

The Regional Determinants of Food Safety in China: Evidence from Popular Media

Nicholas Holtkamp¹
Peng Liu²
William MCGUIRE³

¹ The Ohio State University, holtkamp.6@buckeyemail.osu.edu

² Renmin University School of Public Policy, liupeng1031@gmail.com

³ University of Washington Tacoma, wmcguire@uw.edu

Abstract

China's food safety system is characterized by widespread under-enforcement of regulations punctuated by high-profile food safety scandals. While there has been a wave of public and scholarly interest, official data on food safety are scarce, and some fundamental questions remain unanswered. Our analysis attempts to overcome this problem using a unique data set compiling media reports on food safety incidents at the provincial level between 2004 and 2011. Preliminary results indicate food safety problems are most acute in poor provinces, where regulators are understaffed and underfunded. Food safety problems also increase with the rate of urbanization, which may reflect the increased complexity of urban food systems. Finally, we find that food safety is sensitive to government expenditures, suggesting that increasing the allocation of fiscal resources to regulatory agencies may be effective in combating China's food safety crisis.

Introduction

China's food safety system faces a unique set of challenges due to the country's size, resource constraints and the institutional legacies of its socialist past. The result is widespread under-enforcement of regulations punctuated by high-profile food safety scandals. Such was the case in 2008, when high levels of melamine in milk products poisoned around 300,000 consumers in China, killing six infants (Pei et al., 2011). This incident sparked a wave of popular and academic interest in China's food safety system, as well as policy reform.

Recent scholarship has identified poor institutional design and local fiscal resource constraints as major obstacles to effective food safety enforcement in China. These problems create opportunities for regulatory capture and reduce the incentives for local regulators to enforce national standards (Ni and Zeng, 2009; Li, Qi and Liu, 2010). These issues persist despite evidence that Chinese consumers would be willing to pay more for safer food. Ortega et al. (2012) found that pork consumers were willing to pay an additional 3.5 RMB for 250mL of milk if it were certified "safe" by the government. Similarly, Zhang et al. (2012) found positive willingness to pay for government certification in China for pork, milk and cooking oil. Wang et al. (2008) found that Chinese consumers were also willing to pay a 5% premium for dairy products certified under the voluntary Hazard Analysis Critical Control Point (HACCP) management system. This suggests Chinese consumers do not believe the current regulatory framework is capable of keeping tainted food products off the market.

Despite this scholarly interest in China's food safety, much of the existing literature has been qualitative and case-study based. Due in large part to a lack of publically-available data, no study has yet provided an empirical analysis of the regional variation in food safety risk in China. This study represents the first attempt to identify the determinants of food safety risk

using data on a panel of Chinese provinces. Using panel data sourced from media reports between 2004 and 2011, we test several hypotheses derived from the existing qualitative and case-study literature on food safety in China. While the nature of the data pose several methodological challenges, we believe this represents an important first step toward a more objective and regionally comprehensive look at the determinants of food safety in China.

Background

Liu (2010) describes the evolution of the food safety system in China, beginning with the foundations first laid following the formation of the People's Republic of China in 1949. At this time, China's food safety system borrowed heavily from the Soviet model. Food safety fell within the purview of *weisheng fangyi zhan* (WFZs), or sanitation and anti-epidemic stations. These agencies emphasized disease control rather than food inspection, but their efforts were complemented by the close ties between industry and government during China's socialist period. The control various government ministries had over industrial production allowed the government to maintain some control over food production standards.

Reforms in the late 1970s and early 1980s led to the rapid growth of food processing and manufacturing plants outside the control of the state. This period also demonstrated the inadequacy of China's socialist institutions for monitoring food safety in the face of a rapidly-growing private food sector. Passage of the Food Hygiene Act in 1983 empowered the Ministry of Health to oversee food hygiene nationwide, but the efficiency of the food hygiene system was undercut by ambiguities in the law. For instance, WFZs were put in charge of food safety inspection, but were not empowered to take administrative action against violators. There was also significant fragmentation of control over the food system as industrial ministries sought to retain control over key areas of food production.

After 1993, the state effectively withdrew from the food production sector and solidified control over food safety through third-party regulatory agencies. Today, food safety efforts are coordinated by the State Council Food Safety Commission (SCFSC), established in 2009. This agency works with other government bodies to control every aspect of the food safety system from agricultural production to food catering and restaurants. In addition to economic and judicial sanctions, regulators in China increasingly leverage technical standards, public disclosure and risk evaluation techniques to raise food production and handling standards.

However, some scholars argue these reforms have not gone far enough to address food safety risk in China. Li, Qi and Liu (2010) argue the new institutional arrangement does not provide the SCFSC with sufficient control over the various food agencies in China. While SCFSC oversees the food safety system, actual enforcement is divided among five different agencies: the Ministry of Agriculture (primary food production), the General Administration of Quality Supervision, Inspection and Quarantine (food processing and production), the State Administration of Industry and Commerce (food distribution), the State Food and Drug Administration (retail food consumption), and the Ministry of Health (overall coordination and assessment). Significant overlap exists in these agencies' mandates, and enforcement efforts are often complicated by competing claims of jurisdiction. The authors also argue the close ties between business interests and these agencies could lead to regulatory capture, undercutting the credibility and effectiveness of the entire food safety system. Bai et al. (2007) point out that, despite the large number of agencies involved in food safety, the system still lacks the necessary resources to enforce national standards. Inspectors are forced to allocate relatively small budgets to focus on large and medium-size firms, ignoring the nearly 70% of China's food enterprises that employ 10 workers or less.

The weakness of China's food safety system is highlighted by the substantial regional variation observed in the enforcement of food safety standards. As detailed in Liu (2012), the greatest difference can be seen by comparing China's rural and urban food safety systems. Institutional differences between rural and urban areas have been a hallmark of China's "dual track" development approach since 1949. Using the rapidly urbanizing Changping district of Beijing as an example, Liu (2012) explains that rural food safety bodies are often merely "guided" by their district level counterparts, unlike urban areas where district-level administrators exercise strict control. This generally leads to less reliable enforcement of food safety standards in rural areas.

Rural areas are also put at a disadvantage due to their lower level of economic development. Generally speaking, rural food safety agencies lack the highly trained and educated personnel employed in urban areas. They also have very little financial support from fiscal budgets. Rural food safety agencies largely cover expenditures with "extra-budgetary" fees, opening the door to corruption and bribery. Liu (2012) also argues this rural-urban divide may also reflect the different communities that rural and urban food safety agencies serve. Despite its reputation as an authoritarian state, Chinese policymakers must be responsive to public pressure, especially in an area as sensitive as food safety. Rural residents may consider food safety a lower priority due to their low incomes. This would be consistent with the observed positive correlation between income and willingness to pay for food safety in the empirical literature (Zhang et al., 2012; Ortega et al., 2011).

Increasing national concern over food safety is closely tied to the increased visibility of food safety incidents in digital as well as traditional media. According to Lum (2006), access to the internet is especially important in China because it provides a way for social activists in

circumvent blackouts in the government-controlled media. Increasing media coverage makes food safety issues more visible to Chinese citizens, as well as scholars, and may actually play some role in resolving the crisis. Increasing access to digital media and the internet may make it more difficult to cover up food safety scandals, and perhaps else pressure regulators to allocate more resources to enforcing food safety standards.

Methodology

We will attempt to explain regional variation in food safety using variation in provincial-level variables suggested by the existing literature. Where ideal measures of our variables of interest are not available, we will generally employ reasonable proxies drawn from China's provincial statistical yearbooks. The analysis presented below will leave open many questions of identification, but represents an important step towards understanding what drives variation in food safety across provinces.

Data Description

Measuring Food Safety

We measure food safety incidents using data from *Zhichuchuangwai's Food Safety Database*, a database of mainland Chinese news articles covering food safety incidents that occurred in mainland China between January 7, 2004 and May 31, 2011.⁴ The database was compiled by Wu Heng, at the time a graduate student at Fudan University, and a team of volunteers in 2011. The database includes 2107 articles that the team collected from an already existing database, *Yiyuanshijie's* "Safety Bulletin," and through popular online news portals, such as *Souhu*, *Baidu*, and *Renminwang*. Articles were included in the database if they (1) could be traced to a verified print source, and (2) the reported incident pertained to "poisoned

⁴ Does not include Macau and Hong Kong.

food.” Once an article was validated, the team recorded key information, such as the type of food safety incident, food product(s) involved, and the location and date of the incident. To construct our dataset, we simply used the information provided by *Zhichuchuangwai* to specify the total count of reported incidents in each province in each year.⁵

Figure 1 shows the mean and standard deviation of reported food safety incidents across provinces during the period covered by the survey. The figure shows that there has been a great deal of variation in the frequency of reported incidents over time as well as among provinces in a given time period. The figure suggests a declining rate of reported incidents between 2005 and 2010, ending with a surge in reported incidents in the final year of the survey. The figure also shows fairly large standard deviations in 2005 and 2011, the years with the highest number of reported incidents. This suggests a large part of the variation over time is driven by a large number of incidents in a small number of provinces.

While official data are difficult to find, we were able to gather a small sample of official reported incidents from various provincial yearbooks. The sample was small (n=84), and they do not provide us with a complete time series for a given province or a full cross-section in a given year. Nonetheless, we compare them to our reported food safety incidents in Figure 2. Figure 2 shows a simple scatter plot of the number of reported vs. official food safety incidents, after winsorising the data to reduce the influence of the three largest outlying observations. Casual inspection suggests a positive relationship between the two series, but with large dispersion. Table 1 presents the results of two simple regressions of official incidents on reported incidents to further explore the correlation between the two. Column 1 shows the results for a two-way fixed effect estimator. The results indicate a significant and positive

⁵ For the purposes of the following analysis, incidents reported in multiple provinces were counted toward each affected province’s total incidents for that year.

relationship between reported and official incidents, with a 1% increase in reported incidents corresponding to a 0.13% increase in official incidents. Column two shows the results from a fixed effects negative binomial estimator for the same relationship. These results show no significant relationship between the reported and official incidents. The results of this simple regression analysis suggest that reported incidents have some power to predict official incidents, though a substantial gap exists between the two. In Figure 3, we plot this gap in each year for each province. This illustrates two interesting features of the reported data: First, the reported data tend to underestimate the official data, as suggested by the estimated elasticities in Table 1. Second, the gap between the official results and the reported results appears to narrow over time. All together, these results make us cautiously optimistic that reported incidents can be used as a reasonable proxy for actual food safety incidents, when official data are not available. However, analysts employing these data will have to think carefully about what might drive variation in reported incidents independent of variation in actual food safety incidents.

Explanatory Variables

The existing literature on food safety in China suggests that regional variation is largely driven by the capacity of local regulators to enforce China's national food safety laws. Where enforcement is weak, it can often be attributed to poorly-trained staff and low budgetary funds for inspection and enforcement. It is difficult to find comprehensive regional data on the budgetary resources available to China's myriad food inspection agencies. However, China's National Bureau of Statistics does publish data on total government expenditures by province. We were unable to isolate the portion of these funds allocated to food safety enforcement, but they will give us some sense of the total resources food safety enforcement (as well as other) agencies had to enforce standards at the provincial level

The existing literature also points to the role of China's dual rural-urban regulatory regime in driving variation in food safety across provinces. Rural food safety regulators are typically given more flexibility in the enforcement of food safety standards. They also face higher regulatory transaction costs due to lower population densities, and typically have fewer professional staff. Based on this, we might expect an inverse relationship between food safety incidents and the urbanization rate. However, urban food systems are often more complex. Urban households are more likely to consume processed foods and food prepared away from home. This might actually make food safety incidents *more* likely in urban areas.

Another obvious candidate for an explanatory variable is the per capita real gross regional product (RGRP) of each province. Controlling for the level of government expenditures, food safety might be greater in more developed provinces due to higher quality regulatory institutions, higher levels of education, and also a higher willingness to pay for safe food among the more affluent local consumers. RGRP is taken from the provincial statistical yearbooks and deflated using province-specific price indices.

As shown in Figure 3, there is a large gap between the reported and official number of food safety incidents. Some of this gap may simply be due to the level of media access within a province. Some provinces may report more incidents simply because they have more media outlets. We control for this using per capita rates of newspaper circulation, color TV ownership, and internet usage. At the same time, we cannot exclude the possibility that more media scrutiny affects the underlying frequency of food safety incidents. Regulators may be more willing to enforce food safety standards if they know scandals are more likely to be reported to the public.

Absent publicly-available official data on the emergence of food safety incidents in China, Wu Heng's database provides a unique opportunity for scholars to perform independent analysis of China's food safety issues. Unfortunately, the nature of the data presents a substantial identification problem. Some portion of the variation shown in Figure 1 likely represents variation in underlying food safety risk. However, a large part of the variation is also likely due to variation in media penetration across provinces, and country-wide variation in popular attention paid to food safety over time. Identifying variation in the underlying food safety risk requires controlling for these confounding factors.

Model Specification

We estimate a random effects tobit model of food incidents per capita. This allows us to control for population as a potential confounding variable, as well as control for panel-level unobservables that might be correlated with reported food safety incidents and our explanatory variables. Recognizing the tobit model's sensitivity to assumptions of normality, the dependent variable used in model estimation is a log transformation of the original (and highly skewed) measurement of incidents per capita.

In each model, we control for the potential spurious effects of media access on reported incidents using total newspaper circulation per capita, color televisions per household, and the number of internet users per capita. In order to test our the hypotheses laid out above, we also regress the log of reported incidents per capita on RGRP per capita, the urbanization rate, and real provincial government expenditures per capita. As explained above, the urbanization rate might capture the competing effects of superior regulatory institutions and the more complex urban food system. We attempt to identify these separately by including a separate measure of the share of total food expenditures by urban households in one model specification. In a

separate specification, we also decompose GRP into its primary, secondary and tertiary components to see if the composition of GDP has any effect on food safety, independent of its level. We have argued in a previous paper (Liu and McGuire, 2013) that food safety enforcement is more difficult in regions where regulators must monitor food consumption as well as agricultural production and processing. Interviews with regulators have also revealed evidence of strategic under-enforcement in regions reliant on agricultural production because of concerns over potential negative effects on GRP growth. Every specification also includes year fixed effects (not reported) to control for unobservables constant across provinces but varying over time. After cleaning the data and eliminating observations with missing data, we are left with a maximum sample size of 208.

Results

Estimation results for the random effects tobit model are presented in Table 2. Values in parentheses are p-values calculated using bootstrapped standard errors. The first column includes our three measures of media access as well as the urbanization rate and RGRP per capita. The estimated coefficients on our measures of media access are all positive, with only the estimated coefficient on color TV ownership being insignificant at the 10% level. These coefficient estimates and significance levels are fairly robust across model specifications, and we are able to reject the null of their joint insignificance in each of our specifications at the 10% level. The estimated coefficient on the urbanization rate is also positive and significant at 10% level. The coefficient estimate implies that a one percentage point increase in the urbanization rate leads to an increase in reported incidents of approximately 5%. The estimated coefficient on the log of RGRP per capita is negative and significant at the 5% level, implying a one percent increase in RGRP per capita leads to a 1.27% decrease in reported food safety incidents.

Finally, the estimated coefficient on total provincial government expenditures is negative and significant at the 10% level, implying a one percent increase in government expenditures is associated with a 0.67% decrease in reported food safety incidents.

The second column adds the share of urban households in total food expenditures as an explanatory variable to try to isolate the effect of the size of the urban food system, which might otherwise drive the positive relationship between urbanization and food safety incidents. The estimated coefficient on the urban share of food expenditures is not significant, and the estimated coefficient on the urbanization rate appears unchanged. GRP per capita is still negatively correlated with reported incidents per capita, though the level of significance has dropped. The estimated coefficient on government expenditures is essentially unchanged.

In column 3, we introduce the share of primary industry in GRP to see if the composition of provincial output affects food safety risk. The estimated coefficient on the share of primary industry is negative, but insignificant at the 10% level. The sign and significance of the estimated coefficients on real GRP per capita, the urbanization rate, and the level of government expenditures per capita are essentially unchanged.

Discussion

While the empirical analysis supports some of the conclusions drawn from the qualitative literature on food safety in China, the reliance on reported as opposed to realized food safety incidents is problematic. There is likely to be a great deal of variation across provinces in terms of the proportion of realized incidents that are reported. We attempted to control for this by including measurements of media access as well as year fixed effects and province random effects in every specification. The tobit model results indicate that these controls do capture

some of the variation in reported incidents, which strengthens our argument that the other estimated coefficients capture variation in food safety risk.

The robust negative relationship with total government expenditures per capita supports the hypothesis that some part of the observed variation in food safety reflects the budgetary resources available to local regulators. Well-funded agencies can hire more skilled personnel and keep them on full time. They, therefore, experience a lower overall level of food safety risk. Without the ability to directly measure the budgetary and extra-budgetary resources of food safety regulators, we cannot exclude the possibility that total government expenditures are simply correlated with some other omitted factor. We also acknowledge that the level of spending is not exogenous to the underlying food safety risk.

We also find a fairly robust negative relationship between GRP per capita and food safety incidents. Controlling for the level of government expenditures, this may be because consumers in regions with higher GRP likely have a higher willingness to pay for safe food. Regions with higher GRP may also enjoy higher quality regulatory institutions. Finally, GRP may also correlate with technological differences among food processors and retailers, which would have important implications for food safety risk. While this result conforms with our prior expectations, additional work is needed to clarify this relationship.

We encounter similar problems interpreting the estimated coefficients on the urbanization rate. The existing literature suggests that urban areas enjoy a better structured and better funded regulatory structure. Regional inspection offices are more closely watched by central administrators, and inspection staff are more highly skilled and better compensated for their work. However, the positive coefficient estimates on the urbanization rate suggests that urban areas are at higher risk to experience a food safety incident. As with GRP per capita, this

urbanization rate may reflect differences in the consumption baskets of consumers. Urban households buy more processed food and consume more food away from home, potentially creating more opportunities for food to become tainted. Our attempt to control for this using the share of urban expenditures in total food expenditures was unsuccessful. Food safety incidents may also be observed more frequently in urban areas simply because they are under more scrutiny by regulators. It will be important to control for these other factors in future iterations of this work.

Conclusions

This study is the first to empirically examine the regional determinants of food safety in China using a full panel of provinces. While a great deal of qualitative and case-study work has been done, it is clear that more rigorous empirical analysis is needed to explore the problem in detail. Drawing on the existing literature, we examined the role that regional differences in urbanization, GRP, and provincial government expenditures have on the frequency of food safety incidents. While the results generally conformed to our expectations, future work should focus on developing a more rigorous identification strategy.

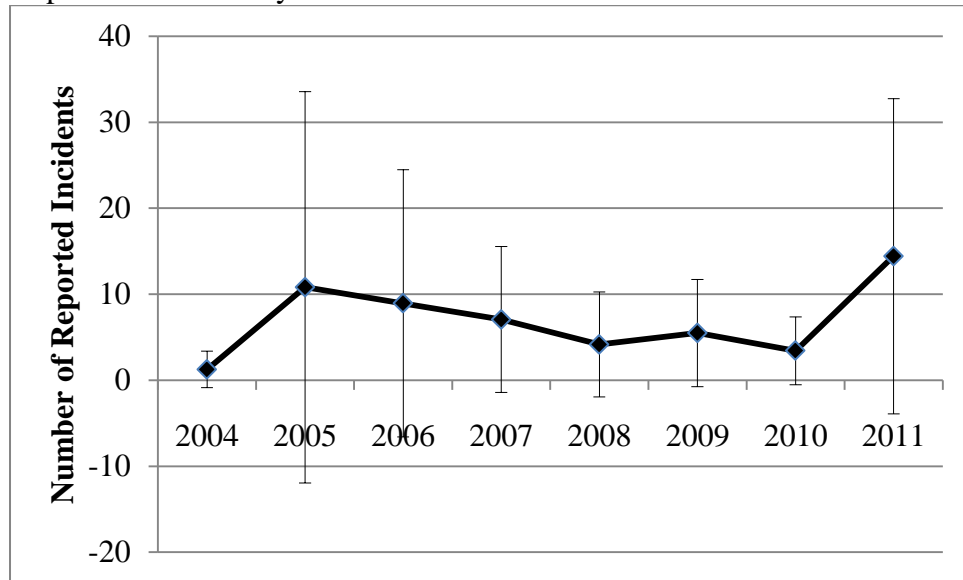
Since regional data on food safety incidents is not publically available, these results depend on a unique database recording reported food safety incidents across provinces between 2004 and 2011. A central problem in the analysis is to distinguish the likelihood of a food safety incident from the likelihood a realized incident is reported. We attempted to control for this by including measurements of media access as well as year and province effects in our regressions, but additional work is needed to address this problem.

Overall, our results support the argument that more developed provinces, which have better funded regulatory bodies, enjoy a higher degree of food safety. Surprisingly, food safety

incidents appear to be more frequent in more urbanized provinces. This may be because urban food systems are more complex, thus creating more opportunities for food to become tainted. These conclusions should be interpreted with caution. These data are likely subject to a great deal of measurement error, and we cannot exclude the possibility of bias due to endogeneity problems. Still, this work represents an important first step toward a more rigorous, empirical analysis of China's food safety crisis. It also demonstrates that the publically-available data gathered from media reports has some utility in doing serious academic work. We hope future work in this area will continue to test the hypotheses proposed in qualitative and case-study work, with increased focus on empirical identification strategies.

Appendix

Figure 1
Reported Food Safety Incidents



Note: The error bars show one standard deviation above and below the mean number of reported incidents in a given year.

Figure 2
Reported vs. Official Food Safety Incidents

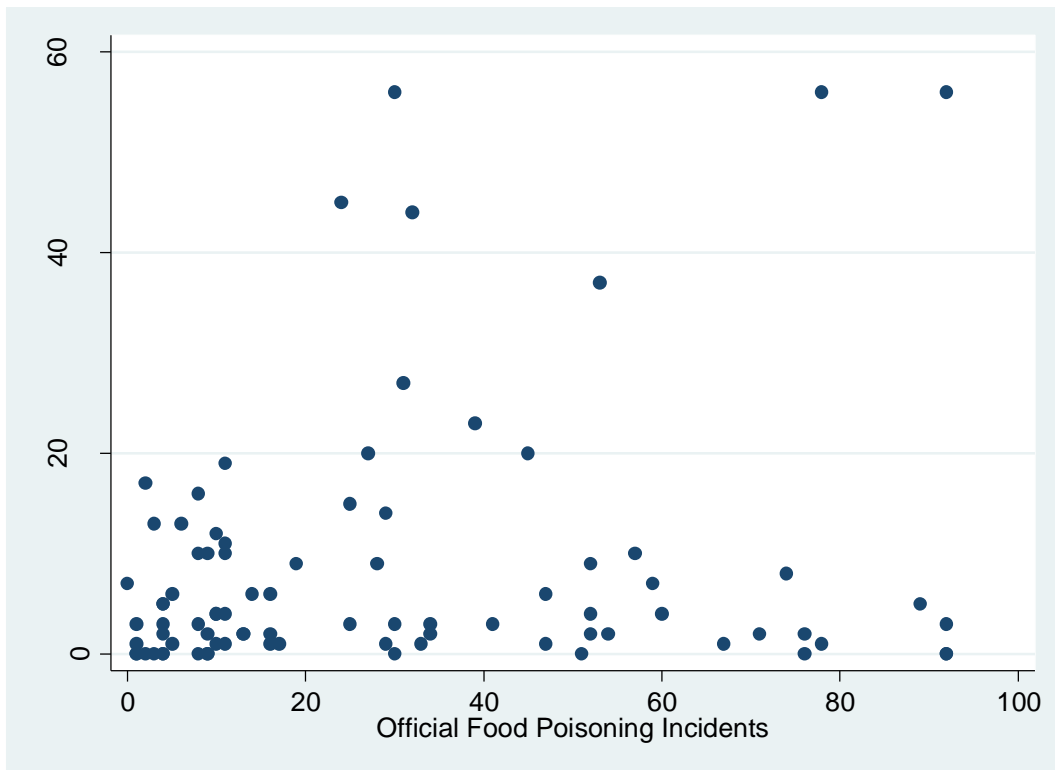


Figure 3
Gap Between Reported and Official Incidents

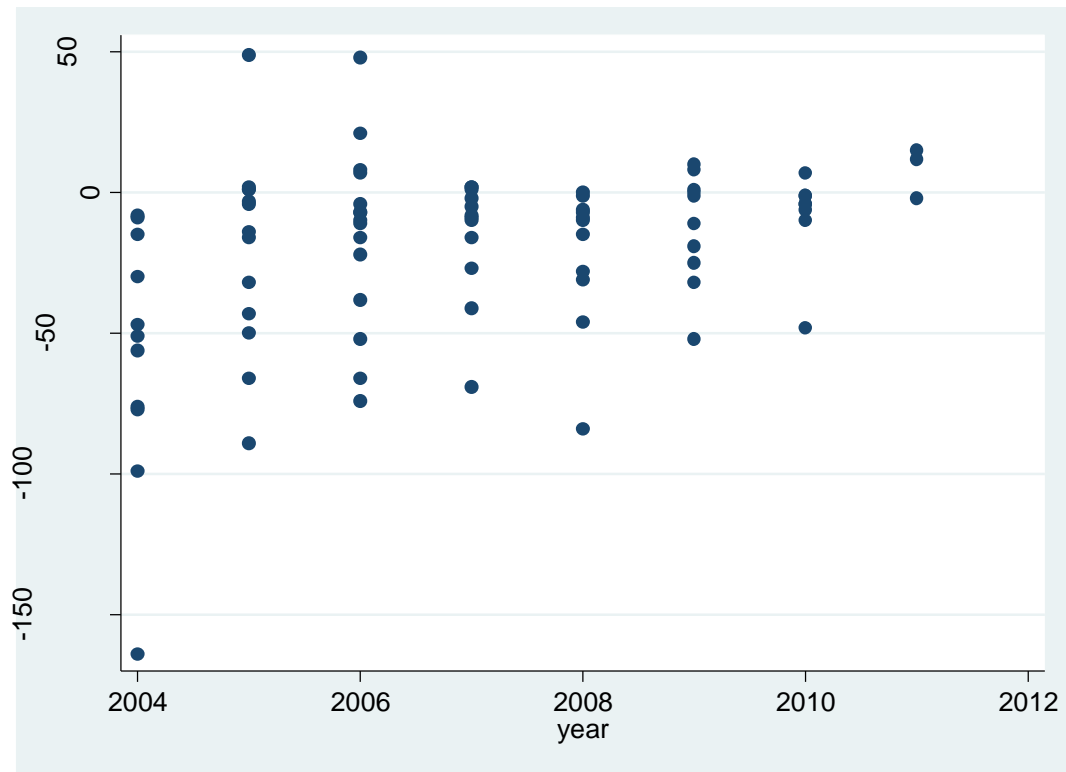


Table 1
 Reported vs. Official Food Safety Incidents

	(1) TWFE	(2) Negative Binomial
Reported Food Safety Incidents	[0.13]** (0.02)	[0.02] (0.60)
Observations	84	83
R-squared	0.38	.
Wald p>chi2	.	0.00
Province FE	Yes	Yes
Year FE	Yes	Yes

*** p<0.01, ** p<0.05, * p<0.1

Values in brackets are elasticities.

Values in parentheses in Column 1 calculated using robust std. errors

Values in parentheses in Column 2 calculated using bootstrap std. errors

Table 2
Random Effects Tobit

DV= Log Reported Incidents per Capita	(1)	(2)	(3)
Log Total Newspaper Circulation per Capita	0.60* (0.09)	0.58 (0.13)	0.61 (0.12)
Log Color TVs per household	1.48 (0.11)	1.81* (0.07)	1.54 (0.17)
Log Internet Users per Capita	0.99* (0.07)	0.91* (0.09)	0.98* (0.06)
Urbanization Rate	0.05*** (0.01)	0.05*** (0.01)	0.05*** (0.01)
Urban Food Share		-0.66 (0.35)	
Log GRP per Capita	-1.27** (0.05)	-1.19* (0.10)	-1.23* (0.07)
% Primary in GRP			0.53 (0.92)
Log Government Exp. per Capita	-0.67* (0.05)	-0.73** (0.04)	-0.66 (0.13)
Province RE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Wald $p > \chi^2$	0.00	0.00	0.00
LR Test vs. Pooled	0.04	0.04	0.05
Observations	208	208	208
Censored Obs.	40	40	40

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

P-values in parentheses calculated using bootstrapped standard errors

References

- Li, Y., R. Qi and H. Liu. "Designing Independent Regulatory System of Food Safety in China." *Agriculture and Agricultural Science Procedia*. 1 (2010), 288-295.
- Liu, P. "Tracing and Periodizing China's Food Safety Regulation: A Study on China's Food Safety Regime Change." *Regulation & Governance*. 4 (2010). 244-260.
- Liu, P. "One Country, Two Regimes: An In-depth Case Study from Changping to Explain Dual regimes in China's Food Safety Regulation During its Urbanization Process." *Working Paper*. (2012)
- Lum, T. *Social Unrest in China* (RL33416) [Electronic version]. Washington, DC: Congressional Research Service. (2006) <http://digitalcommons.ilr.cornell.edu/crs/19/>
- Ni, H. and H. Zeng. "Law Enforcement is Key to China's Food Safety." *Environmental Pollution*. 157 (2009). 1990-1992.
- Ortega, D., H. Wang, N. Olynk, L. Wu and J. Bai. "Chinese Consumers' Demand for Food Safety Attributes: A Push for Government and Industry Regulations." 94 (2012), 489-495.
- Zhang, C., J. Bai and T. Wahl. "Consumers' Willingness to Pay for Traceable Pork, Milk, and Cooking Oil in Nanjing, China." *Food Control*. 27 (2012). 21-28.
- Liu, P. "Tracing and Periodizing China's Food Safety Regulation: A Study on China's Food Safety Regime Change." *Regulation & Governance*. 4 (2010). 244-260.
- Pei, X., A. Tandon, A. Alldrick, L. Giorgi, W. Huang and R. Yang. "The China Melamine Milk Scandal and its Implications for Food Safety Regulation." *Food Policy*. 36 (2011), 412-420.
- Wang, Z., Y. Mao and F. Gale. "Chinese consumer Demand for Food Safety Attributes in Milk Products." *Food Policy*. 33 (2008). 27-36.
- Zhang, C., J. Bai and T. Wahl. "Consumers' Willingness to Pay for Traceable Pork, Milk, and Cooking Oil in Nanjing, China." *Food Control*. 27 (2012). 21-28.