traceability (Jin et al., 2021b). Once a seller's product was discovered to be unsafe, products from the same source would be recalled and confiscated by the local market regulation administrator, according to the Food Safety Laws. But in reality, limited traceability adoption makes product recalls difficult, causing little supply shocks.

3. Data

Our study investigates whether and how government disclosure of unsafe pork affects pork market prices. We combine two datasets, one related to pork prices, and the other pork safety information disclosure. First, pork price data refers to city-level and weekly wholesale prices of pork products, constructed using the National Agricultural Products Price Database. The database, supported by the Chinese Ministry of Agriculture, covers China's major wholesale markets of agricultural products (Ruan et al., 2021). Second, pork safety information disclosure refers to the records of safety sampling tests conducted and announced by the Chinese Central and Provincial Administration for Market Regulation. Each sampling test record includes whether or not a product fails the safety test, the sampling date and location, information announce date and the source of the product. Regarding pork products, approximately 90 % of the safety test failures in our sample are attributable to the abuse of additives and antibiotics. To match the pork safety records to wholesale price information, we exclude the records (i) whose sampling location is not at wholesale markets, (ii) the pork is not sourced from wholesale markets. Meanwhile, to avoid confounding effects of Asian Swine Flu and Covid-19 on pork prices, observations on two periods, namely 2018 August to 2019 March, and 2019 December to 2020 March (Delgado et al., 2021; Ruan et al., 2021), are dropped from our sample. In addition, other datasets are combined and used to conduct heterogeneous analyses of our treatment effects, including the China city statistical yearbook, China public health statistical yearbook, and fiscal investment on food safety regulation available at the official websites of the provincial Administration for Market Regulation.

Finally, we obtained a city-level and weekly panel dataset, with a time span from January 2018 to March 2021, and 103 prefecture-level cities in 26 provinces of China. Cities in our sample accounted for over 53 % of China's GDP in 2018. Fig. 1 illustrates provinces that have announced pork safety test failure, with darker red denoting more safety failure announcements.

4. Empirical strategy

We used the event study method to investigate the dynamic effects of disclosure of pork sampling test results on pork wholesale prices. The model specification can be expressed:

$$lny_{cw} = \alpha_0 + \sum_{j=-5}^{10} \beta_j D_c \times treat_{cw}^{j} + \mu_c + \mu_w + \tau_{py} + \tau_{cy} + \varepsilon_{cw} \tag{1}$$

where c denotes city, p is province, w is week, and y means year. lny_{cw} is the pork price of city c in week w in log form. The key variables include a series of dummy variables: D_c is a dummy variable that equals to 1 when city c belongs to the treatment group, that is, city c disclosed pork safety test failure(s) in our study period, and 0 otherwise; $treat_{cw}^{j}$ is also a dummy indicator, with a value of 1 if week w is j weeks after the disclosure of pork safety test failure(s) in city c, and zero otherwise. In the case that j is negative, it means that | j | weeks before the information disclosure. To illustrate, treat_{cw}^{-5} equals to 1 if week w is at least 5 weeks prior to the information disclosure week in city c, and treat_{cw}^{9} if week w is 9 weeks following the disclosure of pork safety test failure(s) in city c. The parameters, β_j, govern the causal effect of the disclosure of pork safety test failure(s) on pork prices, which are the focus of our study. When $j < 0$, we would expect β_j to be not significantly different from zero. Intuitively, this implies that there has no systematic differences in pork prices between the treatment and control groups prior to the information disclosure intervention, which underlies the validity of our identification strategy. β_{-1} is omitted from equation (1) such that the information treatment effects are relative to one week before the information disclosure. When $j = 0$, β_0 denotes the immediate impact of the information disclosure on pork wholesale prices; β_j, if $j > 0$, denotes such effect in a j-week lag.

We also included several control variables in equation (1), such as city fixed effect (μ_c), week fixed effects (μ_w), province by year fixed effects (τ_{py}), and city by year fixed effects (τ_{cy}). μ_c captures time-invariant city specific effects on pork prices, including pork production condition and consumption habit; and μ_w captures the weekly trends of pork prices that are common across all cities, such as holiday week. τ_{py} and τ_{cy} are considered in equation (1) to account for confounding factors that vary by year and province, year and city respectively, for example, annual GPD per capita and annual population in each province or city. ε_{cw} denotes random error terms unobservable to researchers.

Several robustness checks were conducted to guard our findings. First, cities may announce pork safety test failure for several times, but only the first disclosure would be considered for equation (1). If the time interval between announcements is close, β_j, if $j > 0$, is potentially overestimated. This is because estimated β_j includes not only the impact of the first disclosure of unsafe pork, but also that of the succeeding disclosure. We investigated how the succeeding information disclosure affects pork prices for relevant cities. Second, we estimated equation (1) with j ranging from −5 to 5, which allows us to explore whether our

Table 1
Average treatment effects of government information disclosure on pork prices.

	Model 1	Model 2	Model 3
β_{-5}	0.003	−0.020	−0.033
	(0.024)	(0.018)	(0.023)
β_{-4}	−0.007	−0.034	−0.036
	(0.028)	(0.022)	(0.024)
β_{-3}	0.007	−0.012	−0.015
	(0.033)	(0.027)	(0.030)
β_{-2}	0.019	−0.004	−0.006
	(0.043)	(0.038)	(0.040)
β_0	0.016	0.012	0.014
	(0.022)	(0.022)	(0.022)
β_1	−0.012	−0.013	−0.012
	(0.023)	(0.022)	(0.023)
β_2	−0.013	−0.014	−0.007
	(0.025)	(0.024)	(0.023)
β_3	−0.057**	−0.066**	−0.050**
	(0.026)	(0.027)	(0.026)
β_4	−0.030	−0.061*	−0.040
	(0.038)	(0.034)	(0.028)
β_5	0.025	−0.001	0.006
	(0.033)	(0.026)	(0.025)
β_6	−0.019	−0.044	−0.033
	(0.042)	(0.035)	(0.038)
β_7	0.029	0.005	0.013
	(0.038)	(0.033)	(0.034)
β_8	−0.026	−0.053**	−0.051**
	(0.033)	(0.026)	(0.025)
β_9	−0.044	−0.066**	−0.055*
	(0.035)	(0.032)	(0.032)
β_{10}	−0.016	−0.044*	−0.017
	(0.027)	(0.023)	(0.016)
Week FE	Yes	Yes	Yes
City-Year FE	No	No	Yes
Province-Year FE	No	Yes	No
City FE	Yes	Yes	Yes
Observations	8,492	8,492	8,492
R^2	0.912	0.916	0.930

Note: ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Robust standard errors clustered at province level are in parentheses.

results are robust to different event windows. Last, given the fact that a minority of the sample has reported multiple pork safety test failures, we use the De Chaisemartin and d'Haultfoeuille (2020) estimator (DIDM) to obtain unbiased estimates of dynamic treatment effects.

5. Results

In discussing our empirical findings, we first focus on the average treatment effect of government disclosure of food safety information on pork wholesale prices, followed by the spillover effect results and robustness checks.

5.1. Impact of food safety information disclosure on pork prices

Table 1 reveals the average treatment effects of government disclosure of food safety information on pork wholesale prices. In the table, Model 1 controls for week and city fixed factors that affect pork prices, Model 2 builds on Model 1 by including province-by-year fixed effects, and Model 3 adds to Model 1 with city-by-year fixed effects. The coefficients, β_j, when $j < 0$, across different model specifications, are close to zero and are not statistically significant. This suggests no systematic differences in pork wholesale prices between the treatment and control groups prior to the government information disclosure about unsafe pork products. As Model 3 performs best in terms of goodness of fit, we refer to this model when discussing the baseline results.

Several points can be made from the estimation result of Model 3. First, cities that have failed pork safety tests experienced pork wholesale price drops after such information was made public by governments, though the coefficients are significant at the level of 5 %. Second, local wholesale prices in the treatment group didn't decrease immediately after the information disclosure. Instead, the local pork prices declined two weeks later. The coefficient, $\widehat{\beta_3}$ equals −0.05, indicating that the information disclosure significantly decreases pork prices by 5 %, relative to the control group.

Table 2
Spillover Effects of government information disclosure.

	All neighboring cities	Neighboring cities within province	Beef prices
β_{-5}	0.005	0.019	−0.006
	(0.064)	(0.049)	(0.021)
β_{-4}	0.046	−0.018	−0.026
	(0.067)	(0.047)	(0.028)
β_{-3}	0.054	0.010	−0.007
	(0.072)	(0.037)	(0.026)
β_{-2}	0.042	0.051	0.000
	(0.054)	(0.036)	(0.039)
β_0	0.004	0.038	0.014
	(0.076)	(0.048)	(0.025)
β_1	−0.009	0.026	−0.012
	(0.061)	(0.043)	(0.025)
β_2	0.050	0.044	−0.009
	(0.069)	(0.047)	(0.028)
β_3	−0.042	−0.074*	−0.055*
	(0.079)	(0.043)	(0.031)
β_4	−0.022	−0.097*	−0.060*
	(0.070)	(0.053)	(0.032)
β_5	−0.016	0.030	0.006
	(0.061)	(0.048)	(0.029)
β_6	0.010	0.013	−0.042
	(0.056)	(0.044)	(0.034)
β_7	−0.009	0.027	0.015
	(0.057)	(0.052)	(0.029)
β_8	−0.117*	−0.053	−0.039
	(0.066)	(0.045)	(0.035)
β_9	0.002	−0.018	−0.059
	(0.069)	(0.043)	(0.037)
β_{10}	−0.020	0.009	−0.038
	(0.068)	(0.044)	(0.023)
Week FE	Yes	Yes	Yes
City-Year FE	Yes	Yes	Yes
Province-Year FE	No	No	No
City FE	Yes	Yes	Yes
Observations	8,492	8,492	8,492
R^2	0.913	0.916	0.750

Note: ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Robust standard errors clustered at province level are in parentheses.

5.2. Spillover effects on nearby cities and non-pork products

Table 2 indicates the estimation results on the spillover effects of pork safety information disclosure. Column (1) in Table 2 concerns how pork safety information disclosure affects pork prices of all cities adjacent to the treatment group, while column (2) focuses on the adjacent cities within the province. If a city announced the safety test failure of pork products, the average wholesale pork price of the city's all neighboring cities will experience a drop of nearly 12 % in the 8th week, although the coefficient is marginally significant. The estimated spillover effects become stronger when restricting neighboring cities to be in the same province as the treated cities, and on average, among these adjacent cities, pork wholesale prices declined 7 % and 10 % in the second and third weeks after the event, respectively. Column (3) in Table 2 reports the estimation results about how pork safety information disclosure affects wholesale prices of other meat products, namely beef. We chose beef prices for several points. Ideally, chicken prices, instead of beef prices, would be investigated as chicken is found to be a major substitute for pork in China (Ma et al., 2021). But chicken prices in our

Table 3
Robustness Checks.

	(1)	(2)	(3)	(4)
β_{-5}	0.022	0.001	−0.020	
	(0.043)	(0.032)	(0.020)	
β_{-4}	0.010	−0.007	−0.034	
	(0.059)	(0.046)	(0.036)	
β_{-3}	0.059	0.029	−0.012	
	(0.059)	(0.036)	(0.025)	
β_{-2}	0.039	−0.017	−0.004	
	(0.063)	(0.071)	(0.031)	
β_0	0.035	0.009	0.013	
	(0.061)	(0.052)	(0.024)	
β_1	0.047	0.021	−0.013	
	(0.058)	(0.045)	(0.022)	
β_2	0.046	0.013	−0.014	
	(0.059)	(0.037)	(0.026)	
β_3	0.041	−0.063*	−0.067***	
	(0.064)	(0.033)	(0.017)	
β_4	−0.126**	−0.032	−0.061	
	(0.064)	(0.067)	(0.042)	
β_5	−0.050	0.042**	−0.042**	
	(0.061)	(0.016)	(0.014)	
β_6	0.058	−0.020		
	(0.067)	(0.063)		
β_7	−0.064	0.025		
	(0.067)	(0.046)		
β_8	−0.018	−0.033		
	(0.069)	(0.029)		
β_9	0.017**	−0.033*		
	(0.008)	(0.024)		
β_{10}	0.004	−0.052		
	(0.045)	(0.029)		
did_{cw}				−0.021**
				(0.009)
Week FE	Yes	Yes	Yes	Yes
City-Year FE	Yes	Yes	Yes	Yes
Province-Year FE	No	No	No	No
City FE	Yes	Yes	Yes	Yes
Observations	8,492	6,789	8,492	8,492
R^2	0.916	0.913	0.916	0.750

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors clustered at the province level are in parentheses.

dataset are not feasible for such analysis. On the other hand, beef is the fastest-growing meat consumed in China surpassing the demand growth of pork, and beef consumption per capita in China reached 8.5 lb in 2019 (Lin et al., 2022). It reveals that government disclosure of pork safety information decreased local beef prices by approximately 6 % three and four weeks later, despite that the estimated effect is of marginal statistical significance.

5.3. Robustness checks

In this subsection, we adopt the three aforementioned approaches to guard the estimated treatment effects of government disclosure of food safety information, whose results are presented in Table 3. First, in the benchmark, we explore the impact of the first disclosure of pork safety information during our study period. But pork safety test failure(s) could happen more than once in a city within our sample period.[4] This implies that our baseline results are likely to be confounded by the second and third disclosure of pork safety test failure(s). To rule out such a possibility, we focus on a subsample where cities had announced pork safety test failure at least three times and then investigate how the third disclosure of pork safety failure affects local pork prices (Column (1) of Table 3). Results reveal that the effect of the third disclosure ($\widehat{\beta_4} = -0.12$) largely parallels that of the first disclosure of pork safety test failure, which is discussed in the baseline results subsection. Besides, we generate another subsample where the cities announced one and only one pork safety test failure in our dataset, and re-estimated Model (3) in Table 1. The estimated treatment effects, shown in Column (2) of Table 3, are robust. Second, we test whether our baseline results are sensitive to the study time window specified in the event study. We adopted the specification of Model (3) in Table 1 but shorten the post-event time window (Column (3) of Table 3). The result indicates that the announcement of pork safety test failure dropped pork wholesale prices three and five weeks later, at a rate of about 5 %. Third, we also explore whether the baseline results remain robust to model specification by using a staggered difference-in-difference approach. Results in column (4) of Table 3 suggest that the estimated treatment effect of pork safety information disclosure on pork prices is about −2.1 % at a 5 % significance level, which is again consistent with our previous findings.

[4] Over 80% of the cities announced one and only one pork safety test failure in the sample period, and less than 10% of the cities announced pork safety test failure three times.

Table 4
Effects of government information disclosure: main pork production versus consumption subsamples.

	Main pork production	Main pork consumption
β_{-5}	−0.022	0.030
	(0.034)	(0.032)
β_{-4}	0.020	−0.067
	(0.039)	(0.044)
β_{-3}	−0.007	0.037
	(0.048)	(0.026)
β_{-2}	0.038	−0.007
	(0.115)	(0.031)
β_0	0.063*	0.041
	(0.029)	(0.033)
β_1	−0.055	−0.025
	(0.046)	(0.032)
β_2	0.040	−0.059*
	(0.057)	(0.034)
β_3	−0.037	−0.100**
	(0.058)	(0.038)
β_4	0.005	−0.161***
	(0.048)	(0.026)
β_5	0.073	−0.044*
	(0.067)	(0.025)
β_6	−0.029	0.036
	(0.054)	(0.062)
β_7	0.011	0.032
	(0.085)	(0.060)
β_8	−0.023	−0.090
	(0.036)	(0.064)
β_9	−0.034	−0.121**
	(0.065)	(0.052)
β_{10}	0.007	−0.041**
	(0.034)	(0.019)
Week FE	Yes	Yes
City-Year FE	Yes	Yes
Province-Year FE	No	No
City FE	Yes	Yes
Observations	6,017	5,266
R^2	0.916	0.923

Note: ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Robust standard errors clustered at the province level are in parentheses.

6. Heterogeneity

In this section, we investigate several heterogeneity that could explain the information treatment effects on pork wholesale prices documented in Section 4. Changes in pork prices depend on the ways that information shifts pork demand versus pork supply. Thus we examine the roles of (i) supply chain position, (ii) information accessibility, and (iii) information salience. We note that our goal is not to disentangle and quantify the impact of each role, but instead, we investigate whether a particular force has bite.

6.1. Supply chain position

Wholesalers in main pork production areas are at a larger scale than those in main consumption areas (Xie et al., 2020), whose average registered capital is two million RMB higher (self-calculated based on the Chinese enterprise registration dataset by the year 2021). Larger vendors and those close to farms in the supply chain have lower transaction costs in obtaining traceable information, resulting in higher adoption of traceability (Zhou et al., 2022). When a wholesaler failed a pork safety test, her pork product will be confiscated, causing a supply decline for large-scale wholesalers common in major pork production regions. Thus we expected the information treatment effects on pork prices to be mainly driven by reduced pork supply among main production cities, while this supply channel would be limited for main consumption cities. The estimation results were derived from the estimation of Model 3 in Table 1 using the main pork production and consumption sub-samples, respectively. We generated the sub-samples based on the 2019 hog production action plan by the Ministry of Agriculture and Rural Affairs of China.[5] In the plan, cities in Sichuan, Henan, Shandong, Hunan, and Yunnan provinces belong to the main pork production areas, including 37 % of the national pork production in 2019. Beijing, Tianjin, Shanghai, and cities in Fujian, Zhejiang, and Guangdong provinces were taken as the main consumption regions, whose pork consumption occupied 24 % of China's pork consumption in 2019 (National Bureau of Statistics of China, 2021).

Table 4 presents the information treatment effects of main pork production cities versus main pork consumption cities. Food safety information disclosure yields differentiated influences on pork wholesale prices between major pork production and consumption subsamples. Expectedly, the information effects on major pork production cities are driven by a reduction in pork supply. Among cities located in major hog production regions, $\widehat{\beta_0}$ equals to 0.063 at a 5 % significance level, meaning that they experienced immediate and significant wholesale pork price increases, at a rate of 6 % when pork products at or from local wholesale market failed sampling tests and the failure was announced. In contrast, the information disclosure causes a significant decline in pork prices of the main pork consumption subsamples, which would be attributed to negative pork demand shocks. For example, $\widehat{\beta_3}$ and $\widehat{\beta_4}$ equal to −0.10 and −0.161, respectively, with at least a 5 % significance level, indicating that after being affected by the safety information disclosure, pork prices for cities who are pork net buyers were 10 % and 16 % lower than the control group, during the third and fourth weeks, respectively. The downward trend in pork prices was mitigated following the 4th week ($\widehat{\beta_5} = -0.04$), but rebounded in the 9th week ($\widehat{\beta_9} = -0.12$). This somewhat parallels the previous results using the full samples.

6.2. Information accessibility

To examine formally whether information accessibility could be one explanation for the estimated average treatment effects, we separated our sample into subgroups with high and low internet penetration rates. Internet penetration rate[6] was used to proxy information accessibility because all results of food safety sampling tests have been first published on the Administration for Market Regulation's websites. Note that all cities in the main consumption subsample were identified to have high internet penetration levels. Table 5 illustrates the estimation results using the high and low information accessibility subsamples. Cities having better access to information, experienced over 7 % pork price drop after the failure of the pork safety test was announced, which is slightly higher than the average treatment effect (5 %). This however fails to hold for the low information accessibility subgroup, whose estimated information treatment effects were statistically insignificant.

Table 5
Effects of government information disclosure: different internet penetration rate subsamples.

	High internet penetration	Low internet penetration
β_{-5}	−0.014	−0.026
	(0.022)	(0.029)
β_{-4}	−0.033	−0.023
	(0.029)	(0.044)
β_{-3}	−0.017	−0.005
	(0.036)	(0.033)
β_{-2}	0.020	−0.115
	(0.039)	(0.088)
β_0	0.014	−0.011
	(0.021)	(0.086)
β_1	−0.008	−0.055
	(0.026)	(0.070)
β_2	−0.020	0.011
	(0.032)	(0.018)
β_3	−0.076**	−0.007
	(0.033)	(0.054)
β_4	−0.073*	−0.035
	(0.042)	(0.044)
β_5	−0.021	0.057
	(0.031)	(0.034)
β_6	−0.071	0.078
	(0.042)	(0.049)
β_7	0.007	−0.006
	(0.040)	(0.025)
β_8	−0.046	−0.067
	(0.035)	(0.048)
β_9	−0.102**	0.077
	(0.038)	(0.059)
β_{10}	−0.049**	0.035
	(0.023)	(0.070)
Week FE	Yes	Yes
City-Year FE	Yes	Yes
Province-Year FE	No	No
City FE	Yes	Yes
Observations	5,450	2,875
R^2	0.932	0.904

Note: ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Robust standard errors clustered at the province level are in parentheses.

6.3. Information salience

In addition to information accessibility, the extent that consumer awareness and attention would affect information treatment effect through information salience. We examined whether market awareness and attention to food safety information could be another explanation for our moderate estimated treatment effects. People in places with high incidence already have experience with foodborne diseases, and the unpleasure experience made them more responsive to food safety information (Kariuki and Hoffman, 2021). To do so, we used the case of foodborne diseases to reflect market awareness and attention as food safety incidents in China have pushed consumers to become more aware of food safety information (Liu and Niyongira, 2017). We generated two subsamples with high and low incidences of foodborne illness, taking the median incidence per capita of the sample as a cutoff. Per capita incidence controls for population size's impact on total cases of foodborne illness. Estimation results between high and low foodborne illness incidence subgroups were presented in Table 6. We find that among cities with more cases of foodborne illness, government disclosure of

[5] See the document at the official website:https://www.moa.gov.cn/gk/zcfg/qnhnzc/201912/t20191206_6332872.htm.

[6] The internet penetration rate was calculated following Shi et al. (2022). Cities above and below the median internet penetration rate were grouped in to the high and low internet penetration subsamples, respectively.

Table 6
Effects of government information disclosure: different incidence of foodborne illness subsamples.

	High incidence	Low incidence
β_{-5}	−0.005	−0.004
	(0.037)	(0.055)
β_{-4}	−0.001	−0.021
	(0.038)	(0.071)
β_{-3}	−0.048	0.028
	(0.053)	(0.071)
β_{-2}	0.002	0.023
	(0.060)	(0.075)
β_0	0.025	−0.006
	(0.024)	(0.072)
β_1	−0.037	0.019
	(0.029)	(0.074)
β_2	−0.027*	−0.016
	(0.014)	(0.075)
β_3	−0.081***	−0.026
	(0.024)	(0.078)
β_4	0.008	−0.086
	(0.051)	(0.076)
β_5	0.032	0.014
	(0.045)	(0.071)
β_6	−0.025	−0.023
	(0.065)	(0.069)
β_7	0.004	0.045
	(0.042)	(0.071)
β_8	−0.013	−0.056
	(0.039)	(0.072)
β_9	0.021	−0.121
	(0.049)	(0.074)
β_{10}	0.011	−0.054
	(0.039)	(0.056)
Week FE	Yes	Yes
City-Year FE	Yes	Yes
Province-Year FE	No	No
City FE	Yes	Yes
Observations	3,774	4,715
R^2	0.931	0.907

Note: ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Robust standard errors clustered at province level are in parentheses.

food safety information significantly decreased pork prices by 2.7 % and 8.1 % in the second and third weeks after the event, respectively. Oppositely, the information disclosure was ineffective in the other subgroup.

We also explored whether the information treatment effects are heterogeneous between cities with strong and weak capabilities and resources on food safety regulation (Table 7). The capability and resource are proxied by budgetary expenditure on food safety regulation (Ma and Liu, 2019). For cities with more food safety regulatory resources, local governments may invest more in information disclosure and salience. Again, the median fiscal expenditure per capita was used to split the data into two subsamples. 42 cities fell in the high fiscal expenditure subgroup including Shanghai, Beijing, and those in Sichuan and Yunnan provinces, while 61 cities from Inner Mongolia, Anhui, Henan and Shandong and other provinces belong to the low expenditure subsample. Table 7 reveals that, within cities rich in food safety regulatory resources, pork wholesale prices dropped almost 10 % after the pork test failure has been announced, relative to the control group. The safety information has yet to exert insignificant impacts on pork prices for cities having relatively weak food safety regulatory resources.

7. Discussions and conclusions

Using an event study approach and a city-level weekly panel dataset including pork wholesale prices and pork safety test outcomes, this study investigates how government disclosure of food safety information affects market outcomes, in particular, market prices. We focus on the largest developing market, China, and a nationwide food safety information disclosure program. No other studies have examined *actual* market responses to food safety information disclosure based on developing markets. Our findings contribute to the understanding of the effectiveness of information-based food safety regulation and have policy implications for other developing countries facing food safety issues.

Table 7
Effects of government information disclosure: different food safety regulatory resource subsamples.

	Strong regulatory resource	Weak regulatory resource
β_{-5}	−0.041	−0.001
	(0.040)	(0.042)
β_{-4}	−0.006	−0.041
	(0.032)	(0.056)
β_{-3}	0.015	−0.020
	(0.035)	(0.057)
β_{-2}	−0.026	−0.000
	(0.067)	(0.060)
β_0	−0.021	0.053
	(0.034)	(0.057)
β_1	−0.008	−0.013
	(0.033)	(0.057)
β_2	−0.002	−0.033
	(0.048)	(0.058)
β_3	−0.095**	−0.041
	(0.053)	(0.059)
β_4	−0.091*	−0.015
	(0.046)	(0.059)
β_5	−0.015	0.028
	(0.047)	(0.060)
β_6	−0.069	−0.027
	(0.051)	(0.056)
β_7	−0.013	0.024
	(0.057)	(0.057)
β_8	−0.016	−0.081
	(0.038)	(0.057)
β_9	−0.075*	−0.057
	(0.044)	(0.058)
β_{10}	−0.066*	−0.026
	(0.039)	(0.042)
Week FE	Yes	Yes
City-Year FE	Yes	Yes
Province-Year FE	No	No
City FE	Yes	Yes
Observations	3,347	5,142
R^2	0.911	0.921

Note: ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Robust standard errors clustered at province level are in parentheses.

Results reveal that lagged price response to government disclosure of unsafety pork in China. Average pork wholesale prices began to decrease by 5 % two weeks after the information disclosure. Disclosure of unsafe pork has a limited spillover effect on local beef prices and on pork wholesale prices of neighboring cities unless the cities are restricted to be within the same province. Heterogeneity analyses indicate that the negative information effects on pork prices found in the main pork consumption cities are largely driven by negative pork demand shocks. Pork price reductions are more evident in the treated cities with higher information accessibility and salience, measured by internet penetration rate, the incidence of foodborne illness, and food safety regulatory resources.

Most of the findings are expected and align with existing literature. Negative and lagged price responses to food safety information are generally consistent with the exited studies (Dillaway et al., 2011), despite the small magnitude of our treatment effects. Possible reasons include reduced demand for pork products in the treatment group after the information about unsafe local pork was made available to the general public, which ultimately led pork prices to drop. Lagged treatment effects on pork prices may be explained by that it takes a while for wholesalers to learn and respond to the safety information disclosure by governments, thus negative shocks in pork demand would not appear promptly. Besides, significant pork price decreases have been seen in eight and nine weeks after the information disclosure, which is potentially caused by further dissemination of food safety information among wholesale market actors, such as non-local traders. The spatial spillover effects of pork safety information disclosure are more evident for cities within the province. This is in part consistent with Toledo and Villas-Boas (2019) who showed that the recalls of contaminated eggs in Northern California reduced egg sales in Southern Californian stores as well. In addition to spatial spillovers, we also test for product spillovers and show that government disclosure of pork safety information decreased local beef prices by approximately 6 % three and four weeks later, despite the estimated effect being of marginal statistical significance. The observed beef price drop may be driven by consumers' overall safety concern about meat products, which is triggered by pork safety test failure.

In assessing the heterogeneous effects of public disclosure of food safety information, we find evident pork price decreases in main pork consumption cities, which could be explained by at least two points. First, cities in the main pork consumption subsample, such as Beijing, Shanghai, and Tianjin, are more developed and urbanized than almost all other parts of China. People in these cities have better access to information and stronger abilities to interpret the information. On the other hand, pork wholesalers in these cities sell products to retailers, restaurants, and educational facilities (Reardon, 2015), who are direct pork buyers and may be more attentive to food safety information, relative to their counterparts (pork traders) in main hog production areas. Secondly, the effect of government disclosure of food safety information on pork wholesale prices is almost led by the high information accessibility subsample, instead of the low information accessibility subsample. This is in line with the previous results showing that the effectiveness of red meat warnings depends on individual exposure to and interpretation of information (Carrieri and Principe, 2022). Thirdly, within cities rich in food safety regulatory resources, pork wholesale prices dropped almost 10 % after the pork test failure was announced, relative to the control group. However, the safety information fails to exert significant impacts on pork prices for cities having relatively weak food safety regulatory resources. One plausible explanation is that cities with greater food safety regulatory resources may allocate more investment to information disclosure and visibility. Consequently, this could lead to an enhanced responsiveness of the wholesale market to food safety information and then a more evident drop in pork prices. This is in part consistent with the finding by Zhou et al. (2022) that government disclosure of food safety information promoted traceability adoption among agricultural producers, especially in cities with more regulatory resources.

In light of our findings, this study highlights the importance and necessity of extending the research focus to emerging agricultural markets using actual market data and also has important policy implications for regulating food safety in developing countries whose food safety issues are evident and urgent. First, our results imply that the Chinese government's disclosure of food safety information is, to some extent, useful, as the program significantly reduces pork wholesale prices by approximately 5 % (although the price response is lagging). Effective food safety information-based regulation crucially depends on whether and how the market responds to that information. Our baseline result highlights that a potential policy instrument for tackling food safety problems in developing countries for public policymakers is to invest in food safety information collection and disclosure.

Second and admittedly, the magnitude of our average treatment effects is not substantial, indicating that there is potential for enhancing the effectiveness of government food safety disclosures in developing economies like China.[7] Given the substantial financial and personnel resources allocated in food safety sampling tests and their result disclosure in China, a more efficient allocation of public resources that improves social welfare would be warranted. To this end, our heterogeneous analyses inform several possible avenues. For informational public policy to be effective, information disclosure alone is insufficient; ensuring accessible and interpretable information is at least equally important, which probably has more implications for developing rather than developed markets. The effect of government disclosure of food safety information on pork wholesale prices is mainly driven by the high information accessibility subsample, relative to the low information accessibility subsample. This echoes a recent study showing that 52 % of food suppliers including wholesalers, processors, and retailers didn't know where to find food sampling test results, and this ratio increased to 80 % among household consumers (An, 2020). Together this implies inefficient use of food safety information due to limited market awareness and attention. Furthermore, enhancing public understanding of food safety test outcomes could not be ignored. In our study, the disclosed information specifies whether a pork product passed or failed safety tests, but lacks follow-up details on health consequences which might hinder public comprehension and dissemination.

It is worth noting that our results suggest that when one pork wholesaler was disclosed to fail pork safety sampling tests, the pork price in the city where the wholesaler was located declined. This implies that the information disclosure imposes a negative externality on other pork wholesalers within the city, suggesting a collective reputation for food safety in developing markets (Bai et al., 2021; Adalja et al., 2022). Without government interventions to address this externality, pork wholesalers would engage in free-riding behavior with regard to food safety, potentially leading to market failures. To internalize the externality, governments in developing markets are encouraged to disclose more details in a more significant place, for example, to put a warning label at the front of the failed pork wholesaler. Meanwhile, more actions need to be taken to push food supply chain players to adopt traceability or even blockchain traceability systems and to have third-party quality certifications. A caveat on our findings is that they could be contingent on the use of the product, i.e. pork, and of wholesale prices. Future research should test the robustness of our findings to variations in these contexts, including testing our spillover effects on chicken prices whenever the data becomes feasible.

Financial disclosure statement

This work was supported by the National Natural Science Foundation of China (No. 72103180, 72273128).

CRediT authorship contribution statement

Wen Lin: Writing – review & editing, Writing – original draft, Validation, Resources, Conceptualization. **Baojie Ma:** Writing – review & editing, Visualization, Software, Investigation, Formal analysis. **Jiangyuan Liang:** Writing – review & editing, Investigation. **Shaosheng Jin:** Writing – review & editing, Project administration.

[7] A reviewer kindly suggests us to distinguish between inadequate information exposure and a weak response to enough information. While we acknowledge the merit of this suggestion, we believe the suitable approach would be a randomized field experiment involving two groups of wholesale markets with varying levels of information exposure. However, this is currently outside the scope of our study.

Table A
Descriptive statistics.

Variable	Unit	Level	Observation	Mean	S.D
Pork prices (*yuan/kg*)	Yuan/kg	Market-Week	8492	28.18	12.36
Beef prices (*yuan/kg*)	Yuan/kg	Market-Week	8492	67.51	8.63
Number of pork test failure		Market-Week	8492	0.05	0.10
Internet penetration (%)	%	City-Year	349	36.70	19.50
Budgetary expenditure on food safety regulation	Million yuan	Province-Year	93	22.59	19.09
Case of foodborne disease	10,000 persons	Province-Year	93	0.32	0.23

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.

Appendix

Table A.

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