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Spillover Effect of FDI on Food Exports: Based on Firm-Level Analysis in China

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Abstract: This paper examines the spillover effect of foreign direct investment (FDI) on Chinese domestic food exports under firm heterogeneity. By using a rich firm-level panel data of China's food firms, the empirical analyses rely on the first-order difference generalized method of moments (GMM) for industry-level analysis, and Heckman's two-stage method for firm-level analysis. The results show that the horizontal FDI led to a positive spillover effect on domestic food industry exports, varying across food subindustries. The paper also finds that a large part of the promotion effect is driven through extensive margin (the probability to export) instead of intensive margin (the quantities of exports) in firm-level analysis. The heterogeneous export spillovers across food firms are further considered to depend on their nature characteristics, like productivity, size, and ownership. Moreover, the heterogeneities of FDI origins and business purpose are confirmed to influence export spillovers. The estimation results are quite robust for different types of regression specifications and substitutions of variable measurement. These findings provide suggestions for decision-makers to carefully assess the impact of FDI and make policy for the sustainable development of domestic food exports.

Keywords: FDI; export spillover; heterogeneous firms; food export growth



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1. Introduction

After the quick growth in both magnitude and range, the global foreign direct investment (FDI) tends to be saturated at the present, yet the FDI flows to developing countries and remains stable and rises steadily. In 2019, while global FDI flows continued decreasing, developing countries registered a remarkable rise to \$706 billion which accounted for 54% of the total amount (UNCTAD, 2019). According to UNCTAD's survey of investment promotion agencies (IPAs), the agricultural and food industries hold the most expectation to attract global FDI inflows for developing and transition economies. China, as the largest developing FDI recipient, received \$139 billion in investments in 2018, of which agricultural and food sector took up approximately 27% of the total FDI inflows [1].

Although attracting investment and promoting exports are still regarded as the key drivers of sustainable economic growth, nevertheless, the concern of whether inward FDI brings benefits as expected does not fade away, especially considering the spillover on the host country's economy [2–6]. A noteworthy issue is the FDI inflow into the food industry and its impact on sustainable food exports [7]. From the host country's perspective, FDI unavoidably becomes double-edged: on the one hand, relaxing the access of FDI could help promote food export growth by reliable funds, source provision, and advanced technology transferring. On the other hand, it is also necessary to keep a sharp lookout for a potential negative impact of FDI by crowding out of the local entities from international market share, which harms domestic food development [8]. Hence, the extent is uncertain, complicating the link from inward FDI to domestic export flows.

Many studies have suggested the crucial role played by FDI in the sustainable development of the agricultural and food sectors [9–14]. The introduction of foreign capital can lead the agricultural and food-processing sectors into the stage of rapid and sustainable development by reducing poverty and hunger, increasing income, encouraging female employees, and so on [15–17]. Yet, curiously, the empirical evidence of FDI's indirect impact on food exports, that is, export spillover on the domestic food industry, remains ambiguous. Sustainable food exports represent an essential economic performance indicator in domestic agricultural development, especially for developing countries of an open economy. In China, food products take an increasing part in total agricultural exports, and this proportion reached nearly 50% in the year 2020 (Development Research Center of The State Council, 2020). The question remains whether inward FDI promotes or restrains the sustainable growth of domestic food export. What does the export spillover reflect on both food industry-level and food firm-level, and by what means is the FDI spillover effect on food firms mediated?

In an effort to answer these questions via careful statistical tests, the paper provides an empirical analysis of the spillover effect of inward FDI on domestic food exports in China. This paper focuses on the export spillovers from horizontal inward FDI, namely, the intra-industry spillover effects on local food exports. A firm-level panel data was constructed with integral shareholders' information and export records that cover most of the food firms from the year 1998 to the year 2013. Specifically, this paper examines the export spillovers of FDI at two levels: (i) aggregated industry-level effect, with more than 50 food subindustries included, and (ii) disaggregated firm-level impact, with the explicit intensive margin and extensive margin of domestic food exporters and non-export ones. Furthermore, this paper analyzes the export spillovers on local food firms under firm-level heterogeneity. Last but not least, different types of FDI and their export spillovers are identified in this article. In terms of robustness, the results are checked with respect to model specification, estimation methods, and variable measurement. The empirical dimension of the study at the industry-level involves two stage least squares (2SLS) and feasible generalized least squares (FGLS) for static panel analysis and GMM estimator for dynamic panel analysis, while using Heckman's two-stage method to take full account of zero trade flows in firm-level study. Additionally, a suitable alternative representor of FDI presence is found and used in this paper.

This paper offers two main contributions: one is a very large number of food firms included in the sample of the dataset for econometric investigation. Moreover, the time frames (1998–2013) for both industry-level and firm-level analyses are relatively long. The other contribution is filling the gap of micro-level investigation of export spillovers. Unlike most of the previous studies that have assessed spillover effects at the aggregate or sectoral level, this paper provides new insight on disaggregated-level analysis and allows for different export spillovers that depend on firm-level heterogeneity. An appropriate method, avoiding estimate bias, is used to measure the export spillovers through firms' export behaviors: whether to export or not and how much to export. A significant discussion focused on firm heterogeneities also demonstrates the accurate spillover on food exporters of host countries in this paper.

The rest of the paper is structured as follows. Section 2 briefly introduces the related literature for this research. Section 3 demonstrates the empirical methodology, including data sources and descriptions, variables, and econometric model. Section 4 shows the empirical results in both aggregated industry-level and disaggregated firm-level specifically. An overview of the conclusions and several implications is in Section 5 of this paper.

2. Export Spillovers of FDI

Along with the direct impact on multinationals of foreign direct investment flows, the potential externality to local firms and industry also attracts the attention of the host country's policymakers and scholars. Until now, a large body of literature has shown the spillover effect of FDI on domestic economic issues, such as productivity spillover,

technology transferring, worker mobility, etc. [18–20]. Among the discussion of the diverse spillovers of FDI, widely explored is export spillover as one of the most spectacular studies of export growth and a host country's economic development [21–23].

According to existing literature, there are three main channels to indirectly impacting the host country's export activity by inward intra-industry FDI. First, export spillover may have happened through a demonstration effect: the multinationals with rich management experience and technological superiority may actively deliver advanced production techniques to help improve productivity and operating efficiency, or be imitated by domestic firms inactively [24–28]. Compared with the manufacturing industry, the food industry seems to be more labor-intensive since it uses primary agricultural commodities of lower prices as inputs and shows lower technology levels [29,30]. This may provide more possibilities to receive technology spillovers and labor mobility to enhance export capacity. However, the demonstration channel cannot be considered too optimistic. The explicit spillover depends on the absorptive capacity of local food firms [31]. Besides, there would be no spillover if the local firms and MNEs were at the same level. Second, the information effect means that multinationals could bring more information about the international market to local firms through business-to-business relationships, as they are more familiar with the world trade environment and own integral distribution channels. Third, it seems complicated while discussing the competition effect. On one hand, MNEs that aim for the export market would lead to competition with local rivals, even stealing exporting shares from domestic exporters. On the other hand, it would also force local food firms to pursue self-promotion and realize better export performance [32].

With the increasing availability of micro-level data, many studies have turned to firm-level analysis to investigate the firm-level spillover effects of FDI presence. Many researches have suggested that food firms exhibit significant heterogeneity in terms of productivity [33–37]. Firm heterogeneity has been incorporated into the research of FDI issues, and as a result, the explicit spillover effect on an individual domestic firm depends on its own characteristics and conditions.

Hence, despite the availability of voluminous literature on export spillovers of FDI, empirical findings are still ambiguous. In consideration of the complicated relationship between inward FDI and local food export development, it is thus an empirical issue to better explore how export spillovers actually occur in the local food sector and individual food firms.

3. Data

3.1. Data Source and Description

The main dataset of specific firm-level information is derived from the Annual Survey of Industrial Survey (ASIF), collected by the China National Bureau of Statistics and spanning the years 1998–2013. The industrial firms that achieve over 5 million RMB gross output were listed in this dataset. There are large arrays of information for every documented firm, such as name, ID, shareholder structure, production, and financial data, as well as export figures. Hence, it could have been used to estimate total factor productivity and size and to identify firm-level nature characteristics. In terms of industry range and information completeness, this dataset far exceeds any other. As this dataset was no longer released after the year 2013, the panel data in the empirical analyses is the most current available firm-level disaggregated data in the context of China. This dataset has been one of the most accurate and widely applied to many empirical studies. Since the current focus is on export spillovers of FDI on Chinese domestic food firms, this paper presents the samples of the food industry according to the Chinese Standard Industry Classification Code (CSIC, GBT 4754-2002). According to Jin et al., the food industry can be defined into three specific sub-industries at the level of the 2-digit CSIC code: the food processing industry (code 13), the food manufacturing industry (code 14), and the beverages and alcohol industry (code 15) [7]. Here, these three different food subindustries are introduced in detail. The agro-food processing industry, code 13, focus on the primary processing staple foods, like grain

grinding, vegetable oil processing, sugar processing, slaughtering and meat processing, and fruits and other agricultural and sideline food processing. The food manufacturing industry, code 14, is mainly about deep processing, such as candy, chocolate, candied fruit manufacturing, convenience food manufacturing, liquid milk and dairy product manufacturing, canning, fermented product manufacturing, and other food manufacturing. The beverages and alcohol industry, code 15, includes alcohol, wine, soft beverages, and refined tea processing manufacturing. See more industrial classification principles in the Industrial Product Catalogue from the National Bureau of Statistics of China.

Before matching the annually selected food samples into firm-level panel data, data clearing procedures have been carefully completed by dropping the unreliable samples with abnormal information or missing key financial data [38,39]. Drawing on the experience of previous research, two types of unqualified observations are dropped: one is the observation with abnormal high or low financial information, such as export figure is large than gross output or less than 5 employees in this firm; another is a lack of vital information to estimate firm's characteristics, like output, investment, and employee numbers for calculating TFP or capital structure for identifying ownerships and obtaining FDI position. Then, a sequential identification method was used to identify and link the same individual over years. Specifically, we follow the matching procedures in accordance with the firm's name, ID, legal representative, province, city, and telephone number [40].

This study constructs two panel data spanning from the year 1998 to 2013 for two levels of empirical analysis, at the industry level and firm level. The industry-level data is collected at 4-digit CSIC level, which contains 51 food subindustries subjected to three main 2-digit level food industries introduced above. Table 1 provides a brief sample of the panel data. In 2013, there were 50 food subindustries exporting products while 3399 firms out of 33,301 total participated in the world food market. Over the relatively long period from 1998 to 2013, there were 16,328 food firms that have ever exported, which account for more than 15% of the total sample.

Table 1. Brief Sample of panel data.

Food Sub-Industries	Numbers of Subindustries (4-Digit CSIC Level)	Firm-Level		
		Total Numbers	Exporters Numbers	Ratio
13 Agro-food processing industry	16	21,164	2038	9.63%
14 Food manufacturing industry	21	6960	1047	15.04%
15 Beverages and alcohol industry	13	5177	314	6.07%
Sum N	50	33,301	3399	10.21%
Sum N *	51	97,994	16,328	16.67%

Note: This table shows the samples of the year 2013 in the first four rows. The last row "Sum N *" is the overall statistics for the period of 1998 to 2013, where the total number of firms and exporting firms are counted unrepeated.

The panel data provides full export information and FDI presence figures (according to UNCTAD, FDI inflows comprise capital provided by a foreign investor. In this paper, the presence of FDI is identified by its stock in the end of year t , that is, the value of the share of the foreign capital) for the empirical analysis. There are several terms of interpretation that need to be emphasized. First, as more disaggregated inward FDI data across food subindustries of official figures is limited through public ways, the presence of FDI is proxied by the sum calculation of foreign capital position of agricultural firms documented in ASIF dataset in this article. As the sum of FDI collected from ASIF accounts for over 90% of the nation's whole inward FDI, this dataset can well represent the presence of FDI in China's food industry. Note that the FDI variables, both in industry-level and firm-level analysis, are measured at 4-digit CSIC level. Second, for matching reasons, the amount of

export value for industry-level analysis is also calculated by the sum of food exports that aggregated to 4-digit subindustry level. Third, in order to identify the spillover effect on domestic export performance, it excludes the exports by foreign firms from the regression model. Like Lu et al., it defines a firm to be a foreign firm if it owns more than 25% foreign capital, and other firms are defined as domestic firms (foreign capital share accounts for less than 25%) [20]. Hence, the industry-level domestic export performance is measured by the sum of food exports by all domestic food firms in the same industry.

Concerns over inflation issues are excluded; like Yu and Jin et al., the export flow and capital have been deflated to the base year of 2008 by using the national food industry producer price indices for industrial products and national price indices of investment in fixed assets, respectively (both indices were obtained from the *China Statistical Yearbook* of corresponding year. See <https://data.stats.gov.cn> (accessed on 1 January 2021) for online version) [7,41].

3.2. Econometric Framework

3.2.1. Industry-Level Analysis

This paper uses panel regression models for industry-level analysis. Compared with the cross-section data or time-series data model, the panel data model has several important advantages, such as reducing multicollinearity among explanatory variables and avoiding the deviation of the estimates by missing variables. The static panel analysis can be written in a simple log-linear function of export flows, FDI presence, and several other observables:

$$\ln EX_{jt} = \alpha_0 + \alpha_1 \ln FDI_{jt} + \delta Z_{jt} + \Phi_t + w_{jt} \quad (1)$$

where $\ln EX_{jt}$ is the log of the export flows of a specific industry j in year t , $\ln FDI_{jt}$ represents the log of FDI position measured at the industry level in year t . Z_{jt} , a vector of characteristics of industry j in year t , helps to control the effect of industry-level factors. Φ_t is a time dummies and w_{jt} is a regular error term which clustered at the industry level. The coefficient α_1 demonstrates the spillover effect of horizontal FDI on export flow across all food industries, which is the interest of this article.

However, there are still some endogeneity concerns: on one hand, the main explanatory variables (FDI) are endogenous relative to the response variables (export amount). That is, the inward FDI in food sector may be attracted by the increasing food export. This endogeneity, raised by reverse causality, would lead to a positive correlation between foreign inward FDI and local food export growth, but not the expected relationship focused on in this paper. On the other hand, the FDI of the current period may also be related to some unobserved variables. Given the potential bias due to the endogeneity, like previous studies, this paper employs two-stage least squares (2SLS) approach and choose one-period lag of the FDI stock as a valid instrumental variable in aggregated industry-level analysis. Furthermore, feasible generalized least squares (FGLS) is recruited as a robustness check for more efficiency while dealing with potential serial correlation and heteroskedasticity [42].

Due to the sunk costs of exports, the export amount at the current period seems unlikely to change dramatically from that in the lag period [43,44]. Hence, the lagged export variable is used as an independent one in Equation (1), thus, estimation turns from a static panel to dynamic panel model. As the lagged dependent variable is correlated with the compound disturbance, it applies the difference generalized method of moments (difference GMM) estimation suggested by Arellano and Bond (1991) [45]. Difference GMM has been widely applied to solve problems in dynamic panel data model with individual-specific fixed effects. At first, the equations are estimated in first-differences to remove the individual-specific effect. Then higher-order lagged dependent variables, as appropriate instruments, are employed by the generalized least square method [46]. The following equations present the dynamic panel model:

$$\ln EX_{jt} = \alpha_0 + \alpha_1 \ln FDI_{jt} + \alpha_2 \ln EX_{jt-1} + \delta Z_{jt} + \Phi_t + w_{jt} \quad (2)$$

where EX_{jt-1} is the one-period lag of the dependent variable. Note that there are two indispensable prerequisites while using the difference GMM method: the validation of instruments and no serial correlation in the error terms. Specifically, the Sargan test is for checking the validity of the over-identifying restrictions and the Arellano–Bond test for serial correlation circumstance.

3.2.2. Firm-Level Analysis

According to Table 1, only approximately 15% of the food firms participate in international market during the time span in the dataset covering 1998–2013. Hence, the export amount of the food firms which only serve domestic market is 0 and the log of the dependent variable is undefined. Standard regressions on full samples inevitably involve the issue of endogeneity bias from self-selection. To control for selection bias from zero export flow in the dataset, it applies the Heckman two-stage method to the firm-level panel analysis. The two stages of Heckman’s approach are able to provide specific export participation decisions (whether to export or not) by a Probit model and export amount decisions (how much to export) by an OLS model, respectively [47]. It estimates both the selection and the outcome equations simultaneously by using the maximum likelihood estimation (MLE), as this integral estimate method is more efficient than a two-stage method.

$$EXD_{ijt} = \alpha_0 + \alpha_1 \ln FDI_{jt} + \alpha_2 X_{it} + \alpha_3 Z_{jt} + \Phi_t + \mu_{ijt} \quad (3)$$

$$EXQ_{ijt} = \beta_0 + \beta_1 \ln FDI_{jt} + \beta_2 X_{it} + \beta_3 Z_{jt} + \Phi_t + v_{ijt} \quad (4)$$

The Equation (3) is the selection equation where EXD_{it} is a 0/1 binary variable, to denote whether the observation is to export or not. If food firm i serves overseas markets in year t , EXD_{it} equals to one and zero otherwise. Equation (4) is the outcome equation, where EXQ_{it} represents the export amount of food exporter i in year t . A time-varying arrays of the firm-level characteristics, X_{it} is also included. Z_{jt} , Φ_t and $\mu_{ijt}(v_{ijt})$ are presented in both the selection equation and outcome equation to control for any industry-specific characteristics (in 4-digit level), time trends, and other unobserved factors. Both Equations (3) and (4) contain the same independent variables except for the selected variables that only exist in the former equation. Note that the selection variables need to be relevant to selection stage but irrelevant to outcome stage; it chooses the variable funds which proxies for financial capability of the firms to differentiate the two equations in case of degenerating into one same equation. The coefficients α_1 and β_1 depict the spillover effect on export involving decisions and export amount decisions. Hence, the export spillover of industrial FDI on indigenous food firms can be identified in the extensive and intensive margins, where the former refers to the probability to become an exporter and the latter refers to the export flow of the incumbents.

In this part, the impact of industrial FDI presence on individual firms is examined. There is no need to concern endogeneity in firm-level empirical analysis, as the industry-level FDI could be regarded as a pure exogenous variable. Reverse causality seldom causes bias issue in firm-level estimation, especially for food firms that are relatively small and hardly influence the FDI presence amount measured at the industry level.

3.2.3. Variables

Based on disaggregated firm-level dataset, the related variables are collected in industry-level and firm-level. Table 2 provides descriptive statistics, where Panel A presents the industry-level information and the Panel B introduces the firm-level statistics.

Table 2. Descriptive statistics of variables.

Variables	Description	Obs	Mean	SD	Min	Max
Panel A: Industry Level						
lnEX	Amount of export value	774	13.65	1.78	7.44	18.78
lnDEX	Amount of domestic export value	667	12.78	1.99	5.48	18.57
lnFDI	FDI presence index	668	13.87	1.62	6.03	17.07
lnHHI_4	Herfindahl index	780	−9.04	3.16	−18.68	10.01
lnKL_4	Capital intensity index	780	4.57	0.44	3.42	5.92
lnFDI_N	Alternative FDI presence index	773	3.90	1.40	0.00	8.62
Panel B: Firm Level						
lnexport	Export value	55,365	4.84	1.77	−5.10	10.24
Foreignshare	Share of foreign capital	356,470	0.09	0.26	0.00	1.00
lnL	Size	356,470	0.15	1.10	−2.53	6.92
lnKL	Capital intensity index	356,470	3.94	1.30	−7.07	11.02
lnTFP	Total factor productivity	356,470	0.54	0.34	−7.90	10.13
Duration(year)	Age (years passed since established)	356,470	8.96	10.11	0.00	113.00
lnFunds	Financial capability	356,470	0.71	197.24	−7.91	116.900

Note: (1) The industry-level statistics are all measured via 4-digit CSIC subindustry-level in panel A, while firm-level statistics are presented in panel B. (2) Variables with ln symbol in front are calculated in logarithmic form. The values of export flows and foreign capital are reported in constant 2000.

In Panel A, the Herfindahl index (HHI) is the sum of squaring the market share of each firm in the food industry measured at the industry level to control the market concentration and market competitiveness of the industry. The exchange rate is derived between Chinese RMB and USD applied following empirical analyses from the Penn World Table 9.0 (PWT) (we made an adjustment for the real exchange rate by using the method following the convention):

$$RER_{ct} = NER_{ct} \cdot \frac{CPI_{ct}}{CPI_{CHN,t}} \quad (5)$$

where the consumer price indices (CPI) index is from the International Financial Statistic (IFS) and the original bilateral nominal exchange rate comes from the Penn World Table (PWT). The CPI-based real exchange rate is calculated by the nominal exchange-rate multiplying United States CPI and dividing by Chinese CPI in the year t .

The numbers of foreign firms are used to substitute for representing FDI presence. In Panel B, with respect to firm characteristics, firm TFP is measured by using the Olley and Pakes methodology (Olley and Pakes semi-parametric methodology has been widely used in previous literature. In the process of calculation, we used firms' gross output value for output (Y), fixed assets for capital (K), number of employees for labor (L), and intermediate inputs for raw material inputs. All variables have been deflated according to Yu and Amity & Konings [41,48]). This method uses investment as proxy variables for the unobserved productivity component [49]. Firm size is measured by the number of employees. Funds denote the financial capability and are measured by capital per sales. Moreover, capital intensity is proxied by total assets per employee, corresponding to different levels.

4. Results

4.1. Industry-Level Estimations

There are 51 food subindustries in the industry-level analysis. The industry-level benchmark empirical results are presented in Table 3 for the full food subindustries sample. Columns (1) and (2) present the results obtained from the log-linearized form of Equation (1) by using the 2SLS method. Columns (1) and (2) are analogous basically, while (2) are estimated based on cluster-robust standard errors to control for heteroskedasticity in

two-step approaches (due to the introduction of instrument, we compute the Cragg–Donald Wald F-statistic in first stage to test the hypothesis of weak instruments. According to Stock and Yogo, we set the threshold value of 10. As the F-statistic is far above 10, this instrument has been proven reliable [50]). Both the R-squared data for the 2SLS regression are over 0.5, indicating the models are well fitted. Column (3) shows the result of FGLS method. The former three columns are results of static panel estimation with fix- effect model, and Column (4) exhibits the results of dynamic panel estimation by using difference GMM. To ensure that this method is appropriate, specific tests procedures are as follows: (i) checking the validity of the instrument by using the Sargan test, which constructs p -value for the null hypothesis of “all instruments are valid”. With a p -value of 0.183, the null hypothesis cannot be rejected at the 10% level; (ii) testing the first- and second- order serial correlation by AR (1) and AR (2), the corresponding values of 0.001 and 0.217 suggest rejecting the null hypothesis of “no serial correlation” at order 1, but not at order 2. Thus, difference GMM is confirmed to be unbiased and consistent by verifying the validity of instruments and no serial correlation between residuals exist at order 2.

Table 3. Industry-level benchmark results.

Dependent Variable	Industry Level			
	(1) 2SLS	(2) 2SLS-r	(3) FGLS	(4) D_GMM
Llnexport				0.169 *** (0.0459)
lnFDI	0.306 ** (0.129)	0.406 ** (0.0696)	0.204 *** (0.0697)	0.734 *** (0.0961)
lnKL_4	0.178 *** (0.0445)	0.151 ** −0.0152	0.190 *** (0.0383)	0.109 *** (0.0393)
lnHHI_4	−0.135 (0.158)	(0.228) −0.901	0.0796 (0.143)	−0.211 ** (0.0858)
RER	−0.720 (1.198)	(1.069) 0.151 **	−0.390 *** (0.100)	−0.086 (0.0768)
Constant	15.61 ** (7.763)	14.62 ** (7.099)	13.36 *** (1.454)	3.236 ** (1.424)
Sargan Test				0.183
AR (1) Test				0.001
AR (2) Test				0.217
Pseudo R ²	0.513	0.506		
Year FE	YES	YES	YES	
Wald chi2	529.280	61.370	4908.200	1018.210
Prob > chi2	0.000	0.000	0.000	0.000
Observations	557	557	561	453

Note: Robust standard errors adjusted for clustering at the firm level are reported in parentheses. ** and *** indicate significance at the 5 and 1 percent levels, respectively.

The results from the 2SLS and FGLS estimators for static panel data, as well as difference GMM estimators for dynamic panel data, are consistent, and the statistical significance of interesting independent variables FDI shows highly robust results. The results show a significant positive spillover effect of horizontal inward FDI on overall domestic food export flow in the full food subsector sample. That is, increasing intra-industry FDI presence induces more food export flow aggregated by all domestic food firms, which highlights the contribution of inward FDI in export-enhancing of local food industries. Compared with the existing literature, this finding supports the positive effect of inward FDI on export growth [17,22,51].

Taking a deeper view of the coefficients of control variables, the capital-intense variable has a significantly positive impact on domestic food exports. It shows robust and consistent positive results in all columns, indicating that the industry of higher capital intensity would have better export performance.

According to the vast literature, the concept behind a disaggregated approach is that the export spillovers from FDI may vary across different types of food subindustries. Many studies have suggested the distinct characteristics among food subsectors. Although most of the food subsectors are labor-intensive, the capital-intensity of the agro-food processing and food manufacturing industry is obviously higher than that of the beverages and alcohol subsector (Soft Science Committee of Ministry of Agriculture, 2001). Moreover, the difference of resource endowments and competitive advantages may also lead to various export performances.

In order to make some progress in determining whether the spillover effect of FDI identified above depends on the specific industry within Chinese food sector, like the previous literature have performed regressions by using sub-industries sample to capture effective estimation, Chinese food firms were divided into three sub-industries by 2-digit industries of CSIC classification standard: agro-food processing (code 13), food manufacturing (code 14), and beverages and alcohol (code 15). Each 2-digit industry is estimated in both a static panel model and dynamic panel model, separately.

Table 4 reports the results of estimation on three main food subsectors. The agro-food processing industry (column 1 & 2) and food manufacturing industry (Columns 3 and 4) are most positively influenced by FDI, suggesting that FDI promotes domestic exports in both food subindustries. For the beverages and alcohol industry (Columns 5 and 6), however, with static or dynamic panel model, its domestic export is almost uncorrelated with FDI. This result implies that capital-intensive food subindustries are more likely to obtain positive export spillover from FDI presence through technology transferring.

Table 4. Industry-level results of different sub-industries.

Dependent Variable	13 Agro-Food Processing Industry		14 Food Manufacturing Industry		15 Beverages and Alcohol Industry	
	(1)	(2)	(3)	(4)	(5)	(6)
	FGLS	D_GMM	FGLS	D_GMM	FGLS	D_GMM
Llnexport		0.047 (0.229)		−0.029 (0.071)		0.286 ** (0.135)
lnFDI	0.402 *** (0.117)	0.808 *** (0.296)	0.392 *** (0.101)	0.333 ** (0.156)	−0.004 (0.156)	−0.257 (0.436)
lnKL_4	0.218 *** (0.052)	0.108 (0.087)	0.218 *** (0.056)	0.185 ** (0.073)	−0.076 (0.138)	0.494 *** (0.072)
lnHHI_4	−0.006 ** (0.003)	0.005 *** (0.001)	0.002 (0.002)	−0.004 *** (0.001)	0.002 (0.002)	0.004 (0.003)
RER	−0.258 * (0.139)	−0.019 (0.189)	−0.270 * (0.148)	−0.741 *** (0.116)	−1.010 *** (0.317)	0.581 * (0.312)
Constant	10.390 *** (2.216)	2.459 (4.344)	9.555 *** (1.971)	16.460 *** (3.607)	18.900 *** (2.937)	11.930 (8.458)
Sargan Test		1.000		1.000		1.000
AR (1) Test		0.077		0.059		0.029
AR (2) Test		0.374		0.891		0.186
Year FE	Yes		Yes		Yes	
Wald chi2	2227.330	351.130	1625.110	362.040	913.880	381.140
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000
Observations	188	151	229	186	144	116
Sub-industries Numbers_4	17	17	21	21	13	13

Note: Robust standard errors adjusted for clustering at the firm level are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

4.2. Firm-Level Estimations

To improve the efficiency of overall estimation, the maximum-likelihood approach is applied to the specifications of the Heckman model in the firm-level spillover analysis. Table 5 presents the results of export spillovers on domestic food firms. The correlation

coefficient (ρ) between two error terms and the estimated selection coefficient (λ) of the inverse Mills ratio are statistically significant different from zero, which indicates the existence of sample selection bias and the selection model is appropriate in the empirical analysis. Note that “Funds” is the selection variable and thus only included in Column (1), differentiating the estimation as selection model and outcome model.

Table 5. Firm-level benchmark results: extensive margin and intensive margin.

Dependent Variable	Domestic Food Firms	
	(1) Participation	(2) Amount
lnFDI	0.080 *** (20.99)	−0.048 *** (−3.32)
lnTFP	0.091 *** (7.94)	0.162 *** (4.00)
lnL	0.228 *** (67.30)	−0.102 *** (−8.39)
lnKL	0.064 *** (22.82)	0.033 *** (3.36)
lnKL_4	−0.557 *** (−47.32)	1.079 *** (24.66)
lnHHI_4	−0.118 *** (−75.23)	0.236 *** (37.73)
Duration(year)	0.000 *** (3.35)	−0.001 *** (−3.50)
RER	0.070 *** (6.97)	−0.789 *** (−21.95)
Funds	0.105 *** (−27.92)	
Constant	−1.556 *** (−15.49)	17.886 *** (47.92)
Inverse Mills Ratio		−3.087785
Wald chi2		4558.84
Prob > chi2		0.000
Year FE		Yes
Industry FE		Yes
Observations		251,631
Selected		29,382

Note: Robust standard errors adjusted for clustering at the firm level are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

As indicated by the coefficient of key explanation variable FDI presence for domestic food firms’ sample, the export spillover stems from a selection effect, whereby the FDI induces non-exporting food firms to become exporters. However, the incumbents may have eroded the market power and decreased export intensity against new exporters as well as foreign-invested exporters, at the same time, bringing more competencies in the international market share. It is noteworthy that this viewpoint is different from the analysis cited in a similar literature, which covered China’s manufacturing sector between 2000 and 2003 [52]. The same significant extensive margin but opposite intensive margin is observed in export spillovers of firm-level analysis. Although FDI benefits exports at the industry level, it shows a huge difference in firms’ export behavior across targeted industry ranges and timespans.

For domestic food firms, terms of productivity (TFP), size (L), and capital intense (KL) have a significant positive effect on extensive margin and positive effect on intensive margin except for size variable estimated results in outcome model. The industrial capital intense index (KL_4) and market concentration index (HHI) positively impact the export participation decision and negatively affect the export intense decision. That means a more capital-intensive and concentrated industry would encourage non-exporting food firms to

enter the international market, but the serious competition between new entrants and old incumbents also leads to export flow decreasing.

To further determine whether the firm characteristic leading to different spillovers vary across subindustries, we reran the three subindustries sample again. The results of firm heterogeneity analysis on the three split food subsectors are reported in Table 6. Columns (1), (3), and (5) and Columns (2), (4), and (6) trace the extensive margin and intensive margin for each subindustry, respectively. With a view to differentiate subsectors in food industry, one notable finding is the differences in coefficients of FDI presence. The estimated export spillovers on the food manufacturing industry (code 14) and beverages and alcohol industry (code 15) go in the opposite direction in extensive margin and intensive margin, while the estimated coefficients in the agro-food processing industry (code 13) show consistent signs as an overall effect. As for the food manufacturing industry and beverages and alcohol industry, the horizontal FDI encourages export value growth of incumbent exporters while discouraging the presence of China's local food firms in the international market. The possible explanation is that foreign-owned firms in these two subindustries have significant exporting superiority and raise the threshold of exporting, inhibiting new entrants of local food firms. Conversely, these local food-exporting incumbents are forced to pursue self-improvement and enhance exporting due to the pressure from foreign-owned exporters.

Table 6. Firm-level results of different sub-industries.

Dependent Variable	13 Agro-Food Processing Industry		14 Food Manufacturing Industry		15 Beverages and Alcohol Industry	
	(1) Participation	(2) Amount	(3) Participation	(4) Amount	(5) Participation	(6) Amount
lnFDI	0.173 *** (29.16)	−0.214 *** (−10.63)	−0.050 *** (−6.18)	0.196 *** (5.64)	−0.030 *** (−3.35)	0.283 *** (7.23)
lnTFP	0.162 *** (11.04)	0.328 *** (6.82)	−0.018 (−0.75)	0.587 *** (6.43)	0.057 ** (2.01)	−0.303 *** (−2.94)
lnL	0.222 *** (49.67)	0.047 *** (3.21)	0.265 *** (38.25)	−0.256 *** (−9.72)	0.289 *** (30.18)	−0.437 *** (−10.44)
lnKL	0.042 *** (11.81)	0.078 *** (6.99)	0.078 *** (13.71)	0.043 ** (2.11)	0.145 *** (16.92)	−0.171 *** (−4.87)
lnKL_4	−0.981 *** (−53.21)	1.515 *** (22.78)	−0.004 (−0.16)	0.044 (0.54)	−0.322 *** (−11.39)	0.632 *** (5.31)
lnHHI_4	−0.108 *** (−58.16)	0.197 *** (29.75)	−0.108 *** (−15.23)	0.203 *** (6.98)	−0.207 *** (−38.12)	0.285 *** (9.75)
Duration(year)	0.000 (1.35)	−0.000 (−0.33)	0.000 *** (3.63)	−0.001 *** (−3.62)	0.000 ** (2.32)	−0.001 *** (−2.90)
RER	0.194 *** (14.73)	−0.978 *** (−22.78)	−0.053 ** (−2.29)	−0.690 *** (−7.74)	−0.209 *** (−7.25)	−0.442 *** (−3.68)
Funds	−0.134 *** (−20.88)		−0.085 *** (−16.74)		−0.083 *** (−9.15)	
Constant	−1.876 *** (−11.59)	18.765 *** (33.62)	−1.410 *** (−7.13)	18.562 *** (24.32)	−0.757 *** (−3.19)	15.420 *** (15.51)
Inverse Mills Ratio	−2.761		−3.376		−3.293	
Wald chi2	2828.80		1749.64		268.77	
Prob > chi2	0.000		0.000		0.000	
Year FE	Yes		Yes		Yes	
Observations	160,914		52,321		38,396	
Selected	18,298		7804		3280	

Note: Robust standard errors adjusted for clustering at the firm level are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

4.2.1. Productivity and Size Heterogeneity

In order to explore the heterogeneous export spillover across different food firms, interaction terms of firm heterogeneity and FDI presence were added based on the bench-

mark model to deliberate the firm-level characteristics that account for the heterogeneity in export spillovers. The empirical model can be expressed as:

$$EXD_{ijt} = \alpha_0 + \alpha_1 \ln FDI_{jt} * \ln A_{ijt} + \alpha_2 \ln FDI_{jt} + \alpha_3 \ln A_{ijt} + \alpha_4 X_{it} + \alpha_5 Z_{jt} + \Phi_t + \mu_{ijt} \quad (6)$$

$$EXQ_{ijt} = \beta_0 + \beta_1 \ln FDI_{jt} * \ln A_{ijt} + \beta_2 \ln FDI_{jt} + \beta_3 \ln A_{ijt} + \beta_4 X_{it} + \beta_5 Z_{jt} + \Phi_t + v_{ijt} \quad (7)$$

where the variables have the same definitions as above equations. $\ln A_{ijt}$ represents the logarithm of nature characteristics value—namely, productivity or size—for firm i in year t (according to heterogeneous firm trade theory, the productivity heterogeneity and other important characteristics are key factors in firms' export decisions). Notably, the focus of interest is turned to the coefficient of interaction term instead of the FDI presence. The coefficient captures how the impact of the inward FDI on domestic food exports varies by food firms' characteristics. Hence, econometric model Equations (6) and (7) analyze the FDI export spillover effect on the extensive margin and intensive margin of local food firms, where firms are heterogeneous in their productivity and size.

According to the first two columns of Table 7, the coefficient of the interaction term of firm TFP and FDI presence shows a significant impact on export spillovers. In light of the selection model and outcome model estimation results, higher-productivity local food firms increase their likelihood of participating in export activities. However, the most productive incumbents suffer more unfavorable impacts on export amounts, while the least productive food exporters experience fewer impacts on export intensity. With regard to firm size heterogeneity in Columns (3) and (4), the interaction term shows no statistically significant effect on the extensive margin but positively impact the intensive margin. No heterogeneity with regard to firm size was identified for probabilities to export. Nevertheless, bigger food firms exhibited a higher degree of export amount increasing by horizontal FDI.

Export spillovers of FDI depend upon the nature of China's food firms—on one hand, the positive spillover effect on THE export extensive margin, as a result, increases with the level of a firm's productivity. Firms with higher productivity have more possibilities to export, which arrives at a consensus with existing theories and most studies [53,54]. On the other hand, the negative spillover effect on the export intensive margin exacerbates with productivity improvement, yet modifies with size expansion. This result is somewhat against the mainstream thought that high-productive firms often have better export performance. One possible reason lies in the highly overlapped export products and target market shares between local higher productive food exporters and multinational food exporters, up-market food products, for instance, which may lead to more intense competition and decrease the export flows of local productive food exporters to a large extent. Low-productivity firms are less likely to be in competition with multinationals, thus experiencing less harm on their export intensity. The obvious scale effect of bigger firms could help them be less influenced by the negative spillover effect of FDI on the intensive margin [55].

4.2.2. Ownership Heterogeneity

This paper divides all domestic food firms into two sub-samples, SOEs and non-SOEs, according to their capital structure. SOEs represent firms with more than 50% of capital share coming from the state and collective capital, while the non-SOEs are the rest of the firm cluster, except for foreign-owned firms and SOEs [56]. To determine the heterogeneity in export spillovers across firm ownerships, we reran the benchmark estimation Equations (3) and (4) using both subsamples.

Table 7. Heterogeneous spillover effect due to firm productivity and size.

Dependent Variable	TFP		Size	
	(1) Participation	(2) Amount	(3) Participation	(4) Amount
lnFDI	0.088 *** (0.01)	−0.043 * (0.03)	0.116 *** (0.01)	−0.126 *** (0.02)
lnFDI *lnTFP	0.051 *** (0.01)	−0.100 ** (0.04)		
lnFDI *lnL			−0.003 (0.00)	0.051 *** (0.01)
lnTFP	−0.471 *** (0.16)	1.230 ** (0.57)	0.278 *** (0.01)	−0.226 *** (0.05)
lnL	0.198 *** (0.00)	0.029 * (0.02)	0.243 *** (0.05)	−0.710 *** (0.17)
lnKL	0.072 *** (0.00)	0.028 ** (0.01)	0.072 *** (0.00)	0.030 ** (0.01)
lnKL_4	−0.698 *** (0.01)	1.393 *** (0.05)	−0.702 *** (0.01)	1.391 *** (0.05)
lnHHI_4	−0.095 *** (0.00)	0.118 *** (0.01)	−0.095 *** (0.00)	0.120 *** (0.01)
Duration(year)	0.000 (0.00)	−0.001 ** (0.00)	0.000 (0.00)	−0.001 ** (0.00)
RER	0.146 *** (0.01)	−1.049 *** (0.03)	0.145 *** (0.006)	−1.034 *** (0.03)
Funds	−0.106 *** (0.01)		−0.106 *** (0.01)	
Constant	−1.456 *** (0.13)	17.337 *** (0.49)	−1.843 *** (0.10)	18.433 *** (0.42)
Inverse Mills Ratio		−3.034		−3.030
Wald chi2		5877.17		4104.75
Prob > chi2		0.000		0.000
Year FE		Yes		Yes
Industry FE		Yes		Yes
Observations		139,458		139,458
Selected		18,697		18,697

Note: (1) lnKL_4 and lnHHI_4 are measured at the 4-digit CSIC level (sub-industry level). (2) Robust standard errors adjusted for clustering at the firm level are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

The results are collected in Table 8, reporting the estimates for separate ownership categories: SOEs and non-SOEs. Compared to benchmark results, the SOEs group shows little influence on the intensive margin of food export and less positive effect on extensive margin. For SOEs in the food industry, the probability of participating in the international market is increasing from the spillover of FDI and the export intensity does not deliver any response. Also of note is that non-SOEs are more sensitive to FDI presence: they receive more significant spillovers in both the extensive margin and intensive margin than that on the average overall effect.

4.3. FDI Heterogeneity

Owing to geographic and political reasons, two main types of FDI can be by their origins in Chinese context: FDI from Hong Kong, Macao, and Taiwan by Chinese investors, and FDI from other countries by foreign investors. Compared to the Chinese Mainland, Hong Kong, Macao, and Taiwan (HMT) are newly industrialized economies, and their investments in China's food sector account for over 30% of overall FDI during the sample period. HMT investors prefer labor-intensive industries while the FDI from other countries tends to flows into capital-intensive and technology-intensive industries [57,58]. Many studies have argued that the latter type is more likely to transfer technology and bring positive benefits to local economies; however, the majority of the former type of FDI enjoys many preferential policies and regards China as the ideal place for investment [59,60].

Table 8. Heterogeneous spillover effect due to firm ownerships.

Dependent Variable	SOEs		non-SOEs	
	(1) Participation	(2) Amount	(3) Participation	(4) Amount
lnFDI	0.070 *** (12.76)	−0.003 (−0.13)	0.139 *** (28.01)	−0.205 *** (−10.88)
lnTFP	0.103 *** (6.15)	0.099 (1.54)	0.212 *** (15.30)	−0.033 (−0.65)
lnL	0.228 *** (44.69)	−0.155 *** (−8.04)	0.227 *** (49.66)	−0.052 *** (−3.22)
lnKL	0.082 *** (17.77)	−0.029 * (−1.74)	0.059 *** (16.42)	0.061 *** (5.00)
lnKL_4	−0.748 *** (−43.58)	1.681 *** (23.73)	−0.712 *** (−53.41)	1.533 *** (28.55)
lnHHI_4	−0.076 *** (−41.45)	0.155 *** (19.85)	−0.102 *** (−58.91)	0.149 *** (19.45)
Duration(year)	0.000 (1.06)	−0.001 ** (−2.19)	0.000 *** (4.06)	−0.001 *** (−2.64)
RER	0.113 *** (8.05)	−0.816 *** (−15.45)	0.216 *** (11.30)	−1.230 *** (−18.91)
Funds	−0.097 *** (−18.43)		−0.111 *** (−21.43)	
Constant	−0.838 *** (−5.56)	15.038 *** (25.83)	−2.752 *** (−17.66)	20.821 *** (37.61)
Inverse Mills Ratio		−3.207932		−3.027913
Wald chi2		1762.20		3083.70
Prob > chi2		0.000		0.000
Year FE		Yes		Yes
Industry FE		Yes		Yes
Observations		97,562		154,069
Selected		11,037		18,345

Note: Robust standard errors adjusted for clustering at the firm level are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

The difference in the business purposes of foreign investment may also bring heterogeneous export spillover. In terms of export-oriented FDI, it could bring more information spillovers of the international market, which also intensifies export competition. As for domestic market-oriented FDI, it seems more likely to interchange technical expertise and experience with peer local firms, which may promote export capacity for domestic food firms.

Rethinking the spillover effects of FDI on domestic agricultural exports depending on its type might be quite reasonable. This section investigates how FDI heterogeneity influences the spillover on China's domestic food exports.

According to the database constructed by detailed sources of foreign investment, it is attainable to identify FDI heterogeneity by the origin country and business purpose of every foreign investment. Table 9 shows the descriptive statistics of different FDI types and their position. Most inward FDI is being pitched to export-oriented firms and comes from other countries instead of flowing to domestic market-oriented firms and coming from the HMT regions of China. It also indicates that a significant portion of foreign investments prefers to take advantage of low production costs and preferential tax policies in China and exporting to international market to achieve high markups.

4.3.1. FDI Origin Heterogeneity

This section estimates a similar regression of Equations (1) and (2) as reported in Table 10 to further distinguish FDI presence by origins. An interesting finding unique to the Chinese context is the different export spillovers by FDI origin-heterogeneity—the FDI from HMT regions shows less apparent positive spillover to domestic food export than the FDI from other countries.

Table 9. Descriptive statistics of FDI types.

FDI Heterogeneity (4-Digit CSIC Subindustry Level)	Obs	Mean	SD	Min	Max
lnFDI	668	13.868	1.619	6.026	17.068
lnFDI_fs	666	13.402	1.711	6.026	16.750
lnFDI_hmt	646	12.738	1.551	7.115	15.767
lnFDI_dmo	572	11.961	1.848	5.704	15.897
lnFDI_eo	665	13.502	1.819	6.026	16.892

Note: (1) All FDI presence variables are aggregated to the 4-digit CSIC industry level, calculated by the sum of corresponding foreign capital. (2) “_fs”, “_hmt” are used to distinguish FDI from foreign countries and FDI from HMT regions of China, which can be obtained from dataset directly. “_dmo”, “_eo” are used to differentiate FDI with orientation of domestic market or with orientation of exports. The firms with export/sales ratio over 50% could be collected to the source of export-oriented FDI, while firms with export/sales ratio below 50% is identified as the source of domestic market-oriented FDI.

4.3.2. FDI Business Purpose Heterogeneity

By re-estimating the benchmark model of FDI presence with different business purposes, the different export spillovers are highlighted in Table 11. It is worth noting that only FDI presence with domestic market orientation brings positive spillovers on local food export performance, while export-oriented FDI does not have significant influence. The possible explanation is that export-oriented foreign-invested firms may exert more competitive pressure on domestic food firms in terms of international market share, squeezing market share of domestic exporters and thus unable to bring spillovers.

Table 10. Heterogeneous spillover effect due to the origin of FDI.

Dependent Variables	FDI_fs		FDI_hmt	
	(1) FGLS	(2) D_ GMM	(3) FGLS	(4) D_ GMM
L.lnexport		0.117 *** (0.04)		0.217 *** (0.05)
lnFDI_fs	0.106 ** (0.05)	0.272 *** (0.03)		
lnFDI_hmt			0.060 * (0.04)	0.065 ** (0.03)
lnKL_4	0.203 *** (0.08)	0.236 *** (0.02)	0.196 *** (0.04)	0.286 *** (0.03)
lnHHI_4	0.103 (0.15)	0.073 (0.07)	0.165 (0.14)	0.095 (0.11)
RER	−0.413 *** (0.01)	−0.163 ** (0.07)	−0.476 *** (0.10)	−0.0152 (0.08)
Constant	15.320 *** (1.14)	11.140 *** (0.74)	16.310 *** (1.01)	11.910 *** (1.30)
Sargan Test		0.364		0.239
AR (1) Test		0.001		0.001
AR (2) Test		0.335		0.138
Year FE	Yes		Yes	
Wald chi2	4865.000	812.240	4966.890	908.920
Prob > chi2	0.000	0.000	0.000	0.000
Observations	559	450	549	440
Sub-industries Numbers_4	51	49	51	49

Note: Robust standard errors adjusted for clustering at the firm level are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table 11. Heterogeneous spillover effect due to the objective of FDI.

Dependent Variables	FDI_DMO Domestic Market-Oriented		FDI_EO Export-Oriented	
	(1) FGLS	(2) D_ GMM	(3) FGLS	(4) D_ GMM
L.Inexport		0.198 *** (0.05)		0.328 *** (0.05)
lnFDI_dmo	0.151 *** (0.05)	0.421 *** (0.08)		
lnFDI_eo			−0.004 (0.03)	0.027 (0.02)
lnKL_4	0.175 *** (0.04)	0.176 *** (0.04)	0.217 *** (0.04)	0.229 *** (0.03)
lnHHI_4	0.147 (0.14)	−0.134 * (0.07)	0.185 (0.16)	0.002 * (0.00)
RER	−0.447 *** (0.10)	−0.063 (0.07)	−0.456 *** (0.11)	−0.044 (0.06)
Constant	14.760 *** (1.05)	7.431 *** (1.80)	17.040 *** (0.96)	10.890 *** (1.24)
Sargan Test		0.232		0.391
AR (1) Test		0.001		0.002
AR (2) Test		0.166		0.706
Year FE	YES		YES	
Wald chi2	5009.220	1074.880	4046.710	1234.940
Prob > chi2	0.000	0.000	0.000	0.000
Observations	559	453	479	378
Sub-industries Numbers_4	51	51	50	48

Note: Robust standard errors adjusted for clustering at the firm level are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Interestingly, the results of different export spillovers from FDI origin and business purpose heterogeneities are consistent with previous studies (Abraham et al., 2010; Girma et al., 2009). Export-oriented FDI, however, has barely any spillover on domestic food exports in this section. As previously mentioned, compared to FDI from foreign countries, FDI from the HMT regions of China mainly flows into labor-intensive and more export-oriented industries, such as the food industry, which leads to insignificant export spillover for indigenous food firms. Therefore, this empirical analysis proposes a reasonable link and demonstrates the relationship between FDI heterogeneity in some cases.

4.4. Robustness

As for the regression of interest in this paper, the main explanation variable is FDI presence. Hence, to control for the possible bias brought by the measurement of FDI presence, this paper presents an alternative empirical estimation by measuring foreign presence based on the cumulative counts of foreign firms instead of foreign capital position.

By rerunning Equation (1) of the static panel model and Equation (2) of the dynamic panel model with the alternative FDI presence measurement, it is practical to compare the coefficients to benchmark results at the industry level. This paper also re-examines Equations (3) and (4) to check the firm-level estimation results.

The results, presented in Table 12, are essentially unchanged from benchmark results of industry-level analysis in Table 3. It shows that the result of the industry-level spillover effect is robust. Table 13 is at the firm-level analysis, rerunning Equations (3) and (4) of Heckman's method. The regressor of interest *FDI_N* stays consistent and robust in both significance and signs. This result indicates the necessity of considering sample selection bias (the ρ significantly unequal 0), as well as the positive spillover effect on the extensive margin and negative spillover on the intensive margin for domestic food firms.

Table 12. Robustness results of alternative measures in industry-level estimation.

Dependent Variables	Industry-Level			
	(1) 2SLS	(2) 2SLS-r	(3) FGLS	(4) D_GMM
L.Inexport				0.395 *** (0.017)
lnFDI_N	0.640 *** (0.159)	0.593 ** (0.285)	0.236 *** (0.077)	0.106 *** (0.022)
lnKL_4	0.167 *** (0.040)	0.173 *** (0.062)	0.204 *** (0.036)	0.208 *** (0.014)
lnHHI_4	0.0434 (0.147)	0.165 (0.268)	0.118 (0.138)	−0.273 *** (0.032)
RER	−0.966 (1.179)	−1.170 (1.161)	−0.480 *** (0.095)	10.180 *** (0.640)
Constant	18.420 ** (7.259)	19.390 *** (6.126)	15.780 *** (0.910)	0.395 *** (0.017)
Sargan Test				0.305
AR (1) Test				0.000
AR (2) Test				0.631
Pseudo R ²	0.494	0.497		
Year FE	YES	YES	YES	
Wald chi2	562.920	5541.490	5549.320	3334.710
Prob > chi2	0.000	0.000	0.000	0.000
Observations	611	563	615	493
Sub-industries				
Numbers_4	51	51	51	49

Note: Robust standard errors adjusted for clustering at the firm level are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table 13. Robustness results of alternative measures in firm-level estimation.

Dependent Variable	Firm-Level	
	(1) Participation	(2) Amount
lnFDI_N	0.247 *** (57.70)	−0.374 *** (−23.29)
lnTFP	0.090 *** (7.74)	0.146 *** (3.69)
lnL	0.238 *** (69.42)	−0.108 *** (−8.91)
lnKL	0.066 *** (23.10)	0.030 *** (3.10)
lnKL_4	−0.373 *** (−32.34)	0.755 *** (18.48)
lnHHI_4	−0.126 *** (−78.93)	0.249 *** (40.08)
Duration(year)	0.000 *** (4.33)	−0.001 *** (−4.23)
RER	0.039 *** (3.92)	−0.777 *** (−22.57)
Funds	−0.107 *** (−27.63)	
Constant	−2.142 *** (−24.29)	20.135 *** (63.75)
Inverse Mills Ratio		−2.991421
Wald chi2		4043.86
Prob > chi2		0.000
Year FE		YES
Industry FE		YES
Observations		251,830
Selected		29,403

Note: Robust standard errors adjusted for clustering at the firm level are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Apart from the alternative of key variables, additional empirical analyses by different methods or specifications are recruited for the robustness check to confirm the results. In aggregated industry-level analysis, as reported in Section 4, the two-stage least squares (2SLS) method and feasible generalized least squares (FGLS) method have been used to examine the relationship between inward FDI and domestic export flow. To avoid the affection of path dependence in export, the dynamic panel model is applied to ensure the robustness of the results. In terms of the firm-level Heckman's method, both the Maximum Likelihood Estimate (MLE) estimator and two-stage estimation are applied to obtain robust results.

5. Conclusions and Implications

Capital flowing to emerging market economies creates externalities on the host country's economy and firms [8]. This paper explored the export spillovers of inward horizontal FDI on China's domestic food industry.

The findings suggest that the export spillover effect of horizontal FDI presence is generally positive on aggregated food subsectors. After taking a closer look at China's indigenous food firms, it was found that the horizontal FDI presence positively affects the decision on whether to export (the extensive margin), yet negatively influences decisions of how much to export (the intensive margin). That is, FDI may encourage domestic food firms to participate in export activities, but it diminishes the exports flow of incumbent food exporters.

Particularly, this paper provides empirical support for the different spillover effects on food exports across two perspectives: firm-level heterogeneities and FDI heterogeneities. Disentangling the spillover effects due to FDI heterogeneity reveals more nuanced results. Specifically, the direction and degree of spillover is related to the nature and characteristics of individual food firms, even given the same level of FDI in a food subindustry. High-productive non-exporters are more willing to participate in the international market while incumbents of higher productivity would reduce their export intensity to a greater extent than that of lower productivity. Bigger food exporters may less decrease export intense compared to smaller ones. Additionally, state-owned food firms only experience positive impacts on their export participation decisions by FDI spillover while the negative spillovers on export intensity do not happen to SOEs. Furthermore, it is instructive to note that the FDI origin and orientation heterogeneities may also incur different export spillover effects in China's food industry.

In terms of broader implications, this study provides emerging markets, especially economies that are partly based on agricultural exports, a new opportunity to re-examine the relationship between inward FDI and local food exports. As the general domestic export-enhancing spillover effect of inward FDI on sustainable domestic food exports, more support should be provided for ongoing incentive policy of foreign capital in food industry. Yet, the presence of FDI may encourage more domestic food firms to participate in exporting and raise competitiveness for the international market share. The indigenous incumbents should be aware of the magnitude of this problem for the possibility of food export induction. Another cautionary concluding remark: the increasing FDI position should not be regarded as an entire positive sign for domestic export. For decision-makers, policy formulation and actual implementation of any FDI inflow in the food industry will have to be carried out carefully after making clear its business purpose and origin countries.

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