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Drivers of Food Safety Adoption among Food Processing Firms

A Nationally Representative Survey in Ghana

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Abstract

Globally, food system transformation is characterized by the increasing importance of food safety and quality standards for consumers. This trend is challenging for the food processing sector in Ghana, which is dominated by micro and small firms. This study investigates the factors influencing the adoption of food safety practices and the effect of such adoption on the profitability of nationally representative food processing firms in Ghana using instrumental variable approach and matching techniques. The study uses nationally representative data for 511 food processing firms. The data show few food processing firms (20 percent) have adopted food safety practices. Wide diversity of firms was observed, and firm size, firm age, registrations, trainings, processing activities, types of buyers, and number of distinct products explain the differing firm adoption of food safety practices. We also find that adopters of food safety practices earn more per month than do nonadopting firms, implying the presence of economic incentive to adopt food safety practices. Support in terms of food safety awareness and training to food processing firms can help improve adoption of food safety practices.

Keywords: food safety, food processing, firm performance, Africa

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1. Introduction

Food safety is a growing public concern in both developing and developed countries. Factors contributing to the growing demand for safer foods globally include an increasing knowledge of food-borne diseases; improper agricultural practices; poor hygiene at all stages of the food value chain, including food processing and handling; misuse of chemicals, drugs, and antibiotics; and contaminated raw materials, ingredients, and water (Hassan et al., 2006; FAO and WHO, 2003). The food production chain has become more complex with urbanization, providing greater opportunities for contamination along the chain. Food processing and value addition have also been expanding and are fueling agricultural transformation in developing countries and inclusive global value chains, but these add another layer of potential risk for food contamination. Compliance with and adoption of food safety and quality standards are critical for the success and sustainability of these food industries. Regulations and market-based factors, including voluntary adoption of food standards, are among the strategies available to achieve food safety in agro-processing. Both have been more challenging to developing countries, where regulatory enforcement capacity is weak and resources are limited. Few studies look at the status and processes of adoption of food safety standards among food processing firms or at how these firms ensure consumers' confidence in the safety of the food they eat in the context of weak regulatory enforcement.

In this paper, we assess the status of adoption of food safety standards using a unique nationally representative sample of food processing firms in Ghana. The paper aims to contribute to the small body of literature utilizing large samples of food processing firms to analyze their adoption of food safety practices. There is current debate on the cost and benefits of food safety standards adoption. On the one hand, several studies highlight compliance costs that can be prohibitive to many small-scale producers and processors (Ragasa et al. 2011a, 2011b; Kumar et al. 2017; Yapp and Fairman 2006). On the other hand, some studies show the economic benefits of food safety adoption through price premiums and consumer confidence (Kumar et al. 2017). Ragasa et al. (2011b) analyze compliance costs for seafood processing firms in the Philippines. Kumar et al. (2017) examine compliance with food safety practices among smallholder dairy farmers in India, whereas Kumar et al. (2016) analyze the adoption of food safety measures for milk production in Nepal and its impact on smallholder farm-gate prices and profitability. Herath et al. (2017) analyze the adoption of food safety and quality controls in the Canadian food processing sector considering firm characteristics; Arpanutud et al. (2009) analyze the factors influencing food safety management system adoption in Thai food manufacturing firms; Mensah and Denyse (2011) examine the implementation of food safety management systems among food manufacturing enterprises in the United Kingdom. Aside from those studies, there is little research on this topic due to the difficulty of collecting and accessing firm-level data (Yapp and Fairman 2006). By utilizing a nationally representative large sample of food processing firms in Ghana, this paper adds to the emerging literature in the context of developing countries, particularly those in Sub-Saharan Africa, and covers a wider range of food and industry types.

This study investigates two issues using different estimation methods. First, we analyze the determinants of food safety adoption among food processing firms. We specifically investigate the role of firm characteristics and trainings in explaining the adoption of food safety practices. Second, to gauge firm incentives and financial returns from improving food safety, we measure the effect of food safety adoption on firm performance measured in terms of monthly firm profit and firm growth rate. We use a nationally representative dataset of 511 food processing firms operating in Ghana in 2017.

The food processing sector in Ghana plays an important role in the economy. Rising household incomes and increasing urbanization have resulted in higher demand for processed foods and greater consumer willingness and capacity to pay premiums for safe foods (Andam et al., 2015; Andam et al., 2018; Ragasa et al., 2019). Omari et al. (2018) show that the majority of the sample respondents in Accra were either extremely or very worried about food hazards and risks, and that most of these risks are related to the food processing stage. Nonetheless the weak regulatory regime in Ghana makes implementation and enforcement of regulations and standards challenging.

We investigate the interplay of these factors in the case of the sample food processing firms. The findings of the study are expected to assist policymakers, national and international agencies to formulate policies and programs to promote safe foods in the food processing value chain. The remainder of the paper is organized as follows. Section 2 summarizes Ghana's policies and regulations on food safety. Section 3 discusses the conceptual framework, estimation strategy, and data sources. Section 4 presents the results, and Section 5 concludes.

2. Ghana's food safety policies and regulations

The public discourse on food policies in Ghana has recently expanded to include food safety. The Ministry of Health and relevant ministries, departments, and agencies (such as the Ministry of Food and Agriculture; Ministry of Trade and Industries; Ministry of Environment, Science and Technology; Ministry of Local Government and Rural Development; Ministry of Education; the National Development Planning Commission; and other partners) play different roles to ensure safer foods are consumed in the country (MOH, 2013).

Several pieces of legislation governing food safety in Ghana exist; they include legislation governing food and drugs, legislation governing standards, legislation governing health and safety of animals and animal products, and legislation controlling pests that affect plants and plant products. The relevant governing laws for food safety in Ghana include the Public Health Act, 2012 (Act 851); Food and Drugs Act, 1992 (P.N.D.C.L. 305B) as amended; the Tourism Act, 2011 (Act 817); and the Local Government Act, 1993 (Act 462). The Food and Drugs Authority (FDA) is the national regulatory body mandated under Act 851 to provide and enforce standards to ensure the safety and wholesomeness of food sold to consumers. FDA's roles include inspection of food manufacturing and processing sites, licensing, product registration, and monitoring. In addition, it also provides guidelines in relation to food hygiene practices and training for food handlers. In accordance with the provisions of Act 851, FDA has developed guidelines for the licensing of food service establishment (FDA/FSMD/GL-FSE/2013/02) and a code of hygienic practice (FDA/FSMD/CP-FSE/2013/03) to ensure hygienic practices for the preparation, packaging, distribution, storage, and sale of food for human consumption. To ensure compliance, FDA conducts inspection of the food processing site until the firm meets the required standards. Challenges remain, however, because the food processing sector is dominated predominantly by micro, small, and medium-scale firms that operate in the informal sector (Owoo and Lambon-Quayefio, 2017).

The major constraints to the implementation of food safety regulations include institutional challenges such as poor coordination in harmonizing the roles of various institutions, thus leading to inefficiencies; limited infrastructure such as laboratories; outdated or lack of resources and expertise to detect hazards and assess their risk. In addition, the large share of informal sector actors within the food value chain have limited knowledge of standards and regulations on good food safety practices (Omari et al. 2018; Ragasa et al. 2019). Recognizing these challenges, Ghana has developed a National Food Safety Policy aimed at establishing and maintaining an integrated farm-to-fork food safety system that ensures consumer safety (MOH, 2013). Despite the presence of the National Food Safety policy document, the regular food inspection and monitoring system is limited in its ability to assess food safety.

The adoption of food safety practices among food processing firms may be largely driven by external and internal factors (Cobanoglu et al., 2013). Externally, firms may meet legal requirements or respond to the needs of their customers; internally, they may improve operations by minimizing errors, waste, and cost of production. In this paper, we investigate these potential factors in the case of food processing firms in Ghana.

3. Conceptual framework and estimation strategy

3.1. Drivers of food safety adoption

The adoption literature can be used to model a firm's decision to adopt food safety practices based on expected profit gain. Studies by Karshenas and Stoneman (1993) indicate that a firm's adoption of a new technology will depend on firm characteristics, the number of other adopters, and the firm's position among other adopters. In this study we aimed to determine the factors—including firm characteristics, type of activities and products, location, and trainings—influencing the decision of food processing firms to adopt food safety practices and the effect of adoption on firm performance. We model the adoption decision based on a utility maximization framework. We assume that a utility-maximizing firm opts for food safety adoption if the expected utility of adoption is higher than the expected utility of nonadoption. The unobserved net benefits underlying the food processing firm's decision process are modeled as

$$Y_i^* = \boldsymbol{X}_i'\boldsymbol{\beta} + \varepsilon_i, \qquad (1)$$

where Y^* describes the latent variable representing expected net benefit of food safety adoption by firm i, $\boldsymbol{X}$ is a vector of exogenous variables explaining the food safety decision, $\boldsymbol{\beta}$ is a vector of parameters to be estimated, and ε is a normally distributed error term with mean of zero and variance of one. The observable outcome of the binary choice problem is represented by a binary indicator variable that is related to the unobserved dependent variable Y_i^*, as follows:

$$Y_i = 1 \; if \; Y_i^* > 0 \qquad (2)$$
$$Y_i = 0 \; if \; Y_i^* \leq 0 \qquad (3)$$

To provide a detailed analysis of whether or not the firm adopted food safety system, we applied a discrete choice probit model. In probit regression, the cumulative standard normal distribution function $\Phi(\cdot)$ is used to model the regression function when the dependent variable is binary, that is,

$$E(Y|\boldsymbol{X})=P(Y=1|\boldsymbol{X})=\Phi(\boldsymbol{X}'\boldsymbol{\beta}) \qquad (4)$$

where E is the expected value of Y (food safety adoption), P is the probability of observing $Y=1$, $\boldsymbol{X}$ is a vector of exogenous variables explaining the food safety decision, $\boldsymbol{\beta}$ is a vector of coefficients to be estimated.

3.2. The effect of food safety adoption on food processing firms' performance

We further explored the effects of food safety adoption on the performance of food processing firms by measuring two important indicators. Following Andam and Asante (2018), Sleuwaegen and Goedhuys (2002), McPherson (1996) and Evans (1987a; 1987b), we first measure firm growth in terms of the number of employees. Second, we measure the profitability of the food processing firm. Firm owners or managers are likely to adopt standard food safety practices only if positive net income margins are expected. Kumar et al. (2017) find that Indian and Nepalese dairy enterprises obtained higher prices by adopting food safety practices. Similarly, we expect food processing firms in Ghana that adopt food safety systems to see an increase in profits. To assess the effect of food safety adoption on food safety performance we follow same approaches adopted by Kumar et al. (2017). We ran a model, controlling for the firm characteristics as follows:

$$P_i = \alpha FS_i + \boldsymbol{\beta X} + \varepsilon_i, \qquad (5)$$

where P is the measure of firm performance (profits and firm growth), FS is the indicator for food safety adoption, α is the effect of food safety adoption on firm performance, $\boldsymbol{X}$ is the vector of exogenous variables affecting firm performance, $\boldsymbol{\beta}$ is a vector of parameters estimated, and ε is the error term and is assumed to be identically and independently distributed. In reality, however, the relationship between food safety adoption and performance indicators (firm growth and profit) could be interdependent; therefore, ε may not be necessarily identically and independently distributed. Adopting food safety practices is likely to increase firm growth and profits; as such, larger firms (employing more than 100 persons) and those with greater profits may be better disposed towards adopting a food safety system. Hence, estimating equation (5) with ordinary least squares could lead to biased estimates. To address this endogeneity issue (correlation between FS and ε), we employ an instrumental variable approach. An ideal instrumental variable should not correlate with the dependent variable in equation (5); however, it should be correlated with FS_i, the variable representing adoption of food safety. Additionally, the variable should not be from the vector of firm characteristics, $\boldsymbol{X}$. It is indeed hard to find an ideal instrument in this setting.

The instruments used for food safety adoption are training in food safety standards and the type of processing activity (simple versus complex). Simple processing refers to activities that do not involve the transformation of the raw material and involve cleaning, sorting, drying, winnowing, destoning, and freezing. Complex processing refers to activities the involve the transformation of the raw material, including peeling, de-husking, polishing, cutting, grinding, cooking, mixing, extruding, and packaging. We predict that simple processing and the related food safety measures are easy and inexpensive, whereas complex processing requires more complex food safety measures and more investment and therefore will likely discourage more firms from adopting food safety measures. Intuitively, training in food safety standards can directly affect food safety adoption and indirectly affect the performance of food processing firms except through the effect of food safety.

Various formal tests were conducted to ascertain the validity of the instruments. The minimum condition for these instruments to be valid is that they are sufficiently correlated with the endogenous variables (Verbeek 2004). This can be tested by estimating the first stage regression of the endogenous variable on the instruments used and performing an F-statistic test (Verbeek 2004). Stock and Watson (2003), also cited in Verbeek (2004), suggest that a minimum F-statistics of 10 is sufficient for validity. The first stage regression results are shown in Table 4 in the Results section. The F-statistic test result of the two instruments—training in food safety and simple processing—is 24.0, which confirms that these instruments are strongly correlated with the endogenous variables instrumented. The Sargan-Hansen test (i.e., joint null hypothesis is that the instruments are valid instruments or uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation) confirms that our instruments are valid. Moreover, Kleibergen-Paap Wald F-statistic (which is larger than the Stock and Yogo statistics for a 10% maximal Instrumental Variable (IV) size for valid instruments) also suggest that the instruments used are valid.

We use five estimation models that utilize instrumental variables: (1) two-stage least squared regression (2SLS); (2) three-stage least squared regression; (3) two-step generalized methods of moments (GMM); (4) limited-information maximum likelihood (LIML); and (5) control function (CF) approach. The 2SLS uses the predicted probabilities from the first-stage regressions (i.e., of adoption of food safety) as instruments in the second-stage regressions (i.e., firm performance). We further extended this estimation to a 3SLS following the approach by Adams, Almeida, and Ferreira (2009). In the first stage, we estimate a probit regression of the determinants of adoption of food safety including the instruments. In the second stage, we regress adoption on food safety on the fitted probability from the first stage and ***X***. In the third stage, we regress y on x and the fitted values of the second stage. This procedure is different from the "pseudo-IV" procedure of running an ordinary least squares regression of y on fitted probabilities from the first stage and x. In the latter case, consistency is not guaranteed unless the first stage is correctly specified, and the standard errors need to be adjusted (Adams, Almeida, and Ferreira 2009). This approach has several advantages. First, it takes the binary nature of the endogenous variable into account. Although the 2SLS consistency of the second stage does not hinge on getting the functional form right in the first stage (see Angrist and Krueger, 2001), 2SLS leads to biased estimates in finite samples and it is not known how misspecification in the first stage may affect this bias. Second, unlike some of the alternative procedures, it does not require the binary response model of the first stage to be correctly specified (Adams, Almeida, and Ferreira 2009). Third, although some regressors are generated in the first stage, the standard IV standard errors are still asymptotically valid (see, e.g., Wooldridge, 2002, 623, procedure 18.1).

The two-step efficient GMM estimator has advantages over the traditional 2SLS estimator by using optimal weighting, overidentifying restrictions of the model, and relaxation of the identically and independently distribution assumption (Baum et al. 2010). LIML is also known as the maximum-likelihood estimation of a single equation (endogenous variables and excluded instruments) and relaxes the identically and independently distribution assumption (Baum et al. 2010). The Stata software command ivreg2 is utilized for these estimators (see Baum et al. 2010).

Usually, CF approaches require fewer assumptions than instrumental variable approach and maximum likelihood, and CF methods are computationally simpler (Wooldridge, 2015). While CF is less robust compared to IV for linear models, CF produces more efficient results compared to IV for complicated models or those involving nonlinear models for the endogenous variable (Imbens and Wooldridge, 2007). Imbens and Wooldridge (2007) indicate that, for models nonlinear in parameters, the CF approach has been identified to offer distinct advantages. The CF method involves using the residuals from a reduced-form model of the factors influencing the adoption of food safety (equation (1)) and including them as covariate in the structural of profitability (equation (5)). The significance of the coefficient on the residual both tests and controls for correlation between FS and ε. The CF estimator solves the issues associated with endogeneity by adding the scalar to the model, which is generally much more precise than the IV estimator. We derive the generalized residual from a first-stage probit model for food safety adoption using the following formula (Ragasa et al., 2016; Imbens and Wooldridge 2007):

$$gr_{i2} = y_{i2}\lambda(Z_i\beta_2) - (1 - y_{i2})\lambda(-Z_i\beta_2), \qquad (6)$$

where gr_{i2} is the generalized residual, y_{i2} represents adoption of food safety and $\lambda(.)$ is the inverse mills ratio, expressed as the ratio of the standard normal density function and the cumulative standard normal distribution.

To check robustness, we use propensity score matching techniques to address selection bias and heterogeneity among the sample firms. Propensity score matching requires no assumption about the functional form in specifying the relationship between predictors and outcome variables. This study applies the propensity score matching technique proposed by Rosenbaum and Rubin (1983) as a treatment correction model to reduce self-selection bias, specifying nearest neighbor, kernel matching, and inverse probability weighting. Results are presented in Annex 2 and are largely consistent with main results in main text.

3.3. Data

The study is based on a field survey conducted during August and September 2017 in collaboration with the Ghana Statistical Service. In 2014, the Ghana Statistical Service conducted a census of all business establishments engaged in economic activities using a spatial sampling approach in which enumerators visited every fixed building within the country. Enumerators collected basic information including firm location and status of operations, respondent characteristics, production and sales, type of activity or subsector based on the UN Inventory of Classifications, number of employees, year of establishment, business registration, assets, and operating cost.

The survey targeted a national representative sample of 800 firms. We adopted a combination of random and purposive sampling techniques in selecting food processing firms from three strata. The first stratum includes the largest cities, Accra and Kumasi, with populations greater than 1 million. The first stratum was defined according to the concentration of food processing activities in urban areas (GSS, 2015). The second stratum involves six secondary cities (Cape Coast, Ho, Koforidua, Sekondi-Takoradi, Tamale, and Sunyani) with populations less than 1 million and greater than 100,000. The third stratum includes one district from each of the 10 administrative regions of Ghana, from all districts with more than 100 food processors listed in the 2014 survey. In addition to the geographical locations of the three strata, firm sizes were considered to ensure representation of all categories. Firm size classification used by the Ghana Statistical Service was adopted for the survey. Micro firms are those that employ 1–5 persons, small firms employ 6–30 persons, medium firms employ 31–100 persons, and large firms employ more than 100 persons. Because of underrepresentation in the food processors list, the research team oversampled the medium- and large-sized firms within each of the three strata. Table 1 provides the distribution of the sampled food processing firms by size. Overall, 73 percent are micro sized, 17 percent are small, 6 percent are medium, and 4 percent are large.

Table 1. Percentage distribution of firm sizes, by region

Region	Micro	Small	Medium	Large	Total
Western	6	1	0	1	8
Central	4	2	1	0	7
Greater Accra	25	3	0	1	30
Volta	4	1	0	0	5
Eastern	6	2	1	1	10
Ashanti	16	5	1	0	22
Brong Ahafo	2	2	1	0	5
Northern	4	1	2	0	8
Upper East	3	1	0	0	4
Upper West	3	0	0	0	3
Total	73	17	6	4	100

Source: Authors' estimates based on 2017 firm survey.

Though we targeted 800 firms, 511 firms were identified to be operating and 289 were not included in the analysis for various reasons. Among the 289 firms, 23 firms were not located by the survey team, 78 firms declined to participate in the survey, 14 firms postponed their interview dates until the survey period passed, 168 firms had exited the sector between 2014 to 2017, and 6 firms that were not profit-seeking ventures (religious groups or associations involved in food processing) were excluded. The questionnaire was administered to firm owners or managers and involved questions on firm characteristics, respondent characteristics, product and sales, and production inputs, and questions on closed business.

3.4. Measure of indicators

Our dependent variables of interest are adoption of a food safety system, firm growth, and profitability. The adoption of a food safety system (*food safety*) is based on whether the firm has a food safety certification (e.g., Hazard Analysis and Critical Control Points (HACCP), Good Manufacturing Practices (GMP)) or a documented food safety plan prepared specifically for the firm, has a documented food safety plan adopted from other firms, or has some food safety measures as posted and seen on premises based on the observations by the survey enumerators. Firms not having any of the above are referred to as nonadopters. The adoption rate of 20 percent suggests that the majority of food processing firms in Ghana do not have food safety measures they follow. Annex Table 1 presents the descriptive statistics of the variables used in the analysis and hypothesis in terms of their effect on food safety adoption and firm performance.

The *Firm growth* variable is measured in terms of the number of employees, following previous studies conducted by Andam and Asante (2018), Sleuwaegen and Goedhuys (2002), McPherson (1996), and Evans (1987a, 1987b). It measures the difference between the natural logarithm of current employment (as of June 30, 2017, before the time of survey) and initial employment (start of operation) divided by firm age as shown in the equation (7).

$$Firm\ Growth = \frac{\ln(current\ employment) - \ln(initial\ employment)}{Firm\ Age} \quad (7)$$

The average firm growth is 0.01, suggesting a very slow growth rate of 1 percent in the number of employees as food processing firms age. The variable *ln(gross profits)* measures the natural logarithm of the difference between the revenue and production cost per month in Ghanaian cedi. The average profit per month for food processing firms is 6.93 percent.

The explanatory variables for the determinants of food safety adoption practices and firm performance focus on respondent characteristics and firm characteristics. The firm characteristic variables include continuous variables such as age of the firm in 2017 (*firm age)*, the number of employees as of June 30, 2017 (*no. of employees*), the initial starting capital of the firm in thousand Ghanaian cedis (*initial capital*), and the number of products sold by the firm (*no. products*). These show complexity of the size and complexity of firm's experience and operations and are predicted to be positively associated with food safety adoption. The average age of the firm in 2017 was about 17 years, and the average number of persons employed was about 21. The average initial starting capital for a food processing venture is estimated at 101,979.00 cedi. On average, firms sold about two different processed products in the period January–June 2017. The location-specific variables are dummy variables indicating firm location in an urban district (*urban*), inside or outside a residential compound production site (*home site*), or in an industrial site or free zone production site (*industrial site*). Of the surveyed food processing firms, 62 percent are in urban districts, and the majority (66 percent) of firms have their main production activities inside a house or a residential compound. Firms in urban and industrial sites may have more pressure, capacity and incentive to adopt FS than those in rural areas and in residential sites. They may also be closer to consumer and buyers of products.

We also include the different registration requirements for a food processing entity. They include formal registration (*formal registration*), district registration (*district registration*), and FDA registration (*fda registration).* On average, district registration was highest, representing 65 percent compared to 17 percent with registrar-generals (formal) registration and 14 percent with FDA registration. The training variables are dummy variables that describe firm support received from government, a nongovernmental organization, or a donor project since the firm's establishment. They include training in compliance with food safety regulations (*training in food safety*), training in food manufacturing (*training in food manufacturing*), and training in business management training (*training in management*). These trainings are likely to be positively related to food safety adoption. On average, training support received by firms on compliance with food safety, on food manufacturing, and on business management is low (9 percent, 8 percent, and 4 percent, respectively). The other firm characteristic variables are dummy variables describing the processing activity (simple and complex), main buyers (supermarkets, exporters, individual customers, agents, depots), and the main crop or commodity processed. On average, 40 percent of firms use white maize for their processing and about 63 percent of firms have their products purchased by individual customers. Simple processes may be easier to implement and thus positively related to food safety adoption than complex processes. More perishable commodities such as tomato, meat or fish products may require greater food safety measures; and grains and beans that are prone to aflatoxin contamination may require more food safety measures than other commodities.

4. Results

4.1. Descriptive analysis

Major differences between food safety adopters and nonadopters are shown in Table 2. We find mean values of gross profit per month and firm growth to be higher for adopters compared to nonadopters of food safety in the pooled data, micro-scale firms only, and larger firms only. We find significant differences between adopters and nonadopters with respect to number of employees, number of products sold, firm location, registration status, training, processing activity, main buyers, and main crop or commodity used in food processing.

Table 2. Descriptive statistics of adopters and nonadopters of food safety

Variable	Adopters (N=100)	Nonadopters (N=411)	Mean difference
Dependent			
Ln(gross profit per month)	8.29	6.66	1.63***
Firm growth	0.02	0.01	0.01
Firm characteristics			
Firm age	17.49	16.79	0.70
No. of employees	74.99	8.20	66.79***
Initial starting capital (000 cedi)	491.55	7.19	484.36**
No. of products sold	3.14	2.10	1.10***
Location			
Urban	0.73	0.60	0.13**
Home site	0.50	0.70	-0.20***
Industrial site	0.24	0.09	0.15***
Other site	0.14	0.10	0.04
Registration			
Formal registration	0.45	0.10	0.35***
District registration	0.82	0.61	0.21***
FDA registration	0.42	0.07	0.35***
Training			
Food safety	0.29	0.04	0.25***
Food manufacturing	0.23	0.04	0.19***
Business management	0.13	0.02	0.11***
Processing activity			
Simple processing	0.70	0.38	0.32***
Complex processing	0.98	0.97	0.01
Main buyers			
Supermarket	0.14	0.06	0.08***
Individuals	0.49	0.66	-0.17***
Agents	0.23	0.14	0.09**
Depots	0.09	0.07	0.02
Main crop/commodity			
White maize	0.20	0.45	-0.25***
Yellow maize	0.08	0.21	-0.13***
Rice	0.00	0.03	-0.03*
Soybean	0.04	0.01	0.03**
Groundnut	0.04	0.06	0.02
Cassava	0.14	0.24	-0.10**
Tomato	0.05	0.09	-0.04

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

Source: Authors' estimates based on 2017 firm survey. FDA=Food and Drugs Authority

Table 3 illustrates food safety adoption status by firm size. Overall, the rate of food safety adoption is highest among medium- to large-scale food processing firms, representing 44 and 61 percent, respectively. This finding suggests that adoption of food safety practices is low among micro and small-scale food processing firms, which make up the majority of the food processing sector. Our finding is consistent with Jayasinghe-Mudalige and Henson (2006, 2007) who argue that larger firms tend to have the capacity to implement food safety controls whereas most micro and small firms show limited capacity or desire to implement them.

Table 3. Adoption of food safety practices, by firm size

Size of firm	% of Nonadopters (no. of firms)	% of Adopters (no. of firms)
Micro (1–5 employees)	88 (328)	12 (46)
Small (6–30 employees)	67 (58	33 (29)
Medium (31–100 employees)	56 (18)	44 (14)
Large (more than 100 employees)	39 (7)	61 (11)
Total	80 (411)	20 (100)

Source: Authors' estimates based on 2017 firm survey.

4.2. Factors explaining food safety system adoption

Empirical results from the probit model are presented in Table 4. Among the exogenous variables considered, the number of employees, the number of processed food products, urban location of firm, district assembly registration, FDA registration, training in food safety, and simple processing significantly influence the probability of adopting food safety practices.

The results of the study reveal a positive significance of number of food products sold by the firm, indicating that the greater the number of processed products sold by a firm the more likely the firm is to adopt a food safety system. Food processing firms located in urban areas are 16 percent more likely to adopt a food safety system, implying that the further away a firm is from an urban location the less likely that firm is to adopt and implement a food safety system. The different types of registration—district assembly registration and FDA registration—also positively and significantly influence the adoption of a food safety system. FDA-registered firms are 29 percent more likely to have a food safety system as compared to firms with district assembly registration, which are 9 percent more likely to have a food safety system.

Results further indicate that firms with training in food safety are 22 percent more likely to adopt and implement food safety systems in their processing activities. Similarly, studies by Kumar et al. (2017) find that contacting a source of information on food safety and value addition increases the adoption rate of food safety measures. Contrary to our expectation, food processing firms using simple processing activities such as cleaning, sorting, drying, winnowing, and freezing are 19 percent more likely to adopt a food safety system. This finding implies that the minimum level of processing activity requires the implementation of food safety practices. Exporters, individuals, and agents who are main buyers or beneficiaries of processed food products were identified to positively and significantly influence the likelihood of adopting a food safety system. This finding is consistent with studies by Arpanutud et al. (2009) who indicate that the higher the percentage of export sales of a food manufacturing firm the greater its level of food safety management system adoption. Food safety standards adoption is a requirement in most supermarkets and exporters. Contrary to expectation, firms processing crops such as maize or pulses that are more prone to aflatoxin or more perishable crops such as tomatoes were not significantly different from other firms not processing these crops. The findings corroborate past studies indicating that the presence of an unseen contaminant is not reflected in prices of maize and affects how the maize is used and processed (Hoffmann et al. 2013), and therefore not a determinant of food safety adoption.

Table 4. Determinants of adoption of food safety practices

Variables	Adoption of food safety (=1)
Firm characteristics	
Firm age	-0.001
	(0.002)
Number of employees	0.001*
	(0.001)
Initial starting capital	0.000
	(0.000)
Number of products sold	0.029**
	(0.012)
Location of firm	
Urban location	0.164***
	(0.046)
Industrial site location	0.070
	(0.066)
Registration completed	
District registration	0.092**
	(0.041)
FDA registration	0.285***
	(0.083)
Training	
Training in compliance with food safety [/a]	0.220**
	(0.098)
Processing activity	
Simple food processing [/a]	0.192***
	(0.050)
Complex food processing	-0.068
	(0.176)
Main buyers	
Supermarket and export buyers	-0.071
	(0.058)
Agent buyers	-0.028
	(0.048)
Depots	-0.046
	(0.059)
Main crop/commodity	
Maize (white)	-0.058
	(0.055)
Maize (yellow)	-0.029
	(0.063)
Soybean	0.069
	(0.101)
Groundnut	-0.089
	(0.059)
Cassava	-0.015
	(0.049)
Tomato	-0.020
	(0.076)
Observations	511
Pseudo R^2	0.330

Source: Authors' estimates based on 2017 firm survey. Note: Figures are the marginal effects, computed from the coefficients in equation 4. Robust standard errors in parentheses. Significant at *** $p<0.01$, ** $p<0.05$, * $p<0.1$. [/a] These are the excluded instruments that are highly significant in food safety adoption but not directly related to firm performance.

4.3. Effect of food safety adoption on firm performance

We assessed the relationship between firm performance, food safety adoption, and firm growth as shown in Figure 1. In all figures, the dashed line suggests the 95 percent confidence interval level. The data suggest a positive relationship between food safety adoption and firms' gross profit per month, indicating that firms adopting food safety are better off than the their nonadopting counterparts. One likely reason for this is that firms realize the potential benefit of ensuring food safety practices in their processing activities. The relationship between firm growth and food safety adoption was also assessed, but we see no clear increase in firm growth when food processing firms are engaged in food safety adoption.

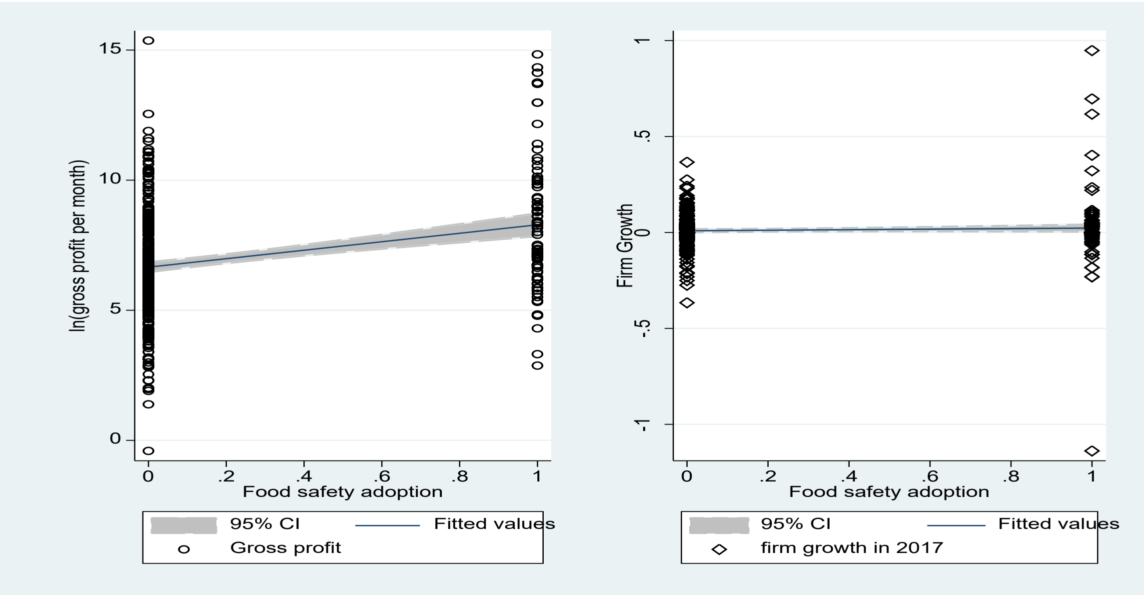

Figure 1. Relationship between gross profit, firm growth and food safety adoption
Source: Authors' estimates based on 2017 firm survey.

Table 5 illustrates the results showing the effects of food safety adoption on firm performance indicators. We found very small changes in the magnitude of the coefficients and some changes in the statistical significance for some variables after controlling for firm characteristics. Our variable of interest, food safety adoption, was found to be highly and consistently significant in the firm profit model (Table 5) but not significant in the firm growth model (Annex Table 3). This is consistent with the results of the different matching techniques (Annex Table 2). Some firms reported that having a food safety plan helps them to organize their processes, reduce wastage, and avoid risk and liability of food contamination. Others said they are required to follow food safety standards. Some others said complying with government regulations, including food safety, helps in avoiding fines and in getting and maintaining consumer confidence in and loyalty to their products. Some others who were supplying supermarkets and exporters said they had to comply otherwise they would lose their buyer and therefore profits. Because products are very different across firms, we are not able to test for price premium related to food safety adoption. We see however that the ability to supply to lucrative markets and buyers who pay price premiums seems to be the main mechanism for the effect of food safety on firm profitability.

Table 5. Effects of the adoption of food safety on firm profit indicators

	(1) OLS	(2) 2SLS	(3) 3SLS	(4) GMM	(5) LIML	(6) CF
Food safety adoption (=1)	0.819***	3.128**		3.461***	3.328**	5.721**
	(0.246)	(1.332)		(1.304)	(1.462)	(2.760)
Age in years of firm in 2017	0.004	0.008	0.005	0.009	0.008	0.006
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Number of employees in 2017	0.005***	0.004**	0.005***	0.004**	0.004**	0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Initial capital (000 cedi)	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of district food products sold	0.019	-0.026	-0.014	-0.035	-0.030	-0.016
	(0.051)	(0.061)	(0.055)	(0.061)	(0.063)	(0.054)
District location (1=urban; 0=otherwise)	-0.695***	-0.860***	-0.793***	-0.856***	-0.874***	-0.844***
	(0.184)	(0.216)	(0.199)	(0.216)	(0.221)	(0.202)
Production location (1=industrial site or free zone or other tax-free zone	0.414*	0.171	0.263	0.148	0.150	0.215
	(0.230)	(0.301)	(0.256)	(0.300)	(0.313)	(0.259)
Registration completed (1=district assembly; 0=otherwise)	0.250	0.076	0.119	0.060	0.061	0.086
	(0.185)	(0.218)	(0.209)	(0.218)	(0.225)	(0.208)
Food and Drugs Authority (FDA) registration (=1)	0.619**	-0.055	0.186	-0.212	-0.113	0.079
	(0.311)	(0.508)	(0.428)	(0.491)	(0.542)	(0.422)
Training in food manufacturing (=1)	0.862***	0.181	0.398	0.002	0.122	0.298
	(0.330)	(0.617)	(0.499)	(0.600)	(0.654)	(0.505)
Supermarket and export buyers (=1)	1.970***	2.012***	2.003***	2.084***	2.016***	2.013***
	(0.373)	(0.397)	(0.359)	(0.393)	(0.402)	(0.358)
Sales agents as main buyers (=1)	0.903***	0.791***	0.849***	0.785***	0.781***	0.836***
	(0.231)	(0.248)	(0.245)	(0.248)	(0.254)	(0.235)
Market stalls or small shops where trader picks are the main buyers (=1)	0.221	0.195	0.231	0.196	0.193	0.229
	(0.340)	(0.344)	(0.350)	(0.344)	(0.348)	(0.339)
Fitted probability in the second stage (FS model)			2.156**			
			(1.022)			
Residual						-3.130*
						(1.754)
Constant	6.389***	6.443***	6.451***	6.418***	6.448***	3.933***
	(0.244)	(0.254)	(0.244)	(0.253)	(0.256)	(1.402)
Observations	485	485	485	485	485	485
Adjusted R-squared	0.265	0.136	0.261	0.096	0.113	0.272
F-stat (instruments)		24.000	24.000	24.000	24.000	

	(1) OLS	(2) 2SLS	(3) 3SLS	(4) GMM	(5) LIML	(6) CF
Underidentification test (Kleibergen-Paap rk LM statistic)		19.527	19.527	19.527	19.527	
Chi-sq(2) P val		0.000	0.000	0.000	0.000	
Hansen test (overidentification test of all instruments)		1.502	1.502	1.502	1.502	
Chi-sq(1) P val		0.220	0.220	0.220	0.220	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' estimates based on 2017 firm survey. OLS = ordinary least squares; 2SLS=2-stage least squares; 3SLS=3-stage least squares; GMM=general methods of moments; LIML=limited-information maximum likelihood; CF=control function.

5. Conclusions

This paper examines determinants of adoption of food safety measures by food processing firms in Ghana and measures the effect of this adoption on firm profitability. Using a nationally representative sample of 511 food processing firms in Ghana, we show the wide diversity of these firms in terms of size, product, buyers, and attention to food safety. The majority are micro-scale firms and do not follow food safety practices. Only 20 percent of firms follow good food safety practices; among the micro-scale firms, only 12 percent adopt some good food safety practices. Food safety regulations and requirements, despite their presence, are largely not enforced. Our findings indicate that most processing firms are never visited or inspected. The most cited reasons from the key informants' interviews are limited human resources and funds for inspection and enforcement of regulations.

The factors that predict food safety adoption among food processing firms include firm size, number of products sold by the firm, urban location of the firm, district and FDA registrations, training in compliance with food safety, type of processing activities, and sales of processed products to supermarkets or exporters. Our findings also indicate a positive effect of food safety adoption on the profitability of food processing firms. These results are robust and consistent using instrumental variable approach and several matching techniques.

These results have implications for how to promote food safety among food processing firms. First, training in food safety has been shown to be effective in encouraging greater adoption of food safety measures. Government and partners can focus on this promotion of training and technical support to firms to adopt food safety practices, which can be done in combination to food processing/value addition with food safety practices training. Our findings suggest a strong positive correlation between food safety practices and firm performance, and these findings can be used and added to the trainings to nudge firms to adopt food safety practices.

Second, government can provide opportunities to expand production, through promotion of Ghana-made products and opening up opportunities to export, to support food processing and increase the likelihood that firms will be able to cover additional costs of food safety considerations. Public policies will need to complement the above efforts with more extensive consumer awareness campaigns and supporting and working together with consumer advocacy groups promoting food safety. The degree of worry about food safety depends on the public's levels of knowledge and awareness. Greater consumer concern about food safety means greater willingness to pay price premiums for safer food or greater pressure on firms and governments to ensure food safety.

Third, in the context of weak government institutions and limited funding, voluntary certification and product differentiation to capture price premiums can be promoted in the short and medium term among food industries. Doing so, however, will require credible certification systems and establishing a positive image and trust in these certification systems, which will take time. Public and private standards will require a strong regulatory enforcement that must be worked on in the long term.

Finally, because much of Ghana's raw materials are imported and much of its processed foods are imported, greater efforts to check the safety of food imports will also be necessary to complement efforts to improve safety of locally produced and processed foods.

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Annex Table 1. Descriptive statistics of outcome and explanatory variables

Variable	Description	Mean (N=511)	Std. Dev.	Expected effect on food safety	Expected effect on firm performance
Dependent					
food safety	Adoption of food safety system (=1), defined based on whether the firm has documented food safety plan prepared specifically for the firm or has a documented food safety plan adopted from other firms or the firm has undocumented food safety plan posted on premises.	0.20	0.40		+ Firms with FS measures may be more likely to get price premiums, capture higher-end consumers and enter in lucrative markets, acquire and maintain consumer's confidence and loyalty, avoid production losses and wastage
firm growth	Firm growth (in 2017)	0.01	0.10		
ln(gross profits)	Ln (gross profits per month in Ghana cedi)	6.93	2.15		
Firm characteristics:					
firm age	Firm age (in years of firm in 2017)	16.92	12.67	-/+ More experience in management practices, including on FS; older firms may be less willing to change practices	+ More experience would mean more profits
no. employees	Number of employees (as at 30th June 2017)	21.27	128.27	+ Bigger firms have greater capacity to adopt FS	+ Bigger firms have greater capacity to invest and improve profits
initial capital	Initial starting capital (in thousand GHS)	101.98	1792.36	+ Firms with more capital have greater capacity to adopt Fs	+ Firms have greater capacity to invest and improve profits
no. of products	Number of food products sold by the firm	2.30	2.32	-/+ More products will require FS measures, but it may also be more difficult and costly	+ More products would mean more diversity and greater profits

Variable	Description	Mean (N=511)	Std. Dev.	Expected effect on food safety	Expected effect on firm performance
location					
Urban	Urban location (1=urban; 0=rural)	0.62	0.48	+ Firms located in urban location may have more pressure to adopt FS	+ Firms located in urban location may be closer to demand and consumers
home site	Home production (1=inside or outside residential compound)	0.66	0.47	- Firms located in residential site may be smaller and may have less pressure and capacity to adopt FS	- Firms located in residential site may be smaller and may have less capacity and investments to increase profits
industrial site	Industrial production (1=industrial site or free zone or other tax-free zone)	0.12	0.32	+ Firms located in urban location may have more pressure to adopt FS	+ Firms located in urban location may be closer to demand and consumers
registration					
formal registration	Formal registration (1=registrar-generals)	0.17	0.38	+ Firms with formal registration may signal seriousness and compliance to rules, and may likely to adopt FS	+ Firms with formal registration may signal seriousness and commitment, and may likely to more profitable
district registration	District assembly registration (1=district assembly)	0.65	0.48	+ Firms with district registration may signal seriousness and compliance to rules, and may likely to adopt FS	+ Firms with district registration may signal seriousness and commitment, and may likely to more profitable
fda registration	FDA registration (1=food and drugs authority)	0.14	0.35	+ Firms with FDA registration may signal seriousness and compliance to rules, and may likely to adopt FS	+ Firms with FDA registration may signal seriousness and commitment, and may likely to more profitable
training					
Training on food safety	Training in food safety regulations (1=Yes; 0=No)	0.09	0.28		

Variable	Description	Mean (N=511)	Std. Dev.	Expected effect on food safety	Expected effect on firm performance
Training in manufacturing	Training support in food manufacturing (1=Yes; 0=No)	0.08	0.27	+ Training on food manufacturing may also include on FS, and may likely influence FS adoption	May not be directly linked, except for effect of FS on firm performance
Business management	Training in business management (1=Yes; 0=No)	0.04	0.20	+ Training on business management may also include on FS, and may likely influence FS adoption	+ Training on business management may be lead to greater human capacity and skills for higher profitability
processing activity					
simple	Simple processing activity adopted (1=Simple) Simple processing refers to activities that do not involve the transformation of the raw material that involves cleaning, sorting, drying, winnowing, destoning, and freezing	0.44	0.50	+ Simple processes may be easier to implement	No clear direction of expected effect on firm performance
complex	Complex processing activity adopted (1=Complex) Complex processing refers to activities the involves the transformation of the raw material including peeling, de-husking, polishing, cutting, grinding, cooking, mixing, extruding and packaging.	0.97	0.16	+ Complex processes may require investments and less capacity and incentive to adopt FS	No clear direction of expected effect on firm performance
main buyers					
Supermarket/exporter	Supermarket and export buyers (1=Supermarket/export)	0.08	0.27	+ Buyers may require FS	+ Buyers may be willing to pay higher price premium for FS
individuals	Individual customer buyers (1=individual customers)	0.63	0.48	- Buyers may not be too concerned of FS	- Buyers may not be willing to pay higher price premium for FS
agents	Sales agents (1=sales agents)	0.16	0.37	- Buyers may not be too concerned of FS	- Buyers may not be willing to pay higher price premium for FS

Variable	Description	Mean (N=511)	Std. Dev.	Expected effect on food safety	Expected effect on firm performance
depots	Depots (1=market stalls or small shops where trader picks the item)	0.07	0.26	- Buyers may not be too concerned of FS	- Buyers may not be willing to pay higher price premium for FS
Main crop/commodity					
white maize	White maize	0.40	0.49	-/+ More perishable commodities may require FS measures; those grains and beans that are prone to aflatoxin may require more FS measures	
yellow maize	Yellow maize	0.19	0.39		
rice	Rice	0.02	0.15		
soybean	Soybean	0.02	0.13		
groundnut	Groundnut	0.05	0.22		
cassava	Cassava	0.22	0.41		
tomato	Tomato	0.08	0.27		

Notes: - we expect negative correlation; + we expect positive correlation; FS=food safety

Annex 2. Results of the matching techniques: Average treatment effects of food safety adoption on firm performance

	NN			Kernel			IPW		
	ATT		SE	ATT		SE	ATT		SE
ln(profit) per month	1.245	***	0.319	0.704	**	0.330	1.058	**	0.420
Firm growth	-0.004		0.021	-0.031		0.018	-0.009		0.024

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' estimates based on 2017 firm survey. NN=Nearest neighbor; IPW=Inverse probability weighting; ATT=average treatment effect of the treated; SE=standard error

Annex 3. Effects of food safety adoption on firm growth

	(1) OLS	(2) 2SLS	(3) 3SLS	(4) GMM	(5) LIML	(6) CF
Food safety adoption (=1)	-0.012	0.074		0.038	0.096	0.085
	(0.016)	(0.062)		(0.059)	(0.079)	(0.214)
Age in years of firm in 2017	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of employees in 2017	0.000**	0.000**	0.000**	0.000	0.000*	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Initial capital (000 cedi)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of district food products sold	-0.002	-0.003	-0.003	-0.002	-0.004	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
District location (1=urban; 0=otherwise)	-0.006	-0.012	-0.008	-0.012	-0.013	-0.009
	(0.012)	(0.013)	(0.016)	(0.013)	(0.014)	(0.016)
Production location (1=industrial site or free zone or other tax-free zone	0.034*	0.026	0.031	0.018	0.024	0.031
	(0.018)	(0.018)	(0.021)	(0.018)	(0.019)	(0.021)
Registration completed (1=district assembly; 0=otherwise)	-0.009	-0.017	-0.012	-0.008	-0.020	-0.012
	(0.011)	(0.013)	(0.013)	(0.012)	(0.015)	(0.013)
Food and Drugs Authority (FDA) registration (=1)	0.029	0.001	0.018	0.015	-0.006	0.019
	(0.023)	(0.026)	(0.019)	(0.025)	(0.029)	(0.018)
Training in food manufacturing (=1)	0.016	-0.012	0.004	-0.004	-0.020	0.005
	(0.022)	(0.029)	(0.041)	(0.029)	(0.034)	(0.037)
Supermarket and export buyers (=1)	0.034	0.034	0.034	0.017	0.034	0.034
	(0.024)	(0.023)	(0.023)	(0.021)	(0.024)	(0.024)
Sales agents as main buyers (=1)	0.004	-0.000	0.002	-0.004	-0.001	0.003
	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Market stalls or small shops where trader picks are the main buyers (=1)	0.016	0.013	0.015	0.012	0.013	0.015
	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.017)
Fitted probability in the second stage (FS model)			0.023			
			(0.094)			
Residual						-0.062
						(0.130)
Constant	0.019	0.020	0.019	0.019	0.021	-0.031
	(0.014)	(0.015)	(0.016)	(0.015)	(0.015)	(0.094)
Observations	511	511	511	511	511	511
Adjusted R-squared	0.075	-0.006	0.074	0.034	-0.053	0.075
F-stat (instruments)		24.000	24.000	24.000	24.000	
Underidentification test (Kleibergen-Paap rk LM statistic)		24.000	24.000	24.000	24.000	
Chi-sq(2) P val		0.000	0.000	0.000	0.000	
Hansen test (overidentification test of all instruments)		2.847	2.847	2.847	2.847	
Chi-sq(1) P val		0.092	0.092	0.092	0.092	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' estimates based on 2017 firm survey. OLS = ordinary least squares; 2SLS=2-stage least squares; 3SLS=3-stage least squares; GMM=general methods of moments; LIML=limited-information maximum likelihood; CF=control function.

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