UNITED NATIONS UNIVERSITY
UNU-WIDER

WIDER Working Paper 2017/77

The effects of Chinese import penetration on firm innovation

Evidence from the Vietnamese manufacturing sector

Duc Anh Dang*

April 2017

United Nations University World Institute for Development Economics Research
wider.unu.edu

Abstract: This paper evaluates the impact of Chinese import penetration on the innovation of Vietnamese manufacturing firms from 2011 to 2015, exploiting variations in import exposure by industry specialization and instrumenting for Chinese import penetration using Chinese global exports. Contrary to the existing literature, the paper finds no systematic evidence that rising imports from China make domestic firms adopt new technologies or innovations in their products.

Keywords: China, manufacturing, innovation, trade
JEL classification: L16, O33, F14

Acknowledgements: This paper is based on research carried out for a UNU-WIDER project on 'Micro, small and medium enterprises in Viet Nam'. I would like to thank Brian McCaig and Catherine Y. Co for their helpful comments on the structure of the paper.

* National Centre for Socio-Economic Information and Forecast, Hanoi, Viet Nam, dang.ducanh@mpi.gov.vn

This study has been prepared within the UNU-WIDER project on 'Structural transformation and inclusive growth in Viet Nam'.

Information and requests: publications@wider.unu.edu

ISSN 1798-7237 ISBN 978-92-9256-301-1

Typescript prepared by Merl Storr.

Katajanokanlaituri 6 B, 00160 Helsinki, Finland

1 Introduction

The emergence of China and its impact on domestic firms worldwide has drawn the attention of researchers and policymakers alike. They are especially concerned that imports from China may have adverse consequences for domestic markets, such as higher unemployment and lower labour force participation. There is a substantial literature showing that Chinese imports have impacted on labour markets, and most of the existing studies focus on the impact of Chinese imports on firms' performance and employment in developed countries. These studies have found that Chinese imports result in lower employment, a higher wage gap, a change in labour composition in favour of more skilled workers, and an upgrade in product quality (e.g., Autor et al. 2013; Balsvik et al. 2015; Bivens 2013; Martin and Méjean 2014; Utar 2014). In particular, Bloom et al. (2016) investigate innovation by European firms in response to increased Chinese import penetration. They use the product quota removal following China's accession to the World Trade Organization (WTO) as an instrumental variable. Their empirical results indicate that competition from China resulted in an increase of roughly 15 per cent in patents, IT intensity and productivity within surviving firms (Qiu and Zhan 2016). However, these findings on firms' behaviour and performance in developed countries may not hold for developing countries, where firms lack the capacity and resources to innovate and compete with similar imported products (Doan et al. 2016).

Viet Nam is a developing country that is likely to be affected by imports from China due to its proximity to that country and its large volume of trade with China. Viet Nam's imports from China escalated from 4 per cent to nearly 30 per cent of total imports between 1998 and 2014 (General Statistics Office of Viet Nam 2015). These rising imports have resulted in intensifying competitive pressure on domestic Vietnamese firms (Doan and Stevens 2012). However, there are almost no studies investigating the impact of Chinese imports on firms' innovation in Viet Nam. Only recently have Doan et al. (2016) examined the effects of rising import penetration on the productivity of domestic firms. They find that imports have an adverse impact on firms' productivity, especially in small and medium enterprises.

This study aims to make progress in our understanding of whether and how local firms in developing countries such as Viet Nam are adjusting to rising import penetration from China. In particular, by using Viet Nam Small- and Medium-Scale Manufacturing Enterprise Survey data for 2011–15, this study examines the consequences of the penetration of Chinese imports for firms' innovation in Viet Nam. The results of fixed-effect estimations reveal that Chinese import penetration into the Vietnamese market makes domestic firms less invested in technological improvement, but the effects are small. It does not affect firms' product quality.

However, the correlations observed here may not be causal, because of potential measurement errors or omitted variable problems due to technological shocks (Bloom et al. 2016). In order to address such potential endogeneity, I used China's global exports as an instrument for import penetration. The results from the instrumental variable (IV) approach suggested that Chinese import penetration did not have an impact on firm innovation. To confirm the findings of the IV approach, I carried out some sensitivity tests on the validity of the instrumental variable. To address the concern as to whether the exclusion restriction was satisfied, I performed a falsification test that examined the reduced-form relationship between Chinese global exports and firm innovation. The results confirmed that Chinese import penetration as estimated by the IV approach does not have an effect on firm innovation.

This analysis is one of very few studies investigating the impact of Chinese imports on innovation among manufacturing firms in developing countries. It also complements other work on the

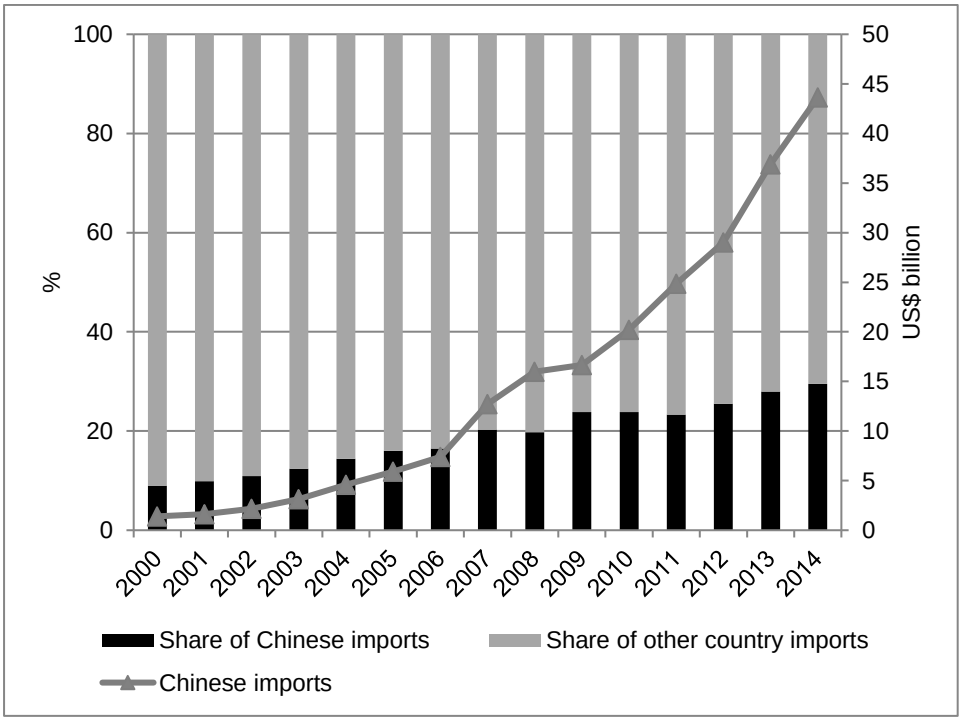
impact of Chinese imports on high-wage countries and using industry-level measures (e.g., Autor et al. 2013; Bernard et al. 2006; Bloom et al. 2016; Ebenstein et al. 2014).

The structure of the paper is as follows. Section 2 focuses on the evolution of Viet Nam's imports from China and their potential effects. Section 3 describes the data. Section 4 details the empirical modelling strategy, describes the results, and discusses some robustness tests. Section 5 concludes.

2 Overview of Viet Nam's imports from China and their potential effects

After normalization, Viet Nam and China signed a bundle of trade and economic agreements (e.g. a trade agreement in 1991, an investment protection agreement in 1992, and a border trade agreement in 1998). China and Viet Nam have been WTO members since 2001 and 2007 respectively. In 2004, China and the Association of Southeast Asian Nations signed a free trade agreement. These international commitments of both Viet Nam and China have created opportunities and are the main factor promoting trade between the two countries.

Figure 1: China's share of Viet Nam's imports



Source: author's illustration based on General Statistics Office of Viet Nam data.

Bilateral trade value between Viet Nam and China has increased rapidly in recent years, and is expected to remain high in the future. The rise in China's share of Viet Nam's imports is also remarkable. Figure 1 shows that in 2011 only 23.3 per cent of imports originated in China, but by 2014 this figure had increased to nearly 30 per cent. The value of Viet Nam's imports from China increased by nearly 26 times, from US$1.4 billion in 2000 to US$43.6 billion in 2014. This increase varied widely across sectors, rising most rapidly in industries such as textiles, fibre and computer components. Meanwhile, the share of export value from Viet Nam to China was almost unchanged, accounting for around 10 per cent of total exports. Thus Viet Nam's trade deficit with China increased continuously from 2002 onwards, reaching nearly US$30 billion in 2014.

Table 1: Top 10 imports from China

No.	Year	SITC Code	Commodities	Value (US$ billion)	China's share
1	2010	6732	Flat, hot-rolld, prod. iron	0.28	0.34
2	2010	5621	Nitrogenous chem. fertlzr	0.29	0.35
3	2010	3510	Electric current	0.30	0.37
4	2010	5629	Fertilizers, nes	0.31	0.39
5	2010	7283	Oth. mineral working mach.	0.33	0.41
6	2010	7641	Line telephone etc. equip	0.35	0.43
7	2010	7522	Digital automatic data processing machines	0.42	0.52
8	2010	7649	Parts, telecommunication equipment	0.53	0.65
9	2010	6552	Oth. knit, crochet, fabrics	0.54	0.67
10	2010	7643	TV, radio transmitters etc.	0.80	0.99
1	2014	6761	Bar, rod iron, hot-fd, coil	0.49	0.56
2	2014	7599	Parts, data proc. etc. mch	0.56	0.64
3	2014	7522	Digital automatic data processing machines	0.58	0.67
4	2014	6534	Fabr <85% syn, stp fbr + othr	0.59	0.69
5	2014	7638	Sound, video recording etc.	0.70	0.81
6	2014	7764	Electronic microcircuits	1.02	1.17
7	2014	7643	TV, radio transmitters etc.	1.16	1.34
8	2014	6552	Oth. knit, crochet, fabrics	1.35	1.56
9	2014	6754	Flat, hot-rolld, alloy stl	1.77	2.03
10	2014	7649	Parts, telecommunication equipment	6.10	7.03

Source: author's calculation based on United Nations Comtrade data.

Table 1 shows that the majority of imports from China are raw materials for the production of Vietnamese export products. Of these, the main groups of imports are machinery, equipment, spare parts and tools, followed by textile materials, footwear, phones and components, computers, electronic products, iron, and steel.

The effects of Chinese imports on Vietnamese firms' innovation might take different forms. First, such imports could increase competition with import-substitute firms, whether intermediate- or final-goods producers. Therefore domestic firms might be expected to innovate in response to competitive pressures from imports. However, the availability of imported inputs might increase the competitiveness of final-goods producers. The response of domestic firms in this case might be more complicated. Because these inputs are available (and presumably they are cheaper), firms will have more resources with which to innovate. Domestic firms might also innovate (or adopt new processes) to use these imported inputs more efficiently. Alternatively, other situations might arise. Perhaps domestic firms will not be motivated to innovate, as cheap imported inputs might allow them to invest less in innovation but still stay in business with their existing products. In addition, if Chinese imports tend to complement rather compete with domestic industries in the sense that they provide inputs that are not available domestically, then increased imports might not affect domestic firms' innovation decisions.

3 Data and descriptive statistics

3.1 Import penetration

Data on Chinese imports has been taken from United Nations Comtrade using the Standard International Trade Classification, Revision Four (SITC 4). This is an international database of four-digit product-level information on all bilateral imports and exports between any given pair of countries. I have matched this four-digit product level with the four-digit International Standard Industrial Classification of All Economic Activities, Revision Four (ISIC 4) industry level, using World Integrated Trade Solution concordance. In this way, I have converted the commodity

classifications used in international trade statistics by the UN Statistics Division into the corresponding ISIC 4 so that I can merge the industry-level import penetration data with the firm-level data set.

I followed Ashournia et al. (2014) to construct a firm-level Chinese import penetration measure CIP_{jkt} for product k of firm j in year t as:

$$CIP_{jkt} = s_{jk} \frac{M_{kt}^{CH}}{M_{kt} + D_{kt}} \quad [1]$$

where M_{kt}^{CH} and M_{kt} are the values of imports from China and all countries for product k at time t respectively. The weights s_{jk} are defined as the shares of domestic sales of main product k (or the most important product) over its total sales in firm j.

Using broad economic categories, all Chinese imports are classified as intermediate goods. Table 1 shows the lists of top 10 SITC products imported from China from 2011 to 2015, while Table 2 shows that Chinese imports hit manufacturing industries very differently. The manufacture of textiles, chemistry, machinery, and equipment stand out as the industries with the highest growth in Chinese imports.

Table 2: Chinese import shares among Vietnamese manufacturing industries

Industries	Names	CIS 2011	CIS 2015	Δ CIS
15	Food products and beverages	1.25	1.17	0.08
16	Tobacco products	0.04	0.01	0.02
17	Textiles	12.99	12.43	0.56
18	Clothing	0.70	0.92	0.22
19	Leather	1.35	1.13	0.22
20	Wood	0.75	0.48	0.27
21	Paper and paper products	0.90	0.94	0.04
22	Publishing	0.24	0.12	0.12
23	Mineral oil	6.99	4.60	2.39
24	Chemistry	11.99	8.97	3.01
25	Rubber and plastics products	2.50	2.76	0.26
26	Other non-metallic mineral products	1.60	1.29	0.31
27	Basic metals	9.99	11.28	1.29
28	Fabricated metal products	3.15	3.45	0.31
29	Machinery and equipment	15.48	22.09	6.61
30	Office and IT	5.99	4.60	1.39
31	Electrical machinery	6.49	8.74	2.25
32	Tele equipment	8.99	9.20	0.21
33	Medical instruments and clocks	1.55	0.97	0.58
34	Car	1.95	2.19	0.24
35	Other transport equipment	0.60	0.23	0.37
36	Furniture and other manufacturing	0.90	0.99	0.09
	Total	96.37	98.57	2.20

Source: author's calculation based on United Nations Comtrade data.

3.2 Firms' data

The primary firm data set used in this paper is drawn from the Viet Nam Small- and Medium-Scale Manufacturing Enterprise Survey (VSMES). The VSMES is conducted by the Institute of Labour Science and Social Affairs of the Vietnamese Ministry of Labour, Invalids and Social Affairs, with technical support from the Department of Economics at the University of

Copenhagen and UNU-WIDER. The VSMES offers an unbalanced biannual panel data set spanning 2011 to 2015.[1]

The VSMES data includes both registered and unregistered (informal) domestic firms. Informal domestic firms (which have no business registration licence or tax code, and are not registered with district authorities) are included in the survey on the basis of on-site identification. The enterprises are distributed across approximately 18 sectors, the dominant sectors being food processing, fabricated metal products, and manufacturing of wood products. Enterprises are classified as micro, small, medium, or large according to current World Bank definitions: micro enterprises have up to 10 employees, small-scale enterprises up to 50 employees, medium-sized enterprises up to 300 employees, and large enterprises over 300 employees. More than 72 per cent of firms in the survey are micro enterprises. The VSMES also provides comprehensive information about firms such as demographics, ownership, business activities, employment, wages, assets, capital, business performance, revenue, and profit.

Firms' outcome variables

The Organization for Economic Co-operation and Development defines innovation as 'the implementation of a new or significantly improved product or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations' (Organization for Economic Co-operation and Development Secretariat 2007: 11). To investigate the impact of import penetration on firms' innovation, I used information from the VSMES that asks firms about the introduction of new technology, improvements to existing products, and new products. As a result, this study considers several types of innovation activity: (i) product innovation (whether a firm produces a new good or not), (ii) process innovation (whether a firm adopts a new production process), and (iii) product improvement (whether a firm improves an existing product).

The exact wording of these questions is as follows: 'Has the firm introduced new product groups?', 'Has the firm introduced new production processes/new technology since the last survey?', and 'Has the firm made any improvements to existing products or changed product specifications since the last survey?' Respondents can answer either 'Yes' or 'No'. I constructed a measure that takes on the binary values of 0 and 1, where 0 corresponds to the response 'No' and 1 to the response 'Yes'. I then estimated a linear probability model. Another strategy was to estimate a logit model. As I discuss below, the estimates were qualitatively identical when I pursued this alternative strategy.

Table 3 shows the proportion of enterprises that obtained a new technology by size. The share of enterprises adopting new technologies decreased by 6.6 percentage points, from 13.1 per cent in 2011 to 6.4 per cent in 2013 and 4.9 per cent in 2015. This overall decrease in the adoption of new technology can be attributed to medium enterprises, which saw the greatest decline in adoption rates. All types of firm tended to be more willing to develop new products than to improve existing ones.

[1] The survey has been carried out in nine provinces: Hanoi, Hai Phong, Ho Chi Minh City, Phu Tho, Nghe An, Quang Nam, Khanh Hoa, Lam Dong, and Long An.

Table 3: Firms' innovation rates

	Innovation 1 (new technology adoption)			Innovation 2 (new product development)			Innovation 3 (improvement to existing product)		
	2011	2013	2015	2011	2013	2015	2011	2013	2015
All	13.1	6.4	4.9	4.3	0.7	23.8	38.1	16.4	13.2
Micro	8.3	5.1	2.9	3.8	0.4	23.9	33.1	12.9	10.5
Small	20.4	8.8	8.5	4.8	1.5	22.1	4.9	24.7	20.1
Medium	36.7	13.3	17.1	7.9	1.2	28.6	54.8	30.4	27.4

Numbers in percentages.

Source: author's calculation based on VSMES data.

The summary statistics for main firm outcomes are presented in Table 4. They indicate that although the share of Chinese imports over total imports is high, almost none of the manufacturing firms was significantly exposed to Chinese import penetration. This is consistent with the figures in Table 2, where the Chinese import shares for major manufacturing industries such as food products, wood, and fabricated metal are very small. This means that Chinese imports are more likely to complement than to directly compete with domestic products.

Table 4: Descriptive statistics

Variables	Obs	Mean	Std Dev.	Min.	Max.
Chinese import penetration	7,494	2.08	9.08	0.00	97.15
Whether firms have technological improvement	7,704	0.08	0.27	0.00	1.00
Whether firms have product improvement	7,704	0.22	0.42	0.00	1.00
Whether firms have new product	7,704	0.10	0.30	0.00	1.00
Log of firm gross profit	7,339	5.11	1.45	-1.86	12.62
Log of firm domestic sale	7,704	18.60	4.57	0.00	33.01
Log of firm employment	7,701	1.88	1.15	0.00	7.44
Proportion of skilled workers	7,704	0.28	0.28	0.00	1.00

Source: author's calculation based on VSMES data.

4 Empirical strategy and results

4.1 Empirical strategies

Baseline models

To examine the effect of Chinese import penetration, I began the analysis with the relationship between import penetration and its outcomes using the following baseline framework:

$$y_{jkt} = \alpha + \beta CIP_{jkt} + X'_{jkt}\Gamma + \lambda_j + \theta_t + \varepsilon_{jkt} \quad [2]$$

where y_{jkt} is the firm-level outcome of interest for firm j based on its main product k at time t, and CIP_{jkt} is the relevant Chinese import penetration of product k faced by firm j at time t. β is the coefficient of my main measures that indicates the relationship between Chinese import penetration and firm innovation. The main variable is included in the estimated specification with a one-period lag to reduce potential simultaneity bias. At the same time, it reflects the possibility that firm innovation does not react immediately to trade shocks.

The term X is a vector of other observable determinants of y_{jkt}. λ_j and θ_t are firm and year dummy fixed effects. The year dummies capture time-specific factors that are common to all firms, while the firm dummies control for firm-specific characteristics. Standard errors are clustered by firm level.

Instrumental variable method

Even after I had controlled for the other determinants of firm innovations, import penetration from China could still be correlated with the error term, thus inducing a bias in the estimate of β. The first concern is reverse causality. For example, imported Chinese products may gain larger market shares in those sectors where Vietnamese manufacturing firms invest less in improving technology or upgrading products, thus inducing an upward bias in β. However, because I take a one-period lag of the import variable, this may not be problematic. A second concern is related to the potential omission from the covariates of time-varying factors that correlate with changes in both product-level Chinese imports and firm-level outcomes (i.e. technology changes, product development, and improvements to existing products) at the same time. Finally, measurement errors in the import penetration variable could induce an attenuation bias.

To overcome these potential biases, I make use of China's global exports as a potentially suitable instrument candidate for my identification strategy (Autor et al. 2013). China's exports may meet two conditions for a valid instrument: China's global exports are expected to be correlated with Vietnamese imports from China, but are plausibly unrelated to domestic firm's outcomes. The instrument I_{jkt} for product k of firm j at time t is:

$$I_{jkt} = s_{jk} WES_{kt} \qquad [3]$$

where WES_{kt} is China's total supply of product k to the entire world, minus exports to Viet Nam, in period t. The world export supplies are based on United Nations Comtrade data at the SITC product level. WES_{kt} is weighted by the share s_{jk} of domestic sales of product k (or the most important product) over its total sales in firm j. WES_{kt} measures changes in China's comparative advantage that are exogenous to Vietnamese firms.

My strategy is based on the idea that the correlation between China's exports to Viet Nam and the world is mostly due to supply-side factors related to industrial development in China (e.g., an increase in China's productivity in product k, or a decrease in transport costs), which are exogenous with respect to demand shocks in Vietnamese manufacturing sectors. However, the exclusion restrictions could be violated if sector-specific demand shocks are common to Viet Nam and the world. For example, positive demand shifts could be stronger in sectors where China holds a comparative advantage, thus affecting both firms' innovation in Viet Nam and Chinese global exports, thus inducing a bias. In addition, my identification approach may also be impaired if time-varying and sector-specific supply shocks (such as a global technology shocks in certain sectors) affect both Chinese supply and Vietnamese firms' innovation. However, these potential threats may not be an issue, as shocks to firm innovation may be well captured by the set of firm-level covariates and sectoral dummy variables included in the baseline specification.

4.2 Results

Baseline results

Before proceeding to the main outcome of interest, i.e. firm innovation, I show how Chinese import penetration measures correlate with other firm outcomes. Table 5 shows results from regressions of a firm-level outcome (value added, domestic sales, employment, wage bill, etc.) where year dummies and firm fixed effects are included to control for specific trends affecting manufacturing firm outcomes. In all estimations, standard errors are adjusted for clustering of observations of the same firms. In the results that follow in the next section I generally use the largest possible sample of non-missing observations. Sample sizes differ between columns within a table primarily because of different samples for the variables due to missing data.

Table 5: Firm-level effects of Chinese import penetration

Variables	Ln (value added)	Ln (wage bill)	Ln (gross profit)	Ln (domestic sales)	Ln (employ-ment)	Proportion of skilled workers
Chinese import penetration	-0.003*	-0.002	-0.006***	0.013	-0.001	0.001
	(0.002)	(0.003)	(0.002)	(0.009)	(0.002)	(0.001)
Observations	7,370	7,494	7,284	7,494	7,494	7,494
R-squared	0.036	0.067	0.037	0.703	0.066	0.072
Number of firms	3,424	3,457	3,411	3,457	3,457	3,457
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors, clustered at firm level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Source: author's calculations.

The results show that most of the correlations are not significantly different from zero, except that import penetration has impacts on value-added and gross profit. I found that when firms are more exposed to import competition, their value-added and gross profit drop. These results are consonant with findings from previous studies. However, the impacts are quite small.

The relationship between import penetration and firms' innovation is reported in Table 6. I started by examining how Chinese import penetration affects firms' innovation without correcting for endogeneity. The specification reported includes log firm value added, log firm wage bill, log firm gross profit, log firm domestic sale, log firm employment, and firm's proportion of unskilled workers; these control for observable determinants that could correlate with both import and innovation variables. In all of the regressions, I control for firm and year dummy effects, and the standard errors are clustered at the firm level. The estimates indicate a negative and statistically significant relationship between technological improvement and import penetration. However, the main coefficient magnitude is quite small. In particular, one percentage point increase in Chinese import penetration only reduces domestic firms' probability of adopting new technology by 0.002, which is equal to 2.5 per cent of the sample average for new technology adoption. These results support the hypothesis that domestic firms do not need to innovate as cheap imported inputs allow them to invest less in innovation. Another possible explanation is that most Chinese imports are complementary rather than substitute goods in relation to domestic products. Therefore they do not create pressure on domestic firms to innovate.

Table 6: Effects of Chinese import penetration on firms' innovation

Variables	New technology adoption	New product development	Improvement to existing product
Chinese import penetration	-0.002**	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
Observations	7,284	7,284	7,284
R-squared	0.048	0.122	0.236
Number of firms	3,411	3,411	3,411
Other controls	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Standard errors, clustered at firm level, in parentheses. Other control variables are log firm value added, log firm wage bill, log firm gross profit, log firm domestic sale, log firm employment, firm's proportion of skilled workers. *** p<0.01, ** p<0.05, * p<0.1.

Source: author's calculations.

Table 7: Effects of Chinese import penetration on firms' innovation (by firm size)

Variables	New technology adoption	New product development	Improvement to existing product
Chinese import penetration	-0.003	0.001	-0.004*
	(0.004)	(0.003)	(0.002)
Chinese import penetration X Micro firm	0.002	-0.001	0.004
	(0.004)	(0.004)	(0.002)
Chinese import penetration X Small firm	0.000	-0.002	0.004*
	(0.004)	(0.003)	(0.002)
Observations	7,284	7,284	7,284
R-squared	0.048	0.122	0.237
Number of firms	3,411	3,411	3,411
Other controls	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Standard errors, clustered at firm level, in parentheses. Other control variables are log firm value added, log firm wage bill, log firm gross profit, log firm domestic sale, log firm employment, firm's proportion of skilled workers. *** p<0.01, ** p<0.05, * p<0.1.

Source: author's calculations.

At the same time, firms may have different competitive capacities in competing with Chinese imports. Bloom et al. (2016) show that firms with less advanced technologies or small firms may find it hard to compete with imports. Therefore, larger domestic firms may suffer less from the presence of increasing imports, due to their generally more sophisticated technologies and business processes, while smaller firms suffer more. The estimates presented in Table 7 show that small manufacturing firms tend to invest in the improvement of existing products in response to intensifying pressure from Chinese imports. However, the magnitude of the estimated coefficients is so small that the effects among different groups are negligible.

I also checked for robustness in relation to alternative estimation methods. Because the responses to the firm innovation questions are binary, they may not be normally distributed. To overcome this problem, I used a logit model instead. The results from the logit model in Table 8 are qualitatively identical to my ordinary least squares estimates. The marginal effects are consistent with those estimated by ordinary least squares.

Table 8: Logistic regression: effects of Chinese import penetration on firms' innovation

Variables	New technology adoption	New product development	Improvement to existing product
China's import penetration at firm levels	-0.022**	0.001	-0.004
	(0.009)	(0.004)	(0.005)
Observations	7,271	7,283	7,283
Number of firms	3,406	3,411	3,411
Other controls	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes

Standard errors in parentheses. Other control variables are log firm value added, log firm wage bill, log firm gross profit, log firm domestic sale, log firm employment, firm's proportion of skilled workers. *** p<0.01, ** p<0.05, * p<0.1.

Source: author's calculations.

Instrumental variable results

To correct for the endogeneity of import penetration, I used an IV method. As discussed earlier, China's exports (or export growth) are a potential instrument for the prediction of the level of Viet Nam's imports, but they may not directly affect firms' innovation in Viet Nam. Therefore I make use of China's global exports as an instrument for import penetration.

Table 9 presents my IV results. The reported coefficient in the lower panel is the first-stage results. The instrument has the expected sign: the coefficient of China's global exports is positive and highly significant for Chinese import penetration in Viet Nam. In addition, the Cragg-Donald F-statistic of excluded instruments is well above the critical values identified by Staiger and Stock (1997), showing that a weak instrument is not our concern. This result is consistent with the existing evidence in the literature, which finds that China's exports are a good instrument to predict imports (Bloom et al. 2016; Bugamelli et al. 2015; Edwards and Jenkins 2015), and is also in line with the theory of trade shocks from China's export boom.

Table 9: IV estimate: effects of Chinese import penetration on firms' innovation

Variables	New technology adoption	New product development	Improvement to existing product
China's import penetration at firm level	-0.000	-0.000	0.004
	(0.002)	(0.002)	(0.003)
	First stage: China's import penetration at firm level		
China's global exports	0.821***	0.821***	0.821***
	(0.024)	(0.024)	(0.024)
Observations	7,264	7,264	7,264
Number of firms	3,408	3,408	3,408
Other controls	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
F-test for excluded Instrument: 1130			

Standard errors, clustered at firm level, in parentheses. Other control variables are log firm value added, log firm wage bill, log firm gross profit, log firm domestic sale, log firm employment, firm's proportion of skilled workers. *** p<0.01, ** p<0.05, * p<0.1.

Source: author's calculations.

In the upper panel, I report the results for different measures of firm innovation exposure to increased competition from China. As shown, the estimated coefficient does not change much from the analogous fixed-effect estimates in Table 4, and no estimated coefficients are statistically significant. These results indicate that a rise in Chinese import penetration does not affect the innovation of Vietnamese firms in the manufacturing sector.

4.3 Robustness

I modified the baseline specification along several dimensions in order to test the robustness of my results. First, I recalculated Chinese import penetration by subtracting the Chinese imports for the firms' own use, because trade flows may not increase competition for these firms. However, information about the source of imported inputs is only available for two years; I tested the results' robustness for the period 2011–13. The estimation results are reported in Table 10. The results show almost no differences, showing that Chinese import penetration does not affect firms' innovation.

Another way to test this likelihood is to estimate the reduced-form relationship between China's global exports and firms' innovation. The results in Table 11 show that although there is a strong positive relationship between China's global exports and firms' innovation, the coefficients are not significant, except with regard to the impact on new production. This correlation is consistent with the IV estimates in Tables 10 and 12: a rise in Chinese import penetration does not create pressure to make Vietnamese manufacturing firms invest in innovation.

Table 10: Effects of Chinese import penetration on firms' innovation (excluding imports for their own use)

Variables	New technology adoption	New product development	Improve-ment to existing product	New technology adoption	New product development	Improve-ment to existing product
China's import penetration	-0.003**	-0.001	-0.000			
	(0.001)	(0.002)	(0.001)			
China's import penetration (excl. import for own use)				-0.003***	-0.002	-0.000
				(0.001)	(0.001)	(0.001)
Observations	4,770	4,770	4,770	4,770	4,770	4,770
R-squared	0.058	0.133	0.048	0.060	0.133	0.048
Number of firms	2,905	2,905	2,905	2,905	2,905	2,905
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors, clustered at firm level, in parentheses. Other control variables are log firm value added, log wage bill, log gross profit, log domestic sale, log employment, firm's proportion of skilled workers. *** p<0.01, ** p<0.05, * p<0.1.

Source: author's calculations.

Table 11: Reduced-form relationship between China's global exports and firms' innovation

Variables	New technology adoption	New product development	Improvement to existing product
China's global exports	0.000	0.000	0.003*
	(0.001)	(0.001)	(0.002)
Observations	7,319	7,319	7,319
R-squared	0.045	0.237	0.119
Number of firms	3,424	3,424	3,424
Other controls	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Standard errors, clustered at firm level, in parentheses. Other control variables are log firm value added, log firm wage bill, log firm gross profit, log firm domestic sale, log firm employment, firm's proportion of skilled workers. *** p<0.01, ** p<0.05, * p<0.1.

Source: author's calculations.

Table 12: IV estimate: effects of Chinese import penetration on firms' innovation (excluding import for their own use)

Variables	New technology adoption	New product development	Improvement to existing product
China's import penetration (excl. import for own use)	-0.000	0.001	0.005
	(0.003)	(0.002)	(0.004)
	First stage: China's import penetration at firm level		
China's global exports	0.757***	0.757***	0.757***
	(0.045)	(0.045)	(0.045)
Observations	4,750	4,750	4,750
Number of firms	2,902	2,902	2,902
Other controls	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
F-test for excluded Instrument: 277.2			

Standard errors, clustered at firm level, in parentheses. Other control variables are log firm value added, log firm wage bill, log firm gross profit, log firm domestic sale, log firm employment, firm's proportion of skilled workers. *** p<0.01, ** p<0.05, * p<0.1.

Source: author's calculations.

5 Conclusion

I have examined whether exposure to import competition from China affects firm innovation, and I have assessed to what extent increased exposure to competition from China can explain the changes in the manufacturing sector's innovation in Viet Nam over the period from 2011 to 2015. To account for the possible endogeneity of imports and firm innovation, I used an instrument to capture Vietnamese import growth from China by using the increase in global imports from China. This instrumental variable strategy, developed by Autor et al. (2013), rests on the assumption that the Chinese supply shock has created similar bundles of exports from China to other countries, and that the increase in imports from China to other countries is uncorrelated with firms' innovation in Viet Nam. The results indicate that exposure to competition from China has a negative impact on the innovation of manufacturing firms. However, these effects are small and not consistent across different methods.

6 References

Ashournia, D., J. Munch, and D. Nguyen (2014). 'The Effect of Chinese Import Competition on Danish Firms and Workers'. Discussion Paper. Oxford: University of Oxford.

Autor, D., D. Dorn, and G. Hanson (2013). 'The China Syndrome: Local Labor Market Effects of Import Competition in the United States'. *American Economic Review*, 103(6): 2121–68.

Balsvik, R., S. Jensen, and K. Jensen (2015). 'Made in China, Sold in Norway: Local Labor Market Effects of an Import Shock'. *Journal of Public Economics*, 127: 137–44.

Bernard, A., B. Jensen, and P. Schott (2006). 'Survival of the Best Fit: Exposure to Low Wage Countries and the (Uneven) Growth of US Manufacturing Plants'. *Journal of International Economics*, 68: 219–37.

Bivens, J. (2013). 'Using Standard Models to Benchmark the Costs of Globalization for American Workers Without a College Degree'. Briefing Paper 354. Washington, DC: Economic Policy Institute Available at: www.epi.org/publication/standard-models-benchmark-costs-globalization (accessed 30 March 2017).

Bloom, N., M. Draca, and J. Van Reenen (2016). 'Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity'. *Review of Economic Studies*, 83(1): 87–117.

Bugamelli, M., S. Fabiani, and E. Sette (2015). 'The Age of Dragon: The Effect of Imports from China on Firm-Level Prices'. *Journal of Money, Credit and Banking*, 47(6): 1091–118.

Doan, T., S. Nguyen, T. Tran, H. Vu, and L. Steven (2016). 'Does Rising Import Competition Harm Local Firm Productivity in Less Advanced Economies? Evidence from Vietnam's Manufacturing Sector'. *Journal of International Trade and Economic Development*, 25(1): 23–46.

Doan, T., and L. Stevens (2012). 'Evolution of Competition in Vietnam Industries Over the Recent Economic Transition'. *Economics*, 6: 1–24. Available at: www.economics-ejournal.org/economics/discussionpapers/2012-12 (accessed 17 March 2017).

Ebenstein, A., A. Harrison, M. McMillan, and S. Phillips (2014). 'Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys'. *Review of Economics and Statistics*, 96(4): 581–95.

Edwards, L., and R. Jenkins (2015). 'The Impact of Chinese Import Penetration on the South African Manufacturing Sector'. *Journal of Development Studies*, 51(4): 447–63.

General Statistics Office of Viet Nam (2015). *Statistical Yearbook of Viet Nam 2015*. Hanoi: Statistical Publishing House.

Martin, J., and I. Méjean (2014). 'Low-Wage Country Competition and the Quality Content of High-Wage Country Exports'. *Journal of International Economics*, 93(1): 140–52.

Qiu, L.D., and C. Zhan (2016). 'China's Global Influence: A Survey through the Lens of International Trade'. *Pacific Economic Review*, 21: 45–71.

Organization for Economic Co-operation and Development Secretariat (2007). 'Discussion Paper on Trade, Innovation and Growth'. Paris: OECD.

Staiger, D., and J. Stock (1997). 'Instrumental Variables Regression with Weak Instruments'. *Econometrica*, 65: 557–86.

Utar, H. (2014). 'When the Floodgates Open: "Northern" Firms' Response to Removal of Trade Quotas on Chinese Goods'. *American Economic Journal: Applied Economics*, 6(4): 226–50.