VOLUME 30 ISSUE 2 2022

ECONOMICS OF TRANSITION AND INSTITUTIONAL CHANGE

WILEY

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comparing them with those obtained from Eurostat. Specifically, data on the employment proportions of various manufacturing industries and large firms (firms with more than 250 employees) are collected from these databases and compared in Figures 1 and 2, respectively. Figure 1 shows that the employment proportion data from Academus are close to those obtained from Eurostat, whereas Figure 2 shows that the Academus data reflect the actual situation much better than the Eurostat data in general. However, due to the data collection range adopted in this paper, the proportion of large firms in the collected Academus data exceeds the actual levels. While information on the financial situation and other aspects of small and micro-firms cannot be easily verified, the manufacturing employment data taken from Academus are close to those obtained from Eurostat (7,198,195 vs. 7,386,411). Given that Academus has a coverage rate exceeding 97%, the samples taken from this database have very good representation.

The collected data are then processed following the procedures of Kalemli-Ozcan et al. (2015), and missing major financial data, including total and fixed assets, number of employees, shareholder information and sales revenues, are removed from the sample. The sample used for the analysis includes 21,351 manufacturing firms. The main explanatory variables are then calculated following the same method adopted by Kalemli-Ozcan et al. (2015), who took the nationality of ultimate shareholders into consideration in their analysis. Meanwhile, firm productivity is calculated along with the explained variables by following the method of Olley and Pakes (1996) and Ackerberg et al. (2015). Specifically, the following Cobb–Douglas production function is established in linear form:

$$y_{ft} = \beta_l l_{ft} + \beta_k k_{ft} + \beta_I I_{ft} + \omega_{ft} + \mu_{ft}, \tag{4}$$

where y_{ft}, l_{ft}, k_{ft}, I_{ft} and ω_{ft} represent firm output, labour, capital, fixed investment and productivity in their logarithmic forms, respectively, and μ_{ft} denotes the errors and other exogenous shocks. Based on Brandt et al. (2012), the capital of firms and investment in fixed assets are then calculated following the approach

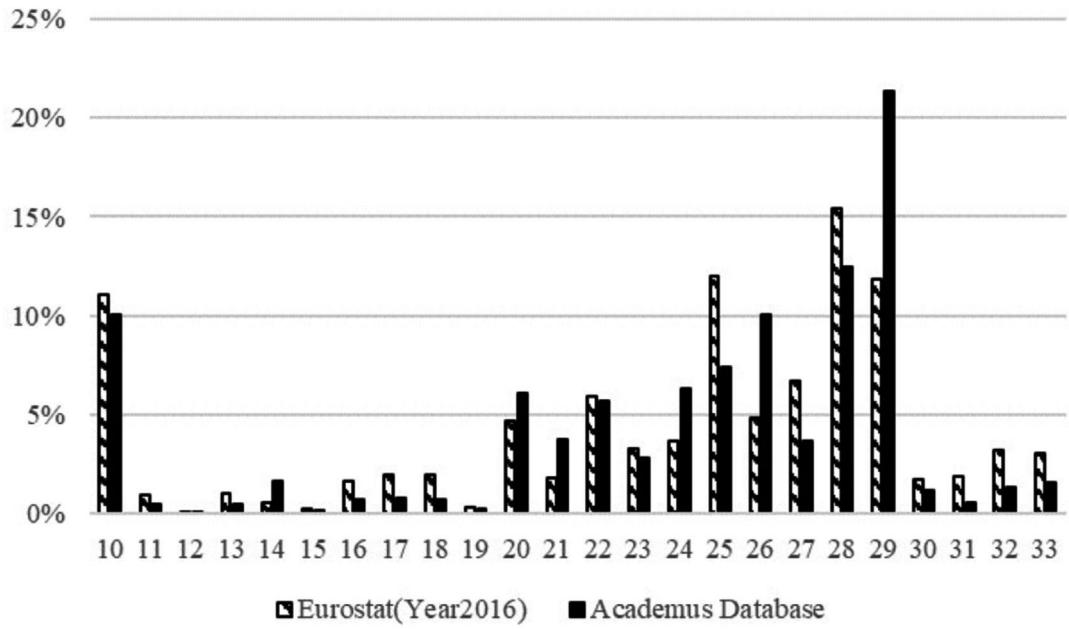

FIGURE 1 Comparison between manufacturing employment ratio data taken from Academus and Eurostat.
Note: The employment proportion data from Academus are close to those obtained from Eurostat

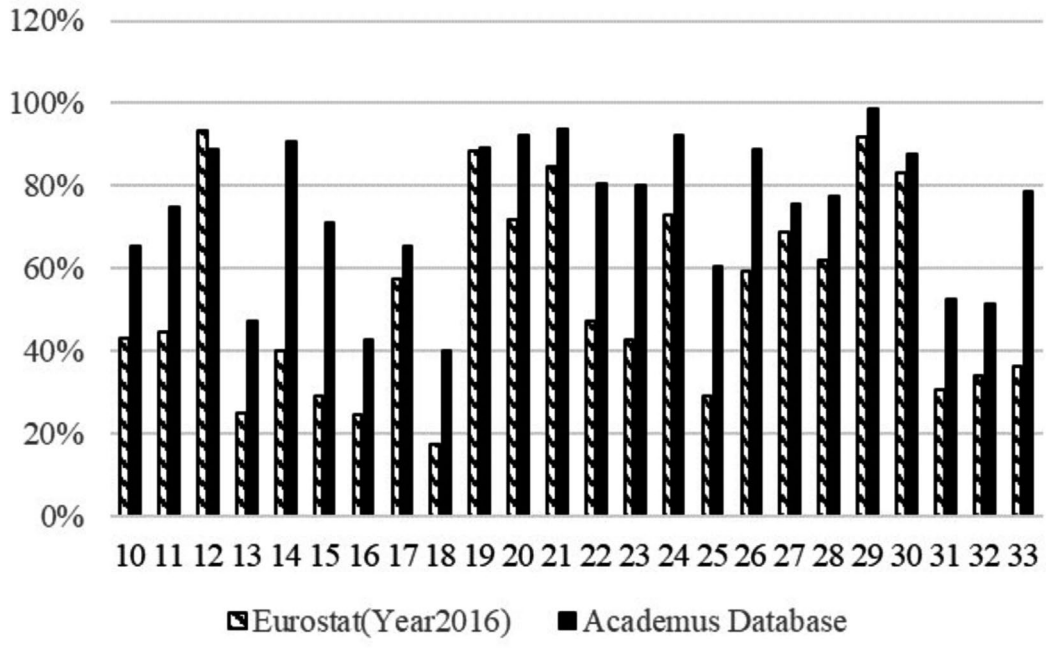

FIGURE 2 Comparison between large firms employment proportion data taken from Academus and Eurostat. *Note*: The Academus data coverage is generally much better than that of Eurostat

of Brandt et al. (2012), and investment demand is computed as follows using investment in fixed assets as a proxy variable:

$$I_{ft} = I_t(k_{ft}, \omega_{ft}), \tag{5}$$

Based on the above equation, the function of productivity ω_{ft} is then inversely solved with respect to k_{ft} and I_{ft}. Afterward, the following output prediction equation is obtained by integrating the function of productivity into Equation (4):

$$y_{ft} = \phi_t(l_{ft}, k_{ft}, I_{ft}) + \mu_{ft}. \tag{6}$$

Based on the above equation, firm productivity can be mathematically expressed as follows:

$$\omega_{ft} = \widehat{\phi}_{ft} - \beta_l l_{ft} - \beta_k k_{ft} - \beta_I I_{ft}. \tag{7}$$

Productivity ω_{ft} is assumed to follow the first-order Markov process to yield the following:

$$\omega_{ft} = g(\omega_{ft-1}) + \xi_{ft}. \tag{8}$$

Productivity is estimated using the moment condition of the production function, which is expressed as follows:

$$E(\xi_{ft}(\beta)\Upsilon_{ft}) = 0, \tag{9}$$

where $\xi_{ft} = \omega_{ft}(\beta) - E(\omega_{ft}(\beta) \mid \omega_{ft-1}(\beta))$, and the logarithmic forms of capital, labour and fixed investment are all accounted for in Υ_{ft}. The estimated value of firm productivity is then obtained as follows by substituting the value of coefficient $\widehat{\beta} = (\widehat{\beta}_l, \widehat{\beta}_k, \widehat{\beta}_I)$ into Equation (7):

$$\widehat{\omega}_{ft} = \widehat{\phi}_{ft} - \widehat{\beta}_l l_{ft} - \widehat{\beta}_k k_{ft} - \widehat{\beta}_I I_{ft} \tag{10}$$

Some control variables that influence firm productivity and FDI at the firm and industry levels are also considered in the analysis. The industry-level control variables include import and export permeability, average age, FDI and logarithmic number of companies, all of which determine how much imports affect the industry. Data on import permeability, which is computed by taking the sum of domestic industrial production and the quotient of industrial exports over imports, are collected from the ComExt database of Eurostat, whereas data on the other variables are calculated based on data taken from the Academus database. Meanwhile, the firm-level control variables include the logarithm of income, leverage ratio and firm age. Given that the recent foreign acquisitions of China are somehow driven by the effects of the global financial crisis on overseas markets, corporate leverage ratio is controlled in the analysis. Meanwhile, the life cycle of an industry can be reflected in the age and number of its companies, with 'mature' industries and those experiencing a decline having a higher tendency to be acquired by players from emerging markets. Revenues can be used to control business scale. Table 1 lists the aforementioned variables along with their descriptive statistics.

4 | EMPIRICAL RESULTS

4.1 | Baseline regression

The new investment review system of Germany is treated as the IV in this study to address potential problems related to endogeneity. Whether the DD model satisfies the parallel trend assumptions or not should be tested before its application in the first stage of the regression. Table 2, which presents the average degree of control of Chinese investments over restricted and unrestricted industries, clearly shows that the treatment and control industries receive nearly the same amount of investments (approximately 0.05% difference) from China in 2015 and 2016. However, such difference grew to more than 0.2% by the end of 2017. Therefore, one may assume that the parallel trend hypothesis holds.

The results of the regression in Table 3 are initially reported via ordinary least squares (OLS). All standard errors are clustered at the firm level. The spillover effects of Chinese investments are presented in columns (1) and (2), of which the former shows that the spillover effects of these investments on the productivity of manufacturing firms are significantly negative. With other conditions unchanged, for every unit increase in China's FDI penetration rate in the industry, non-Chinese-funded enterprise productivity will drop by 0.745 units. Those industries in the sample that are not covered by Chinese investments are dropped from the analysis to enhance comparability between the covered and non-covered industries. Column (2) presents the coefficient estimates after removing the non-covered industries. With other conditions unchanged, for every unit increase in China's FDI penetration rate in the industry, non-Chinese-funded enterprise productivity will drop by 0.949 units. The negative spillover effects shown in column (2) are also larger than those presented in column (1).

Columns (3)–(5) of Table 3 present the first-stage, second-stage and reduced form regression results for the IV for testing the parallel trend hypothesis. The regression coefficient is in line with the predictions. The IV and the absolute value of the coefficient have significantly negative effects on

TABLE 1 Descriptive statistics of the firm- and industry (NACE four-digit)-level control variables

Variables	Description	Observations	Mean	Standard deviation	Minimum	Maximum
Firm-level variables:						
ACF	ACF productivity	21,351	9.125	0.831	−3.620	17.042
Age	Firm age	21,351	2.960	1.029	0	6.597
Gear	Leverage	21,351	2.351	2.207	0.336	21.310
Revenue	Logarithmic of income	21,351	3.082	0.838	0	5.182
Industry-level variables:						
FDI_cn	Industry FDI penetration rate in China	915	0.001	0.015	0	0.324
FDI_world	Industry FDI permeability	915	0.092	0.177	0	1
IM PNT	Industry import permeability	915	0.400	0.280	0	1
_N_Firm	Logarithm of the number of firms in the industry	915	1.961	1.545	0	6.958
Avg_Age	Average age of the industry	915	28.939	22.006	1	178

Note: This table reports the descriptive statistics of variables of firm level and the NACE four-digit industry level.

TABLE 2 Parallel trends

Year	Variable	Number of unrestricted industries	Mean value	Number of restricted industries	Mean value	Mean difference
2015	FDI (China)	161	0.007%	47	0.058%	−0.051%
2016	FDI (China)	227	0.041%	58	0.094%	−0.053%
2017	FDI (China)	231	0.354%	59	0.133%	0.221%

Note: The mean values of the explanatory variables (degree of control of Chinese investments over the industry) between 2015 and 2017 are presented in this table along with the number of industries in the sample, whether restricted or unrestricted. The table clearly shows that the degree of control of Chinese investments increases much faster for unrestricted industries.

Chinese investments in Germany as revealed in the first- and second-stage regressions, respectively. The robustness of such effects is supported by the fact that the absolute value of the coefficient is larger than that presented in column (2). With other conditions unchanged, for every unit increase in China's FDI penetration rate in the industry, non-Chinese-funded enterprise productivity will drop by 9.508 units. Meanwhile, the reduced form regression returns a significantly positive coefficient. All regressions validate the hypothesis that Chinese investments have a negative spillover effect, and that the OLS regression coefficient is approximately 10 times lower than the IV regression coefficient. The F, LM and Cragg–Donald statistics of the first-stage regression are 47.669, 46.778 and 97.130, respectively, thereby rejecting the possible weakness of the IV.

'Wide' and 'narrow' instrumental variables are presented in columns (1) and (2) of Table 4, respectively. Wide IV accounts for the restricted industries, including industries 25, 26, 27, 28, 30 and 33 in the NACE two-digit industrial classification, which are broader than those NACE four-digit industries

TABLE 3 Baseline regression

	(1)	(2)	(3)	(4)	(5)
	OLS	**OLS**	**First stage**	**Second stage**	**Reduced form**
IV			−0.006***		0.057**
			(0.001)		(0.024)
FDI_cn	−0.745**	−0.949***		−9.508**	
	(0.315)	(0.336)		(4.112)	
FDI_world	0.112***	0.133***	0.018***	0.275***	0.107***
	(0.039)	(0.043)	(0.001)	(0.080)	(0.041)
The EX PNT	0.268***	0.268***	−0.024***	0.034	0.268***
	(0.076)	(0.093)	(0.002)	(0.143)	(0.087)
IM PNT	−0.100	−0.111	−0.002	−0.109	−0.088
	(0.071)	(0.089)	(0.002)	(0.082)	(0.081)
_N_Firm	−0.040***	−0.051***	−0.002***	−0.073***	−0.050***
	(0.007)	(0.008)	(0.000)	(0.013)	(0.007)
Avg_Age	−0.209***	−0.193**	−0.009***	−0.270***	−0.180**
	(0.072)	(0.091)	(0.002)	(0.091)	(0.082)
Age	−0.083***	−0.078***	−0.000	−0.078***	−0.078***
	(0.006)	(0.007)	(0.000)	(0.006)	(0.006)
Gear	0.011***	0.009***	−0.000	0.009***	0.009***
	(0.002)	(0.003)	(0.000)	(0.003)	(0.003)
Revenue	0.048***	0.041***	−0.000	0.041***	0.041***
	(0.005)	(0.006)	(0.000)	(0.004)	(0.004)
Constant	8.984***	9.126***	0.034***		9.088***
	(0.111)	(0.134)	(0.003)		(0.110)
Observations	21,351	15,832	15,832	15,832	15,832
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes

Note: The benchmark regression results are presented in this table. The OLS regression results for the manufacturing firms and for all industries excluding those not covered by Chinese investments are presented in columns (1) and (2), respectively. Firm productivity is treated as the dependent variable in the entire regression. The results of the IV, first-stage, second-stage and reduced form regressions are presented in columns (3)–(5), respectively. The significance of each coefficient is denoted by *, where ***, ** and * indicate that the coefficient is significant at $p < .01$, <.05 and <.1, respectively.

presented in Table 5 (including the weapon industry, represented by NACE code 2540). Meanwhile, narrow IV represents the sensitive technology industries specified by the new investment review system of Germany and denoted by * in Table 5. In summary, Chinese investments have a significantly negative spillover effect on German industries as indicated by the regression results in columns (1) and (2), and the robustness of this conclusion has been proven.[1] In comparison to Table 3, and after

[1]To avoid the situation where too few control group samples are available, all manufacturing samples are used when a broader IV is selected. A slightly lower *F* value (11.16) is obtained in the first-stage regression, which may lead to biased estimations in the subsequent regression. Using the precision IV yields an *F* value of 26.15 in the first-stage regression.

TABLE 4 Regression of instrumental variables

	(1)	(2)	(3)	(4)
	Wide IV	**Narrow IV**	**Placebo (year 2015)**	**Placebo (year 2016)**
FDI_cn	−68.812***	−22.560***	−9.719	−8.202
	(20.373)	(6.842)	(6.100)	(6.194)
FDI_world	0.953***	0.492***	0.279**	0.254**
	(0.271)	(0.111)	(0.109)	(0.111)
The EX PNT	−1.114***	−0.323	0.0282	0.070
	(0.400)	(0.198)	(0.181)	(0.183)
IM PNT	−0.091	−0.105	−0.109	−0.109
	(0.118)	(0.103)	(0.092)	(0.091)
_N_Firm	−0.170***	−0.107***	−0.074***	−0.070***
	(0.044)	(0.018)	(0.018)	(0.018)
Avg_Age	−0.560***	−0.387***	−0.272**	−0.258**
	(0.122)	(0.122)	(0.112)	(0.112)
Age	−0.086***	−0.079***	−0.079***	−0.078***
	(0.011)	(0.008)	(0.007)	(0.007)
Gear	0.011**	0.008***	0.009***	0.009***
	(0.004)	(0.003)	(0.003)	(0.003)
Revenue	0.048***	0.041***	0.041***	0.041***
	(0.007)	(0.006)	(0.006)	(0.006)
Observations	21,351	15,832	15,832	15,832
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Note: The results for all other IV regressions are reported in this table. Columns (1) and (2) present the regression results for wide and narrow IV, respectively, whereas columns (3) and (4) present the results of a placebo test. The setting methods are assuming that the German new investment laws were introduced in 2015 and 2016, and the coefficients are no longer significant. The significance of the coefficients is denoted by *, where ***, ** and * indicate significance at $p < .01$, <.05 and <.1, respectively.

distinguishing the wide IV and narrow IV coefficients, the absolute values of the coefficients in columns (1) and (2) of Table 4 have increased to −68.812 (wide IV) and −22.560 (narrow IV), respectively.

In the placebo test, 2015 and 2016 are set as the time dummy variables for the first-stage regression. Columns (3) and (4) show that the coefficients for these variables are negative yet not significant. Approximately 20% of the NACE four-digit industries in Germany are covered by the new review system. The same proportion of industries is selected for another placebo test, and the time dummy variable in the first-stage DD regression is randomly assigned. Afterward, the regression in column (4) of Table 3 is performed 300 times. Chinese investments show a close to normal distribution, and the regression coefficient in column (4) of Table 3 is at approximately the 25th percentile (Figure 3).

The regression results for these instrumental variables indicate that Chinese investments have a significant negative spillover effect on German industries. However, these effects may be underestimated in the OLS regression. The regression coefficient in Column (2) of Table 3 demonstrates that spillover effects in 2016 were−0.01 on average, which increased to −0.022 in 2017. Meanwhile, the

TABLE 5 Industries covered by the new review system

NACE code	Description	NACE code	Description
2540***	Manufacture of weapons and ammunition	2841	Manufacture of metal forming machinery
2611***	Manufacture of electronic components	2849	Manufacture of other machine tools
2612***	Manufacture of loaded electronic boards	2891	Manufacture of machinery for metallurgy
2620***	Manufacture of computers and peripheral equipment	2893	Manufacture of machinery for food, beverage and tobacco processing
2630***	Manufacture of communication equipment	2899	Manufacture of other special-purpose machinery n.e.c.
2640	Manufacture of consumer electronics	2910	Manufacture of motor vehicles
2651***	Manufacture of instruments and appliances for measuring, testing and navigation	2920	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
2660***	Manufacture of irradiation, electromedical and electrotherapeutic equipment	2931	Manufacture of electrical and electronic equipment for motor vehicles
2670	Manufacture of optical instruments and photographic equipment	2932	Manufacture of electrical and electronic equipment for motor vehicles
NACE code	Description	NACE code	Description
2680	Manufacture of magnetic and optical media	3011	Building of ships and floating structures
2711***	Manufacture of electric motors, generators and transformers	3020***	Manufacture of railway locomotives and rolling stock
2712***	Manufacture of electricity distribution and control apparatus	3030***	Manufacture of air and spacecraft and related machinery
2720	Manufacture of batteries and accumulators	3040***	Manufacture of military fighting vehicles
2731***	Manufacture of fibre optic cables	3099	Manufacture of other transport equipment n.e.c.
2732	Manufacture of other electronic and electric wires and cables	3311	Repair of fabricated metal products
2733	Manufacture of wiring devices	3312	Repair of machinery
2740	Manufacture of electric lighting equipment	3313	Repair of electronic and optical equipment
2790	Manufacture of other electrical equipment	3314	Repair of electrical equipment
2821	Manufacture of ovens, furnaces and furnace burners	3315	Repair and maintenance of ships and boats
2824	Manufacture of power-driven hand tools	3316***	Repair and maintenance of aircraft and spacecraft
2825	Manufacture of non-domestic cooling and ventilation equipment	3317	Repair and maintenance of other transport equipment
2829	Manufacture of other general-purpose machinery n.e.c.	3319	Repair of other equipment
2830	Manufacture of agricultural and forestry machinery	3320	Installation of industrial machinery and equipment

Note: *** in the form marks those specified industries in the new review system.

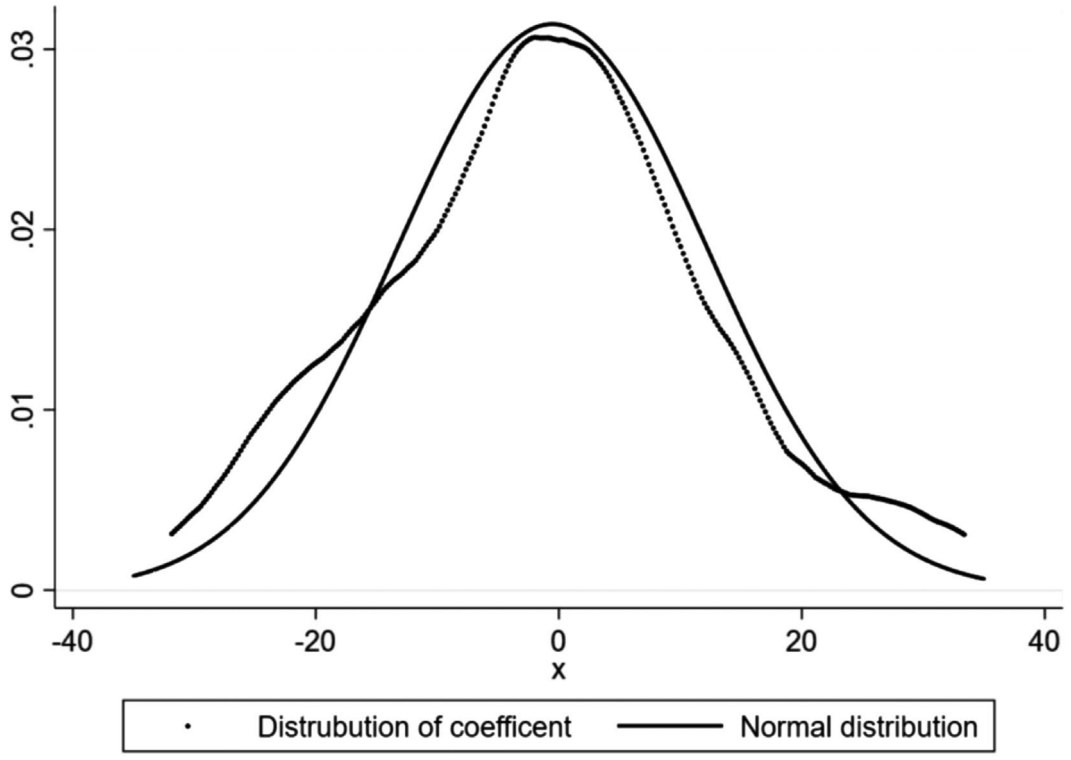

FIGURE 3 Random setting of the reviewed industries and the time variable. *Note*: In this figure, both the time variables and the reviewed industries are randomly selected, whereas the explanatory variable coefficients follow a near-normal distribution

IV regression results (Column 4 of Table 3) show that the spillover sizes for both years were −0.023 and −0.052, respectively. For industries with the deepest penetration of Chinese-funded enterprises, the average spillover effect can be as high as −3.081. As China increases its investments in Europe as part of its 'One Belt One Road' initiative, the aforementioned spillover effects tend to increase.

4.2 | Robustness test

Table 6 presents the results of an IV regression for robustness check. Column (1), which takes all manufacturing firm samples into consideration, reveals a significantly negative regression coefficient (−12.084), whose absolute value exceeds the baseline regression. Productivity is then calculated using the approach of Olley and Pakes (1996), and results show that Chinese investments still have a significantly negative coefficient (−7.244) whose absolute value is below the baseline regression. Interestingly, the ratio of super-large firms in the sample as shown in Figure 2 exceeds the actual proportions. Moreover, the changes in the equity of these super-large firms may greatly affect the entire industry due to the significant influence of these firms, and such effect may lead to biased FDI coefficient estimates. In this case, the super-large firms in each industry in the sample are removed for another round of regression, and the IV is recalculated. Results in column (3) reveal a slight significant decline in the coefficient of Chinese investments. Meanwhile, column (4) presents the regression results for the sample excluding the listed firms given that the investments in such firms

TABLE 6 Robustness test results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All the samples	**OP productivity**	**Exclude big firms**	**Exclude listed firms**	**Wide IV**	**IV**	**Narrow IV**
FDI_cn	−12.084***	−7.244**	−8.031**	−9.411**	−433.422	−79.323**	−77.085*
	(4.197)	(3.422)	(3.869)	(4.051)	(616.194)	(35.530)	(40.906)
FDI_world	0.252***	0.215***	0.196***	0.282***	3.196	0.622**	0.605*
	(0.0644)	(0.066)	(0.063)	(0.081)	(4.520)	(0.304)	(0.337)
EX PNT	0.0380	0.014	0.110	0.032	−0.545	0.291	0.297
	(0.112)	(0.115)	(0.111)	(0.146)	(1.747)	(0.271)	(0.272)
IM PNT	−0.099	−0.071	−0.100	−0.104	−0.758	−0.273	−0.270
	(0.073)	(0.071)	(0.071)	(0.091)	(1.196)	(0.231)	(0.230)
_N_Firm	−0.061***	−0.056***	−0.057***	−0.075***	−0.200	−0.060**	−0.059**
	(0.010)	(0.010)	(0.010)	(0.013)	(0.257)	(0.026)	(0.027)
Avg_Age	−0.267***	−0.222***	−0.223***	−0.298***	−1.086	−0.496**	−0.492**
	(0.077)	(0.079)	(0.077)	(0.100)	(1.237)	(0.193)	(0.194)
Age	−0.083***	−0.074***	−0.076***	−0.078***	−0.220	−0.150***	−0.150***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.143)	(0.022)	(0.022)
Gear	0.011***	0.007***	0.011***	0.009***	−0.037	−0.016	−0.016
	(0.002)	(0.002)	(0.002)	(0.003)	(0.052)	(0.010)	(0.010)
Revenue	0.048***	0.262***	0.086***	0.053***	0.087	0.025*	0.024
	(0.005)	(0.004)	(0.006)	(0.006)	(0.120)	(0.015)	(0.015)
Observations	21,351	15,832	14,822	15,721	3,770	3,770	3,770
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table presents the results of several robustness tests. Column 1 presents the regression results with all firms in the sample considered. Column 2 uses OP productivity as the explanatory variable. Columns 3 and 4 present the regression results with super-large firms and listed firms excluded from the sample, respectively. Columns 5–7 present the regression results for the three instrumental variables after a propensity score matching. The significance of the coefficients is denoted by *, where ***, ** and * indicate significance at $p < .01$, .05 and .1, respectively.

may be short-term equities that do not affect industrial competition and firm operations. The baseline regression is very similar to the regression coefficient presented in column (4).

The IV employed in this study may introduce some problems, such as those resulting from political issues (seeing the political nature of the 'Belt and Road' initiative of China) and the inclusion of state-owned firms (which are generally favoured by the Chinese government when promoting FDI). OFDI from China generate a negative spillover effect owing to the fact that the state-owned firms in the country generally have low productivity (Zhang et al., 2001). The aforementioned political factors may introduce an unobservable missing variable, and such endogeneity may not be solved by the currently employed IV. To this end, we use data from the Oriana Asia-Pacific Firm Analysis Database of BvD (firm identification numbers are uniform with Acdemus Database) to identify investors of Chinese state-owned firms and then perform propensity score matching (PSM) with the nearest neighbour matching method to obtain matching samples of treatment firms whose investors are non-state-owned. A logit regression is also performed following the approach of Heyman et al. (2007), and the results are presented in Figure A1 and Tables A2 and A3. The matching samples are then used to perform another regression of the IV, and columns (5)–(7) of Table 6 present the results. Significantly negative regression results are obtained for all instrumental variables except for the broad IV. Multiplying the coefficients of the mean value of the explanatory variable by the narrow IV yields a value of –0.071, which is close to that shown in column (2) of Table 4 (–0.052). For the first stage and reduced form regression, see Table A4.

4.3 | Vertical spillover effect of Chinese investments

The upstream and downstream industries are also affected by the input–output relationship, in addition to the horizontal spillover effect. The backward and forward FDI_*cn* of domestic firms is then computed as follows with reference to the methods of Javorcik (2004) and Lu et al. (2017):

$$\text{FDI\_}back_j = \sum_{i \in J, i \neq j} a_{ji} \text{FDI\_}cn_i, \tag{11}$$

and

$$\text{FDI\_for}_j = \sum_{i \in J, i \neq j} b_{ij} \text{FDI\_}cn_i, , \tag{12}$$

where FDI_back_j and FDI_for_j denote backward and forward Chinese investments, respectively, a_{ji} and b_{ij} denote the ratio of the output and immediate product input of industry j that is sold to and comes from industry i, respectively, and J denotes NACE two-digit industries.

Columns (1) and (2) of Table 7 show the significantly negative backward spillover effect of Chinese investments on Germany when the forward and backward *FDI_cn* of manufacturing industries are added into the regression. This result may be ascribed to three reasons. First, given their potential control over the Chinese market, Chinese investors may have higher bargaining power compared with German intermediate suppliers when they are engaged in negotiations, thereby reducing the productivity and profits of upstream firms in Germany (Girma et al., 2008). Second, Rodríguez–Clare (1996) argued that the products produced by domestic intermediate suppliers should be similar to the input requirements of foreign firms in order for the backward correlation to generate positive spillover effects. In other words, the productivity of German firms may be negatively affected when they are forced to supply intermediate goods that Chinese investment firms cannot effectively produce

TABLE 7 Industrial vertical spillovers of FDI in China

	(1)	(2)	(3)	(4)
FDI_Back	−18.606***		−8.599***	
	(7.158)		(2.680)	
FDI_For		−9.707		−2.177
		(15.820)		(6.856)
FDI_world	0.303***	0.112***	0.367***	0.116***
	(0.083)	(0.042)	(0.089)	(0.041)
The EX PNT	−0.039	0.218	−0.136	0.265**
	(0.158)	(0.157)	(0.163)	(0.135)
IM PNT	−0.094	−0.104	−0.096	−0.114
	(0.083)	(0.083)	(0.085)	(0.080)
_N_Firm	−0.074***	−0.056***	−0.079***	−0.052***
	(0.012)	(0.015)	(0.012)	(0.014)
Avg_Age	−0.306***	−0.199**	−0.356***	−0.191**
	(0.096)	(0.084)	(0.101)	(0.082)
Age	−0.079***	−0.078***	−0.079***	−0.078***
	(0.006)	(0.006)	(0.007)	(0.006)
Gear	0.009***	0.009***	0.009***	0.009***
	(0.003)	(0.003)	(0.003)	(0.003)
Revenue	0.043***	0.043***	0.043***	0.043***
	(0.004)	(0.004)	(0.004)	(0.004)
Observations	15,832	15,832	21,315	21,315
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Note: The vertical spillover effects of FDI are presented in Table 7. ACF productivity is treated as the explanatory variable. Columns (1) and (2) present the backward and forward spillover effects of Chinese investments when only the internal input–output relationship of the manufacturing industry is considered, respectively, whereas columns (3) and (4) present the backward and forward spillover effects of these investments when the input–output relationship of all industries are considered, respectively. The significance of the coefficient is denoted by *, where ***, ** and * denote significance at $p < .01$, <0.05 and <0.1, respectively.

on their own. Third, the imports of intermediate products from China or other countries can trigger a competition that, in turn, will affect domestic intermediate suppliers in Germany by reducing their productivity and profits.

The forward correlation of FDI from China yields a negative yet insignificant regression coefficient. This result may be explained by the fact that local firms are crowded out by the FDI in the upstream industry, thereby reducing the degree of competition and consequently increasing the mark-up and input price. In this case, local downstream firms have to spend a higher amount when purchasing intermediate inputs.

Diversifying Chinese investments among several industries can weaken the negative forward and backward spillovers. Table 7 shows that when all sectors are considered in the calculation of forward and backward correlations, the effect of Chinese FDI is weakened, but these investments continue to generate negative backward spillovers. Moreover, the correlation between the manufacturing industry and other sectors is generally weaker than the input–output correlation within the manufacturing

industry, which may weaken the spillover effects that are forward and backward calculated with all sectors considered.

5 | FURTHER DISCUSSION

From the perspectives of local market competition, heterogeneous goods and knowledge spillover, this section examines the mechanisms that possibly drive the negative spillover effect of Chinese investment. First, the technical levels of both China and Germany are related to the direction of FDI productivity spillover. The knowledge and technical levels are denoted in this paper by the ratio of R&D to industry-level revenues, which can be computed based on the aggregate firm R&D to the industry levels of Germany and its surrounding countries.[2] The Oriana Database of BvD, which contains information about firms across the Asia-Pacific, is used to collect data on the R&D of China. Second, industry export intensity is related to both the size and direction of FDI spillover effects given that the negative spillover effects of such investment primarily result from competition. In other words, increasing exports will reduce the competition in the local market, thereby reducing the competition effect. Industry import intensity is also related to the size and direction of FDI spillovers. In other words, a high industry import intensity will improve the productivity of domestic firms by allowing imports to replace foreign investment to a certain extent. The Comext database of Eurostat is used to collect information on the exports, production and industrial imports of the analysed firms. Focusing foreign investments towards the production of homogeneous goods will inevitably intensify the competition effect and consequently lead to a negative spillover effect. By contrast, focusing these investments towards the production of heterogeneous goods will reduce the competition effect. Refer to Rauch (1999) for the classification of heterogeneous and homogeneous goods industries.

The interaction terms of Chinese investments with import and export intensity, R&D intensity and heterogeneous goods are integrated into the regression to test the potential mechanism of negative spillover effects. Columns (1) and (2) of Table 8 present the regression results for knowledge spillover. Column (1) shows the significantly negative coefficient of the interaction term between Chinese FDI and R&D intensity in Germany and its surrounding countries, thereby suggesting that by increasing the threshold of Chinese FDI's positive spillover, the negative spillover effect is strengthened when the R&D intensity of the host country increases. Meanwhile, column (2) shows the significantly positive coefficient of the interaction term of Chinese FDI with the difference between the R&D intensities of German and Chinese industries, which suggests that the tendency for a positive spillover effect to occur increases along with the level of R&D in China. The results for import and export intensity are presented in columns (3) and (4) of Table 8. As can be seen from these columns, Chinese FDI continue to have a significantly negative coefficient and show a significantly positive interaction term with industrial export intensity. Meanwhile, the regression coefficient reveals that Chinese FDI generate a positive spillover effect when the industry export intensity exceeds 69%. A significantly positive cross term is also observed between FDI and import intensity, and a positive spillover effect is recorded when the industry import intensity exceeds 75%. Columns 5 and 6 of Table 8 highlight the mechanism behind the effect of heterogeneous goods. When the goods classification of Rauch (1999) is adopted (i.e. goods are classified into 'liberal' and 'conservative' groups), the Chinese investments coefficient

[2]This computation is performed due to the limited amount of R&D data in the BvD database. Such lack of data can be compensated for by using data on Germany and its neighbouring countries, including the Netherlands, Belgium, France, Luxembourg, Switzerland, Austria, Czech Republic, Poland, Finland and Denmark. The knowledge spillover effects of FDI are not limited to Germany given the increasing degree of European integration.

TABLE 8 Mechanism analysis

	(1)	(2)	(3)	(4)	(5)	(6)
	R&d intensity	**R&d intensity**	**Exit density**	**Import density**	**Liberal classification**	**Conservative classification**
FDI	−29.600***	−52.033***	−51.617*	−28.001**	−39.605***	−38.966***
	(9.946)	(19.443)	(30.278)	(13.225)	(14.094)	(13.822)
FDI_RD	13.538***					
	(4.775)					
FDI_Rdgap		14.194***				
		(5.364)				
FDI_EX_int			74.568*			
			(43.713)			
FDI_IM_int				37.170**		
				(17.408)		
FDI_Heter					39.598***	38.959***
					(14.094)	(13.823)
FDI_world	0.235***	0.675***	0.514**	0.350***	−0.036	−0.034
	(0.057)	(0.235)	(0.239)	(0.120)	(0.066)	(0.065)
The EX PNT	−0.214	1.096***	−0.957	−0.287	0.467***	0.466***
	(0.190)	(0.331)	(0.744)	(0.292)	(0.106)	(0.105)
IM PNT	0.066	−0.984***	−0.223*	−0.291**	−0.354***	−0.353***
	(0.098)	(0.352)	(0.130)	(0.124)	(0.115)	(0.114)
_N_Firm	−0.057***	−0.094***	−0.113***	−0.093***	−0.034***	−0.035***
	(0.008)	(0.020)	(0.039)	(0.023)	(0.007)	(0.007)
Avg_Age	−0.358***	−0.139	−0.868**	−0.522***	−0.015	−0.016
	(0.086)	(0.118)	(0.417)	(0.185)	(0.097)	(0.097)
Age	−0.086***	−0.093***	−0.082***	−0.080***	−0.080***	−0.080***
	(0.006)	(0.008)	(0.009)	(0.007)	(0.006)	(0.006)
Gear	0.012***	0.011***	0.008**	0.008***	0.009***	0.009***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
Revenue	0.049***	0.045***	0.046***	0.042***	0.044***	0.044***
	(0.004)	(0.005)	(0.006)	(0.004)	(0.004)	(0.004)
Observations	15,832	15,832	15,832	15,832	21,351	21,351
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: The results of the mechanism analysis are summarized in this table. Column (1) takes into account the interaction between the FDI of China and R&D intensities in Germany and its neighbour countries. Column (2) considers the interaction term of the FDI of China with the difference between the R&D intensities of German and Chinese industries. Columns (3) and (4) consider the interaction of Chinese FDI with the industrial import and export intensities of Germany, respectively, as well as with a dummy of heterogeneous goods. Significance is denoted by *, where ***, ** and * indicate significance at $p < .01$, <.05 and <.1.

and the interaction terms of heterogeneous goods are significantly negative and positive, respectively. In this case, while Chinese investments may not show a negative spillover effect in heterogeneous

goods industries, such effect is approximately four times higher than the baseline in homogeneous goods industries.

In sum, the negative spillover effects of Chinese FDI may be driven by the concentration of these investments in industries that produce homogeneous goods, have low import or export intensity and have technical levels higher than that of China. In this case, instead of the agglomeration effect, these investments are mostly dominated by the competition effect, which in turn drives negative spillover effects.

6 | CONCLUSIONS

By treating the new investment review system of Germany as a quasi-natural experiment setting and by using a sample of German companies, this study performs an empirical analysis of the spillover effect of Chinese OFDI on the productivity of the host country. Apart from conducting several tests to arrive to robust conclusions, this study also analyses the mechanism of these investments' spillover effects. The following main conclusions are derived from the findings:

1. As revealed in the IV and OLS regressions, Chinese investments have a significantly negative productivity spillover effect on Germany. The new review system adopted by Germany does not clearly specify those industries included in its scope of review. Nevertheless, the above conclusion remains robust even after shrinking or expanding the review scope. A placebo test is then conducted with a random selection of time and industries, and random regression coefficients are obtained. The variable regression results are also supported in several robustness tests. Taking into account the endogeneity, we perform PSM, and the PSM regression is very similar to the IV regression coefficient.
2. Chinese FDI have a significantly negative backward correlation spillover effect, whereas their forward correlation spillover effect is negative yet insignificant. However, when the industry vertical correlation is examined across all industries apart from manufacturing, these effects are greatly reduced.
3. From the perspective of homogeneous products, import and export intensities, and industry knowledge spillover, the internal mechanism of the aforementioned negative spillover effect is analysed. Results show that the positive spillover effect can be reduced when the R&D intensity in and around the host country is high. Meanwhile, industries with low or export intensity observe a negative spillover effect, and such effect becomes positive when the intensity crosses a certain threshold. Chinese FDI have a negative spillover effect on the homogeneous goods industry, but such effect is greatly weakened and even becomes positive for the heterogeneous goods industry.

The limitations of this paper warrant consideration. First, this study analyses OFDI by taking China and Germany as cases. Although these countries can explain the spillover effect of investments from developing countries to developed ones, such explanation is not sufficiently comprehensive. Second, the market economy status of China is not widely recognized by western countries, and China's government and state-owned firms have important effects on its OFDI. This study attempts to control such endogenous problems and enhance the robustness of its conclusions. China is still an excellent example of an emerging market country that invests in a relatively developed economy. Therefore, the spillover effect of its investments warrants attention. Examining such effects also has some practical significance. For instance, the findings of this work may aid developed countries in comprehending the importance of investments from developing countries and may help developing countries in

determining the direction of their OFDI. With the knowledge gained from this study, both developed and developing countries can achieve global economic integration and economic cooperation.

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How to cite this article: Gao Y, Li Y, Zhang M. On the spillover effect of China's outward FDI in Germany. *Econ Transit Institut Change*. 2022;30:393–417. https://doi.org/10.1111/ecot.12281

APPENDIX A

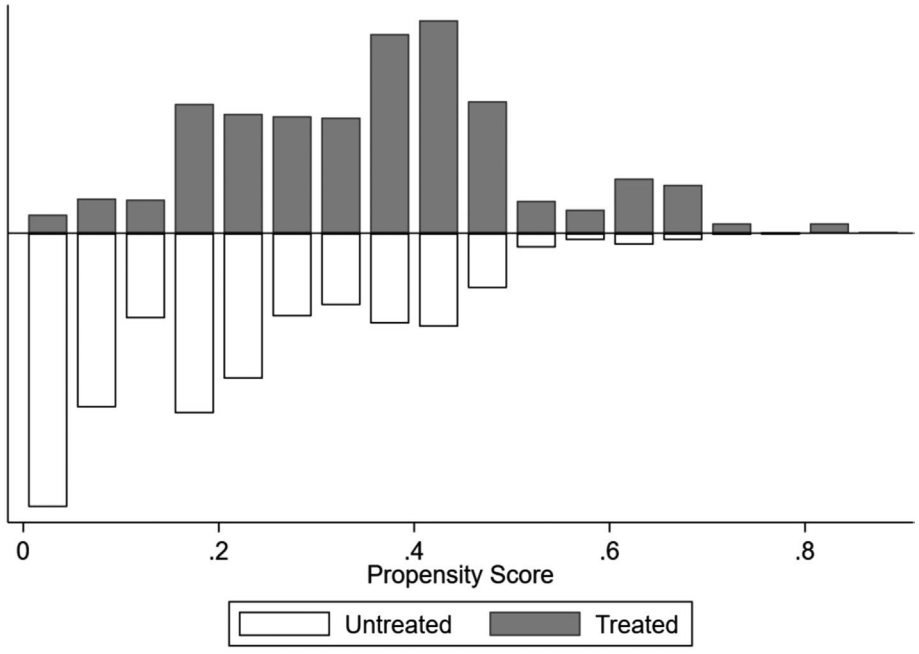

FIGURE A1 Propensity score histogram of treated/untreated. Note: This figure shows the propensity score distribution of the two samples after matching

TABLE A1 BMWi's conduct scope

Review the current investments for certain industries:
1) Manufacturing or development of any goods included in the weapons of war list of Germany (part B)
2) Manufacturing or development of gears or engines that are specifically designed for battle tanks or other armoured vehicles tracked by the German military and
3) Manufacturing of products related to IT security and other components that are important for these products to fulfil their IT security capabilities
Review several industries:
1) Operate any critical infrastructure as cited under the Federal Office of Information Security Act
2) Develop and modify various software that are required in operating the infrastructure of specific departments as specified under the Federal Office of Information Security Act
3) Produce technical equipment that are necessary for the implementation of telecommunications monitoring measures in accordance with Section 110 of the Telecommunications Act
4) Supply cloud computing services and other services that aim to meet or exceed the thresholds defined in Annex 4, Part 3, No. 2 of the critical infrastructure regulations identified in the Federal Office of Information Security Act
5) Provide licenses or components for remote information processing infrastructure as specified in Subsection 1a or 1e of Section V, Section 291b of the Social Law and
6) Encourage public opinion

Note: This table shows what BMWi can review under the new foreign trade clause.

TABLE A2 Logit regression in PSM

	(1)
FDI_world	0.861***
	(0.305)
Profits/Sales	−0.130
	(0.329)
Log Sales	0.117***
	(0.029)
Log Firm Age	−0.008
	(0.042)
Log Labour Productivity e	−0.138*
	(0.073)
Log Capital per Employee	0.114*
	(0.060)
Export Share	0.188
	(0.140)
	(1)
Constant	−6.037***
	(0.797)
Observations	4,352
R^2	0.157
year FE	Yes
Industry FE	Yes

Note: This table shows the result of Logit regression in PSM.

TABLE A3 Matching result in PSM

		Mean		*t*-test	
Variable	**Unmatched/Matched**	**Treated**	**Control**	***t***	***p*>|*t*|**
FDI_world	U	0.116	0.105	2.290	0.022**
	M	0.116	0.124	−1.280	0.199
Profits/Sales	U	0.048	0.049	−0.240	0.812
	M	0.048	0.050	−0.240	0.810
Log Sales	U	17.726	17.205	8.070	0.000***
	M	17.726	17.673	0.770	0.441
Log Firm Age	U	3.313	3.264	1.370	0.171
	M	3.313	3.330	−0.410	0.680
Log Labour Productivity e	U	12.226	12.168	1.830	0.068*
	M	12.226	12.233	−0.180	0.859
Log Capital per Employee	U	12.094	11.920	4.780	0.000***
	M	12.094	12.105	−0.270	0.785
Export Share	U	0.229	0.171	5.920	0.000***
	M	0.229	0.233	−0.300	0.766

Note: This table shows the difference between firm characteristics before and after PSM. After the matching, the difference of all variables is not significant anymore.

TABLE A4 Results of first-stage regression(FS) and reduced form regression(RF)

	(1)	(2)	(3)	(4)	(5)	(6)
	Broad IV		**IV**		**Narrow IV**	
	FS	**RF**	**FS**	**RF**	**FS**	**RF**
IV	−0.001	0.254***	−0.003***	0.218***	−0.003***	0.246**
	(0.001)	(0.071)	(0.001)	(0.071)	(0.001)	(0.097)
FDI_cn	0.007***	0.017	0.008***	0.007	0.008***	0.019
	(0.001)	(0.118)	(0.001)	(0.118)	(0.001)	(0.118)
FDI_world	−0.002	0.434**	−0.002	0.418**	−0.002	0.458**
	(0.002)	(0.189)	(0.002)	(0.190)	(0.002)	(0.189)
EX PNT	−0.001	−0.127	−0.002	−0.112	−0.002	−0.139
	(0.002)	(0.166)	(0.002)	(0.166)	(0.002)	(0.166)
IM PNT	−0.000**	−0.033**	−0.000*	−0.034**	−0.000**	−0.030*
	(0.000)	(0.016)	(0.000)	(0.016)	(0.000)	(0.016)
_N_Firm	−0.002	−0.351***	−0.002	−0.356***	−0.002	−0.364***
	(0.002)	(0.135)	(0.002)	(0.135)	(0.002)	(0.135)
Avg_Age	−0.000	−0.134***	−0.000	−0.133***	−0.000	−0.134***
	(0.000)	(0.015)	(0.000)	(0.015)	(0.000)	(0.015)
Age	−0.000	−0.012	−0.000	−0.012*	−0.000	−0.012
	(0.000)	(0.007)	(0.000)	(0.007)	(0.000)	(0.007)
Gear	0.000	0.010	0.000	0.010	0.000	0.011
	(0.000)	(0.010)	(0.000)	(0.010)	(0.000)	(0.010)
Sales	0.003	9.844***	0.003	9.861***	0.003	9.834***
	(0.003)	(0.234)	(0.003)	(0.234)	(0.003)	(0.234)
Constant	−0.001	0.254***	−0.003***	0.218***	−0.003***	0.246**
	(0.001)	(0.071)	(0.001)	(0.071)	(0.001)	(0.097)
Observations	3,770	3,770	3,770	3,770	3,770	3,770
R^2	0.043	0.123	0.046	0.123	0.045	0.122
year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table shows results of first-stage regression and reduced form regression in three kinds of IV regression.
Indicates the significance of the coefficient, where ***$p < .01$, **$p < .05$ and *$p < .1$.