Trade liberalization, supply chains and productivity

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Abstract

This paper explores the relationship between trade liberalization and productivity focusing on the impact of an expansion in imports on the productivity of domestic firms. The key innovation is that we focus on direct and indirect effects through the supply chain and explore a variety of different channels through which exposure to imports impacts on firm-level productivity, both for firms that import and those that do not. Our identification strategy exploits differences in the effects in competitive and concentrated sectors and in the impact of imports from competitive and concentrated upstream sectors. We use firm level enterprise survey data on over 70,000 manufacturing firms in Vietnam for the 2002 to 2011 period. We pay particular attention to the differential effects of imports on productivity pre and post trade liberalization. Our results suggest that the main impact if imports on the productivity of domestic firms is through within-sector competition induced productivity gains resulting from within-sector reallocations and within-firm behavioral responses. There is also evidence that some of these gains are transmitted through the supply chain to domestic users of domestic inputs. We find no evidence to suggest that imported intermediates yield productivity spillovers for domestic firms.

JEL Codes: F61, F63, F14, O12, O53

Key Words: Trade liberalization, supply chain, productivity, Vietnam

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1. Introduction

Over the last decades many developing countries have experienced a dismantling of barriers to trade that has left domestic industry exposed to greater competition while at the same time affording the most productive firms the opportunity to trade with a larger and more diverse world market. Trade liberalization episodes in the developing world have attracted the interest of much academic research aimed at understanding the extent to which exposure to foreign competition impacts on industry and firm productivity. One relatively underexplored mechanism is the impact that exposure to trade has on the productivity of firms through imports, both directly and through supply chain linkages. In this paper we address this gap by investigating the impact of trade liberalization on the way in which imports of intermediate goods impact on the productivity of domestic firms including domestic competitors, firms that import intermediates and those that do not.

There are two main channels through which imported intermediates can affect productivity: a competition channel and a technology channel. [1] Through the competition channel competitive pressures from imports will force firms to eliminate inefficiencies or slack in the production process or use their inputs more efficiently in order to survive (Holmes and Schmitz, 2001). The least productive firms will be forced to exit leading to a reallocation of resources to more productive firms resulting in within-sector productivity improvements (Melitz, 2003). This will indirectly affect downstream firms who use these intermediates in the production of their goods by lowering their costs of production thereby indirectly increasing cost efficiency along the supply chain. Through the technology channel productivity may be affected by technology spillovers through the purchase of imported intermediates that embody new, more advanced technologies which domestic import firms can learn from (Grossman and Helpman, 1991). Domestic competitors may also learn from the availability of imports on the market, in particular if they are more technologically advanced, are of a higher quality or a new variety. Downstream firms that purchase inputs from domestic firms may therefore also benefit through this channel.

A large and growing empirical literature has linked trade to productivity using firm-level evidence, particularly for developing country contexts, and has attempted to disentangle these mechanisms. Tybout et al. (1991) finds evidence of productivity enhancing effects from increased trade exposure using the case of trade liberalization in Chile in the 1970s. Pavcnik (2002) also finds for Chile that sectors facing new import competition saw faster productivity growth and attributes these effects to both within-firm productivity improvements and reallocations of resources away from the least productive firms. Similarly, Eslava et al. (2004) and Fernandes (2007) show that trade, labor and financial reforms in Columbia in the 1990s were associated with aggregate productivity improvements due to a more efficient allocation of resources. Fernandez also links productivity gains under trade liberalization to increases in imported intermediates, skills and machinery investments. Evidence for imported inputs as a channel for productivity growth is also provided by Kasahara and Rodrigue (2008) and Halpern et al. (2005) for Chile and Hungary, respectively. Amiti and Konings (2007) estimate the productivity gains associated with tariff reductions in intermediate inputs in Indonesia and find that the productivity gains from tariff reductions (that allow for cheaper inputs) is at least as high as the gains associated with lower output tariffs. Moreover, they also show that these gains are achieved through learning, variety and quality effects. Blalock

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[1] See Syverson (2011) for an overview of the literature on the determinants of firm level productivity.
[2] For an overview of the reform to investment laws in Vietnam between 1986 and 2000 see Jenkins (2006).
[3] Blalock and Veloso (2007) also use input-output tables to measure supply chain linkages but focus on backward linkages from downstream import firms to upstream domestic suppliers of inputs.

and Veloso (2007) also investigate the impact of imports on productivity growth of firms in Indonesia focusing on supply chain linkages. They find evidence that importing is a source of technology transfer for upstream firms supplying import-intensive downstream sectors. The overall evidence, however, is not conclusive. Van Biesebroeck (2003), for example, finds no evidence that productivity improvements in Columbia are due the use of foreign inputs. Similarly, Muendler (2004) finds limited effects of foreign inputs on productivity in Brazil.

In this paper, we add to the body of evidence on trade-induced within-firm productivity effects through the import channel, and, in particular, disentangle technology transfers associated with imported intermediates from competition effects. We use an extensive firm level panel dataset on the population of enterprises in Vietnam for the period 2002 to 2011 and match this to import and export data from COMTRADE at the 4-digit sector level. We also use information from the most recent Supply Use Tables (SUT) in Vietnam to explore the impact of trade on the productivity of firms through supply chain linkages. To identify within-firm productivity effects we use data on over 7,500 manufacturing firms in Vietnam for 2009, 2010 and 2011, gathered using a specially designed questionnaire for the direct identification of firms' behavior in relation to technology innovations and investment.

Vietnam represents an illustrative case of economies in transition. The opening up of the Vietnamese economy began in 1986 with the adoption of a range of policy measures under *doi moi* (renovation) in particular relating to trade liberalization and the promotion of foreign direct investment (FDI). The latter occurred through successive revisions to investment laws between the late 1980s and the mid-2000s while trade liberalization took the form of the removal of export taxes and non-tariff barriers and the negotiation of various trade agreements with ASEAN, the US and the EU ultimately leading to WTO accession in 2007.[2] The period of analysis under consideration therefore allows us to explore the differential impact of imported intermediates on firm productivity in two different types of trade regime; a relatively strict regime pre-2007 and a more liberal regime from 2007 onwards.

We make a number of contributions to the empirical literature. First, we explore new mechanisms through which imports can impact on firm level productivity along the supply chain. We consider both horizontal (within-sector) and vertical (between-sector) effects (from upstream to downstream sectors). The latter is particularly relevant as it has received very little attention in empirical literature. Second, to isolate real productivity effects we follow Amiti and Konings (2007) and use sector level concentration ratios to distinguish between impacts on competitive versus non-competitive sectors. We also extend this idea to consider how the level of competition upstream might alter the effect of imports on downstream sectors. Third, we use a measure of supply chain linkages that captures the extent of exposure of a sector to imports upstream using Supply Use Tables, which is a similar approach to that used to identify vertical technology transfers from foreign firms but has rarely been applied in this context (Javorcik, 2004).[3] Finally, we explicitly investigate the mechanisms underlying within-firm efficiency improvements in response to increased imports using a specially designed survey module.

Our results show that the most important channel through which imports impact on productivity is competition. A combination of reallocations, whereby the least efficient firms exit as a result of competition from imports, and within-firm efficiency improvements

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[2] For an overview of the reform to investment laws in Vietnam between 1986 and 2000 see Jenkins (2006).
[3] Blalock and Veloso (2007) also use input-output tables to measure supply chain linkages but focus on backward linkages from downstream import firms to upstream domestic suppliers of inputs.

through investments in new machinery and process innovations, lead to higher levels of productivity among domestic firms. We find evidence to suggest that there are spillover effects of these productivity gains for domestic firms that use these inputs. In contrast, we find no evidence that domestic firms that import inputs experience productivity spillovers.

The remainder of the paper is organized as follows. Section 2 presents our conceptual framework for exploring the mechanisms through which imports might impact on the productivity of firms, both intra- and inter-sector, and explains our identification strategy. We present our empirical approach in Section 3. Section 4 introduces the datasets and describes the evolution of the manufacturing sector in Vietnam over the period 2002-2011. Section 5 presents our results and section 6 concludes.

2. Conceptual Framework

The aim of this paper is to disentangle the various mechanisms through which an expansion in imports impacts on the productivity of domestic firms. We consider horizontal or within-sector effects whereby an expansion in imports leads to an increase in competition for domestic firms (see, for example, Holmes and Schmitz, 2001; Amiti and Konings, 2007). This can lead to the exit of the least efficient firms with only the most efficient firms surviving. Moreover, in order to compete with importers surviving domestic firms can engage in investments that increase their efficiency. It is also possible that there are horizontal spillovers whereby domestic firms copy or learn from the technology embodied in imported goods into the sector (see, for example, Blalock and Veloso, 2007). In addition, and our key point of departure from the literature is that we consider vertical or between-sector effects focusing on the impact that an expansion of imports has on firms in downstream sectors. We consider two mechanisms: first, the extent to which downstream firms benefit from increased competition upstream leading to higher average efficiency levels among domestic input suppliers; and second the extent to which downstream import firms benefit from technology spillovers, variety or quality effects associated with using higher quality imported inputs.[4] The latter is a relatively underexplored mechanism through which trade can lead to productivity improvements. It is based on the idea that in a developing country context, imports from more advanced economies will be of a higher quality and embody more sophisticated technology than those that are locally produced. As such, an expansion of imported intermediates will lead to technology diffusion through greater variety, better quality inputs and new technologies embodied in those inputs (Grossman and Helpman, 1991).

Each of these mechanisms is summarized in what follows.

Mechanism 1. Impact of expanded imports on domestic competitors – horizontal effects

- An expansion of imports will have a direct effect on domestic firms by increasing competition. To survive, firms must engage in efficiency improvements (reduce slack or use inputs more efficiently) in order to compete with a larger more competitive group of suppliers. On aggregate this will lead to productivity enhancing reallocations at the sector level but we should also see firm level efficiency improvements among survivors.

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[4] In developing country contexts it is generally assumed that imports from more advanced countries will be of a higher quality and embody more sophisticated technology than those that are locally produced.

- The technology embodied in imports into upstream sectors may spillover to domestic producers of intermediate goods leading to productivity improvements or to the production of higher quality domestically produced inputs for downstream sectors.

Mechanism 2. Impact on firms that import intermediates from upstream sectors:

- Firms that import intermediates may experience physical productivity improvements through the expansion of imported intermediates upstream if this leads to greater variety, better quality inputs, or inputs that embody new technologies that create opportunities for users of these inputs to innovate. These, however, may already be reflected in the market price for those inputs so it is possible that additional productivity effects will not be present.

Mechanism 3. Impact on firms that do not import intermediates from upstream sectors:

- These firms will face a reduction in costs due to increased competition in upstream sectors. If competition upstream leads to within-firm efficiency or productivity improvements or there are technology spillovers upstream this may lead to productivity improvements in downstream sectors that purchase these inputs. These may be less likely to be reflected in the market price particularly where upstream sectors are very competitive.

Other channels
Trade liberalization is also likely to impact on productivity through the expansion in exports. There is a large literature set in developing country contexts that examines the relationship between productivity and exporting, but the overall evidence on the extent to which firms experience productivity improvements as a result of exporting is inconclusive. Export firms may have higher productivity levels due to the fact that they are generally a self-selected group that are, on average, more productive than other firms. Alternatively, firms may learn-by-exporting or experience technological spillovers from their experience in foreign markets. Productivity gains are also possible through improvements in within-firm efficiency induced by exposure to competitive pressures. Moreover, firms may incur a sunk cost of entry into export markets and so measured productivity improvements may take some time to realize. We do not consider these mechanisms in this paper but control for the simultaneous impact of exposure to export markets through the inclusion of relevant control variables.

3. Empirical Approach

The mechanisms outlined in Section 2 raise a number of empirical questions that we explore in our analysis. First, in relation to horizontal effects (Mechanism 1) we are interested in identifying the extent to which an expansion of imports into a sector impacts on the productivity of domestic firms also producing in that sector. To explore this we will test whether there is a positive relationship between firm level productivity and (4-digit) sector level imports. Second, we are interested in exploring the mechanisms underlying productivity effects of imports, in particular, the extent to which they can be attributed to reallocations (through the exit of inefficient firms) or within-firm efficiency improvements achieved through firm level behavioral changes or technology spillovers from imports. Third, in relation to vertical effects, we are interested in the impact of an expansion in imports into upstream sectors on firms in downstream sectors that use the goods produced upstream as inputs into their production processes. In particular, we explore whether the impact is

different for import firms (Mechanism 2) or non-import firms (Mechanism 3). Positive productivity effects for the former suggest the presence of spillovers from importing intermediates associated with embodied technologies, better quality or greater variety. Positive productivity effects for the latter suggest spillovers for downstream firms from productivity improvements upstream that are induced by import competition.

Our core empirical model used to identify productivity impacts is a one-stage firm level production function approach whereby (4-digit) sector level imports are included as an additional regressor along with a variety of firm and sector specific control variables Using this approach overcomes the need to estimate productivity directly and so avoids the large debate in the empirical literature on the most appropriate approach for measuring productivity at the firm level (Van Biesebroeck, 2003). The baseline model used to estimate horizontal effects is given by equation (1).

$$ln\,Y_{ijt} = \alpha_i + \beta_1\,ln\,L_{ijt} + \beta_2\,ln\,K_{ijt} + \delta_1\,ln\,imp_{jt} + \varphi\mathbf{X}_{ijt} + \eta\mathbf{Z}_{jt} + s_j + \tau_t + e_{ijt} \qquad (1)$$

where Y_{ijt} measures the value added of firm i in sector j in year t; L_{ijt} are labor inputs; K_{ijt} capital inputs; $ln\,imp_{jt}$ the log value of imports into sector j in year t; $\mathbf{X}_{ijt}$ are time varying firm specific controls; $\mathbf{Z}_{jt}$ are time varying sector specific controls; α_i are firm fixed effects; s_j are sector fixed effects and τ_t are time dummies. As such, the identification of the relationship between imports and productivity comes from the impact of the level of imports into the sector on the within-firm variation in productivity over time. In other words, we identify the effects through considering how the productivity of firms varies in response to changes in 4-digit sector level aggregates controlling for all time-invariant heterogeneity in firms and sectors and the time-varying heterogeneity captured by our control variables.

Identifying causality is a challenge in this kind of model given that there may be unobserved sector-specific factors that impact on both the level of imports into a sector and firm level productivity. Controlling for time and sector specific effects goes some way to overcoming this problem.[5] As an additional check on our results we also use an instrumental variables approach to address the endogeneity of the sector import variable. This is explained in more detail in Section 4.

The identification of the effect of imports on productivity is further complicated by the nature of the data that we use, and is commonly used in empirical applications of this kind. We only have data on the value of inputs and outputs which means that our estimate of productivity is a revenue-based measure rather than an estimate of physical productivity but (see Foster et al. (2008) for a discussion). This implies that using our measure, observed productivity changes will embody both within-firm physical productivity gains and changes in prices and/or mark-ups that cannot be easily disentangled. We address this issue by considering how the impact of imports differs in competitive and concentrated sectors (see Amiti and Koenings (2007) who also use this approach). Real productivity effects can be netted out from changes in mark-ups by considering the impact of imports into competitive sectors where price competition will ensure observed improvements in performance are due to productivity improvements. This is achieved through the inclusion of interaction terms between imports

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[5] Blalock and Veloso (2007) base their identification strategy on a similar approach, i.e. controlling for all time invariant heterogeneity across sectors.

and the sector level concentration measured using the standard Hershman Herfhindal Index (HHI) given in equation (2).

$$HHI_{jt} = \sum_{i=1}^{n} s_{ijt}^2 \tag{2}$$

where s_{ijt} is the revenue share of firm i in sector j at time t.

To disentangle the mechanisms through which productivity impacts are realized we consider the impact of imports on firm turnover, and in particular the exit of domestic firms. We estimate a further regression that considers the impact of an expansion in imports on the probability of exit by substituting the left hand side variable in equation (1) with whether firms exit in the subsequent period. We also explore the behavior of survivors to determine whether importing has productivity enhancing effects once we abstract from reallocations. We also consider the extent to which productivity improvements are related to behavior within-firms that would lead to efficiency enhancements. The latter is made possible through the use of a rich data source collected for the purpose of exploring the mechanisms underlying technology transfers, innovation and productivity improvements of this kind. We perform the same analysis described above that disaggregates the impact of imports on firms that engage in various types of investment and innovation behavior. More details are provided in section 4.

We use a similar model to that presented in equation (1) to estimate the impact of imports from upstream sectors on downstream firms. The baseline model is presented in equation (3).

$$\begin{aligned}
ln\,Y_{ijt} &= \alpha_i + \beta_1\,ln\,L_{ijt} + \beta_2\,ln\,K_{ijt} + \delta_1\,ln\,imp_{jt} \\
&+ \delta_2\,primpin_{ujt} + \boldsymbol{\varphi}\mathbf{X}_{ijt} + \boldsymbol{\eta}\mathbf{Z}_{jt} + s_j + \tau_t + e_{ijt}
\end{aligned} \tag{3}$$

where $primpin_{ujt}$ is the proportion of inputs into sector j from upstream sectors u accounted for by imports. It is computed as described in equation (4).

$$primpin_{ujt} = \sum_{u=1}^{J-1} \alpha_{ut}\left(imp_{ut}/(out_{ut} + imp_{ut})\right) \tag{4}$$

where α are weights which capture the proportion of total inputs into sector j that come from sector u computed constructed using input-output tables.

When examining impacts along the supply chain how competitive or concentrated both upstream sectors (where imports are coming into) and downstream sectors (where firms are purchasing imports) are may also matter. Imported intermediates into sectors where there is a lot of domestic competition will potentially lead to two types of gains for downstream import firms: lower prices of inputs leading to cost efficiency improvements and technology spillovers leading to productivity improvements. Both will result in an improvement in measured productivity performance. We are, however, interested in identifying the latter. Imports that do not face much domestic competition (i.e. imports into concentrated upstream sectors) are less likely to lead to lower input prices for downstream import firms. It is therefore likely that any observed productivity effects of imports from concentrated upstream sectors on import firms in competitive downstream sectors are due to real productivity

improvements. To capture this we include interaction terms between both the level of concentration in downstream sectors and the level of concentration in upstream sectors and focus on the differential effect of imports from concentrated upstream sectors into competitive downstream sectors.

Finally, we use an indicator of trade liberalization (accession to WTO) to determine the extent to which trade liberalization alters the impact of imports on productivity through these mechanisms.

We include a variety of time varying firm-specific and sector-specific control variables in our analysis. We include whether the firm is an import or export firm, which is crucial to our identification of the mechanisms, particularly in relation to supply chains. The inclusion of time-varying sector-specific (4-digit) variables allows us to control for factors that may be correlated with firm productivity and with the level of imports into a sector. These include the average capital-labor ratio of firms in the sector, the average size of the sector in terms of the number of employees, the proportion of total revenue in the sector earned by foreign-owned firms and the proportion of total revenue in the sector earned by state-owned firms. In all specifications we control for the sector level concentration ratio as described above. For each of the sector level variables we exclude information on the individual firm in the computation of the measure.

4. Data

Our primary data source is the 2002-2011 Enterprise Surveys collected annually by the General Statistics Office (GSO) in Vietnam. This dataset includes the population of all registered enterprises with 30 employees or more and a representative sample of smaller firms. Our data covers an unbalanced panel of 70,598 domestic manufacturing firms totaling 213,936 observations. As illustrated in Table 1, the number of manufacturing firms more than tripled between 2002 and 2011.[6] The average size of firms in the sector, however, declined from over 150 in the early 2000s to 120 in 2011. This is due to the influx of private domestic firms into the sector and the decline in the prominence of large state-owned enterprises.

Table 1: Manufacturing firm characteristics for Vietnam 2002-2010

	Number of firms	Size (Employees)	Entrants (%)	Exits (%)	Foreign (%)	State (%)	Import (%)
2002	13,257	157	-	17.5	9.2	9.0	14.5
2003	15,222	159	28.2	15.8	9.8	7.1	15.1
2004	18,090	151	29.1	14.5	10.2	4.7	14.7
2005	20,818	142	25.7	18.7	10.3	2.8	14.1
2006	24,220	133	30.1	21.2	10.3	1.5	13.9
2007	27,369	133	30.3	19.7	10.8	0.9	13.4
2008	33.892	112	35.1	23.5	10.0	0.6	11.2
2009	37,188	107	30.3	22.0	10.2	0.5	11.7
2010	39,065	111	25.7	28.7	10.2	0.4	16.9
2011	40,764	116	31.7	-	10.9	0.2	19.0

*Source*: Author's own calculations based on Vietnamese Enterprise Surveys.

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[6] It should be noted that the Enterprise Survey does not include unregistered enterprises so it is possible that some new entry firms are simply firms that move from the informal to the formal economy.

The dynamic nature of the Vietnamese economy is also evident from the descriptive statistics presented in Table 1. New entrants account for between 25 and 30 percent of firms while exits account for between 14 and 28 percent of firms. Foreign-owned firms account for between 9 and 11 percent of firms and despite changes in investment laws over the period this proportion has remained relatively static. In the early part of the decade state-owned firms also made up around 9 percent of firms but over the course of the 10-year period the number of state-owned firms has declined considerably in line with the government's objectives of deregulation and privatization. The proportion of firms that import increased from 14 to 19 percent between 2002 and 2011 following a decline in 2008 and 2009 during the financial crisis.

Import and export data are taken from the UN COMTRADE database available through World Integrated Trade Solutions on the value of exports and imports for 4-digit ISIC sectors for Vietnam with the rest of the world. The growth in exports and imports as a proportion of GDP over the period of our analysis (2002-2010) is illustrated in Figure 1 where steady growth in both is evident throughout the 2000s.

Figure 1: Growth in exports and imports
Vietnam (2002-2010)
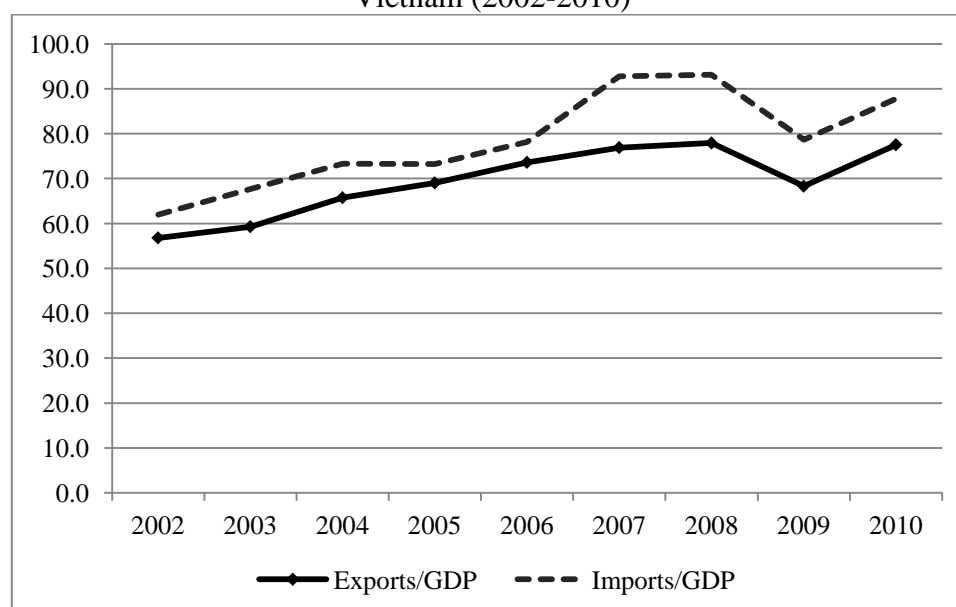
Source: National Accounts, General Statistics Office, Vietnam (www.gso.gov.vn).

To measure supply chain linkages we use the Vietnam Supply-Use Tables (SUT) for 2007. The SUT maps the use of 138 commodities in 112 production activities. We link these production activities to the 4-digit ISIC codes used in the Enterprise Survey to produce 74 comparable sector codes. The SUT data are used to construct a set of weights that captures upstream linkages between sectors, whereby for each (SUT) sector i, their link with upstream (SUT) sector j is the proportional contribution of output from sector j to its total input base. These weights are used to compute a weighted average of imports from upstream sectors where imports are measured as the proportion of total output from the sector that is sold in Vietnam (total output of the sector, plus imports into the sector, less exports from the sector).

Table 2 presents the (average) extent of exposure of each 2-digit sector to imported inputs and how this evolves over the time frame of our analysis. The numbers presented can be interpreted as the proportion of inputs into the sector that are imported. There is a lot of

variation over time and across sectors. Of particular note is the decline in the proportion of inputs that are imported in the latter years which could reflect the dramatic growth in domestically produced output in Vietnam over this time frame but also, particularly since 2008, the world financial crisis and the impact that this had on exports meaning that more domestic output remained in Vietnam.

Table 2: Exposure of downstream sectors to imports from upstream sectors 2002-2011

Sector	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
15	46.8	48.8	49.8	48.0	46.3	50.4	49.4	45.7	44.5	36.5
17	28.3	26.6	28.8	29.9	29.8	31.0	31.8	27.4	27.1	18.9
18	6.5	7.7	8.0	8.1	8.4	8.7	8.2	7.4	7.4	5.6
19	32.8	36.7	35.3	31.1	33.0	31.9	29.0	28.7	27.4	27.5
20	33.0	56.1	55.5	60.8	57.9	60.2	59.1	57.4	52.8	40.9
21	26.6	44.7	41.2	49.4	38.2	44.7	52.7	36.3	41.0	34.8
22	6.0	14.8	15.5	15.9	15.5	18.0	17.8	16.9	15.1	9.2
24	36.8	51.5	51.4	53.0	51.3	54.4	52.1	46.4	45.9	34.1
25	47.6	54.0	52.5	52.1	47.5	52.1	51.6	44.9	45.6	34.1
26	57.5	63.1	63.9	64.2	63.5	62.7	62.8	53.8	53.2	37.4
27	59.7	65.6	66.8	67.4	65.1	66.6	66.5	61.0	52.8	46.1
28	56.7	65.6	66.8	67.4	65.1	66.6	66.5	61.0	52.8	46.1
29	30.8	29.8	30.1	31.1	31.1	31.4	30.5	26.1	26.9	19.2
31	27.2	29.0	29.0	29.0	27.1	29.2	29.1	25.9	25.5	19.7
32	41.2	38.1	37.9	39.5	36.2	37.7	37.4	34.2	31.2	26.8
33	57.0	60.5	60.8	62.1	61.5	62.0	54.5	52.4	40.4	31.3
34	31.3	33.4	32.1	33.3	38.8	36.1	34.8	31.1	30.5	22.4
35	36.6	38.7	39.2	40.3	38.8	39.3	38.0	33.4	32.0	22.4
36	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Source: Author's own calculations based on Vietnamese Enterprise Surveys.

The final dataset which we use is the Technology and Competitiveness Survey (TCS) was included as an additional module for the sampled firms in 2009, 2010 and 2011. The data are matched with information on firms' activities and financial accounts gathered using the main Enterprise Survey. This produces a rich database that allows us to explore in detail the underlying mechanisms at work.

We consider investments in new machinery and information and communications technologies. In the TCS module firms are asked to name the two most important production technologies (machines and equipment) and the two most important information and communications technologies (ICT) used by the firm. They are also asked to report when these technologies were acquired by the firm. For the purpose of our analysis, we consider firms that acquired the technologies during the previous year as having made an investment in new machinery or ICT, as the case may be. We also consider a range of indicators of innovations undertaken by the firm. Firms are asked whether they engaged in any type of innovations to improve their performance. The options given include: improvements in process organization (such as time saving procedures); improvements in product quality; an expansion of product variety; an expansion of activities into a new sector; or changing to a new sector. We also consider whether firms engage in adaptations to technologies, research and development activities and whether the firm has registered any patents.

5. Results

The first part of our analysis explores within-sector or horizontal effects of imports on the productivity of domestic firms. We estimate equation (1) which controls for firm, 4-digit

sector and time fixed effects as well as time varying firm-specific and sector specific control variables as described in Section 3. The results are presented in Table 3.

Table 3: Imports and the productivity of private domestic firms

Dependent variable: lnva	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV
Value of imports	0.013**	0.014**	0.010*	0.011*	0.276***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.076)
HHI * Value of imports		-0.020		-0.018	
		(0.020)		(0.021)	
WTO * Value of imports			0.005**	0.006*	
			(0.003)	(0.003)	
HHI * WTO * Value of imports				-0.015	
				(0.036)	
Production function parameters					
lnlab	0.799***	0.799***	0.799***	0.799***	0.800***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.005)
lncap	0.197***	0.197***	0.198***	0.198***	0.197***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)
Firm level controls					
Import Firm	0.054***	0.054***	0.054***	0.054***	0.052***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)
Export firm	0.051***	0.051***	0.050***	0.050***	0.036***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)
Sector level controls					
HHI	0.026	0.258	0.026	0.213	-0.046
	(0.060)	(0.228)	(0.061)	(0.388)	(0.048)
Value of exports from sector	-0.007	-0.007	-0.006	-0.006	-0.245***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.069)
Capital-labor ratio	-0.288***	-0.289***	-0.289***	-0.239***	-0.278***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.015)
Size	-0.049**	-0.049**	-0.049**	-0.048**	-0.029**
	(0.021)	(0.021)	(0.021)	(0.021)	(0.014)
Concentration of foreign firms	0.038	0.033	0.031	0.026	0.229***
	(0.055)	(0.055)	(0.055)	(0.054)	(0.068)
Concentration of state firms	-0.144**	-0.144***	-0.136**	-0.134***	-0.157***
	(0.045)	(0.044)	(0.045)	(0.045)	(0.032)
R-squared	0.776	0.776	0.776	0.776	0.372
Firms	70,598	70,598	70,598	70,598	70,598
N	213,936	213,936	213,936	213,936	213,936

Robust standard errors clustered at the sector-year level are presented in parenthesis. Results are also robust to clustering at the firm level. All models include firm, year and sector fixed effects. The effect of WTO in levels is absorbed by the combination of time dummies and other control variables included in the model. *** indicates significance at the 1% level, ** the 5% level and * the 10% level.

We find a positive and significant relationship between the level of imports and productivity (column 1). As revealed by the insignificance of the interaction term between sector level concentration (HHI) and the value of imports in column 2, the effect is no different in competitive compared with concentrated sectors. In columns 3 and 4 we find that the impact is greater post WTO as indicated by the positive and significant interaction between the dummy for WTO membership and the value of imports. The level effect is also positive and significant suggesting that productivity benefits were also present pre-WTO but to less of an extent.

Our identification strategy rests on the inclusion of an extensive range of control variables including all within-firm and sector variation over time. It could still be argued, however, that there may be some unobserved factors that simultaneously impact on the level of imports into a sector and the productivity of firms. As a robustness check on our core result we also use an instrumental variables approach where we instrument the level of imports into a sector with the average distance that imports had to travel to arrive in Vietnam. To construct the instrument we compute the distance between Vietnam and the country of origin of imports into each 4-digit sector using the CEPII GeoDist database (Mayor and Zignago, 2011). This database records the distance between capital cities. For each 4-digit sector we compute a weighted average of distances from markets where the weights are based on the proportion of imports into the sector that come from that country in that year. As such the measure varies across time and 4-digit sectors.

Our results using the instrumental variables approach are provided in column (5) of Table 3.[7] As revealed our IV approach produces a much larger coefficient suggesting that the OLS approach is conservative in estimating the impact of imports on firm productivity. Given that we use many interaction terms in our models and do not have enough suitable instruments to address the potential endogeneity problem in all cases we proceed with OLS for the remainder of the analysis bearing in mind that our estimates represent a lower bound.

The next step of our analysis aims to uncover the mechanisms underlying the productivity gains to competitors associated with imports. As discussed in Section 2, productivity gains from import competition could be due to either reallocations, whereby the least efficient firms exit, or could be due to within-firm productivity gains by survivors, achieved through within-firm behavioral changes leading to efficiency improvements or through technology transfers from imports.

To explore the reallocation channel we regress the probability of a firm exiting a sector in the subsequent period on the level of imports into the sector. We include the same set of control variables as is included in our main model presented in Table 3 and interaction terms with the dummy indicator for accession to the WTO and the sector level measure of concentration. The results are presented in Table 4. We find that imports have a positive and significant impact on exit and the effect is more pronounced in the pre-WTO period. This suggests that one of the cannels through which imports impact on productivity is through the exit of domestic firms and the reallocation of resources to more productive firms, particularly in the pre-WTO period.[8]

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[7] Standard errors are clustered at the firm level using the IV approach. We focus here on the magnitude of the coefficients as our robustness check on our core result.

[8] It should be noted that this result is not robust to clustering standard errors at the sector-year level. Future work will explore reallocation effects in more detail through the decomposition of a sector-level productivity measure into its pure productivity component and component due to reallocations of resources. The latter will be regressed on the log of sector level imports to determine the extent to which imports lead to productivity enhancing effects through this mechanism.

Table 4: Imports and the exit of private domestic firms

Dependent variable: Exit	(1)	(2)	(3)
Value of imports	0.015***	0.013***	0.013***
	(0.004)	(0.004)	(0.004)
HHI * Value of imports		0.023	0.008
		(0.015)	(0.018)
WTO * Value of imports			-0.005***
			(0.002)
HHI * WTO * Value of imports			0.018
			(0.018)
Firm level controls			
Import Firm	-0.033***	-0.033***	-0.033***
	(0.004)	(0.004)	(0.004)
Export firm	-0.055***	-0.005*	-0.005*
	(0.005)	(0.003)	(0.003)
Sector level controls			
HHI	0.178***	-0.084	-0.029
	(0.026)	(0.180)	(0.209)
Value of exports from sector	-0.005*	-0.005*	-0.005*
	(0.003)	(0.003)	(0.003)
Capital-labor ratio	-0.017*	-0.017*	-0.016*
	(0.010)	(0.010)	(0.010)
Size	0.008	0.008	0.006
	(0.008)	(0.008)	(0.008)
Concentration of foreign firms	0.040*	0.043*	0.054**
	(0.023)	(0.024)	(0.024)
Concentration of state firms	-0.097***	-0.096***	-0.096***
	(0.019)	(0.018)	(0.019)
R-squared	0.014	0.014	0.014
Firms	60,012	60,012	60,012
N	176,770	176,770	176,770

Robust standard errors clustered at the firm level are presented in parenthesis. Results loose significance when clustering is at the sector-year level and so should be interpreted with some caution. All models include firm, year and sector fixed effects. *** indicates significance at the 1% level, ** the 5% level and * the 10% level.

To explore the possibility that the effect is driven by within-firm productivity improvements we estimate the model given in equation (1) using a balanced panel of 3,115 firms. Given that this sample consists of survivors only, measured productivity gains are most likely attributed to within-firm productivity improvements. The results are presented in Table 5. We find strong evidence that imports into the sector have a positive and significant effect on the productivity of competitor firms in that sector, but only in the post-WTO period. We interpret this as within-firm productivity improvements in response to increased competition from imports.

Table 5: Imports and the productivity of private domestic firms - balanced panel

Dependent variable: lnva	(1)	(2)
Value of imports	0.001	-0.002
	(0.009)	(0.009)
HHI * Value of imports	0.0004	-0.001
	(0.027)	(0.028)
WTO * Value of imports		0.011***
		(0.004)
HHI * WTO * Value of imports		0.004
		(0.010)
Production function parameters		
lnlab	0.780***	0.781***
	(0.013)	(0.013)
lncap	0.188***	0.188***
	(0.013)	(0.010)
Firm level controls		
Import Firm	0.045***	0.045***
	(0.013)	(0.013)
Export firm	0.032***	0.031**
	(0.014)	(0.014)
Sector level controls		
HHI	-0.253	-0.259
	(0.324)	(0.324)
Value of exports from sector	0.001	0.002
	(0.008)	(0.008)
Capital-labor ratio	-0.262***	-0.263***
	(0.040)	(0.040)
Size	-0.037	-0.035
	(0.029)	(0.029)
Concentration of foreign firms	-0.120	-0.140*
	(0.076)	(0.076)
Concentration of state firms	-0.160**	-0.131**
	(0.063)	(0.063)
R-squared	0.842	0.841
Firms	3,115	3,115
N	27,864	27,864

Robust standard errors clustered at the sector-year level are presented in parenthesis. Results are also robust to clustering at the sector level. They are not presented for ease of exposition but are available on request. All models include firm, year and sector fixed effects. The effect of WTO in levels is absorbed by the combination of time dummies and other control variables included in the model. *** indicates significance at the 1% level, ** the 5% level and * the 10% level.

We investigate the mechanisms through which firms might experience such productivity gains using the TCS survey instrument described in Section 3 collected for a sub-sample of firms in our panel in 2009, 2010 and 2011.We consider a range of different measures that capture firm behavior in relation to efficiency improvements to investigate the extent to which they are related to the observed productivity impacts of imports. These are described in Section 3 above and are included in levels and as interaction terms with the level of imports using the same baseline model described in equation (1). We focus on the variables found to have a statistically significant interactive effect when the level of concentration is controlled for as this is more likely to be due to real productivity improvements rather than changes in

mark-ups. The results are presented in Table 6 and reveal.[9] Only two variables have a significant interactive effect: whether the firm invested in new machinery; and whether the firm engaged in process innovations. The inclusion of the interactive effect between each of these variables and the value of imports renders the level effect of imports statistically insignificant. This suggests that most of the productivity improvement experienced by these firms associated with import competition is due to within-firm changes in the form of new machinery investments and process innovations that enhance their productivity. The fact that there is no residual impact of imports in each case suggests that technology transfers are unlikely to be a factor.

Table 6: Imports and the productivity of private domestic firms – within-firm behavior

Dependent variable: lnva	(1)	(2)	(3)	(4)	(5)	(6)
Behavior variable:			New Machinery		Process Innovation	
Imports	0.027	0.032*	0.024	0.029	0.025	0.026
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
HHI * Imports		-0.079		-0.082		-0.010
		(0.069)		(0.072)		(0.073)
Behavior var.			-0.274***	-0.284***	-0.051	-0.147**
			(0.076)	(0.109)	(0.047)	(0.061)
HHI* Behavior variable				-0.013		1.819**
				(0.117)		(0.787)
Behavior var. * Imports			0.024***	0.025**	0.003	0.012**
			(0.007)	(0.010)	(0.004)	(0.006)
HHI*Behavior var. * Imports				0.148		-0.176**
				(1.323)		(0.071)
Other variables:						
lnlab	0.618***	0.617***	0.617***	0.617***	0.618***	0.618***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
lncap	0.201***	0.201***	0.201***	0.202***	0.202***	0.202***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Import Firm	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.016)
Export firm	0.036*	0.036*	0.034*	0.034*	0.036*	0.035*
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
HHI	-0.117	0.774	-0.129	0.808	-0.116	0.065
	(0.084)	(0.733)	(0.085)	(0.768)	(0.081)	(0.786)
Value of exports from sector	0.036*	-0.024	-0.022	-0.022	-0.023	-0.023
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Capital-labor ratio	-0.203***	-0.205***	-0.207***	-0.209***	-0.202***	-0.203***
	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
Size	0.050	0.047	0.050	0.047	0.048	0.043
	(0.070)	(0.072)	(0.070)	(0.072)	(0.070)	(0.070)
Concentration of foreign firms	-0.166	-0.164	-0.166	-0.163	-0.162	-0.148
	(0.181)	(0.181)	(0.182)	(0.182)	(0.181)	(0.181)
Concentration of state firms	-0.020	-0.026	-0.016	-0.022	-0.014	-0.019
	(0.152)	(0.152)	(0.153)	(0.153)	(0.152)	(0.151)
R-squared	0.756	0.756	0.756	0.756	0.755	0.755
Firms	7,665	7,665	7,665	7,665	7,665	7,665
N	16,970	16,970	16,970	16,970	16,970	16,970

Robust standard errors clustered at the sectory-year level are presented in parenthesis. All models include firm, year and sector fixed effects. The effect of WTO in levels is absorbed by the combination of time dummies and other control variables included in the model. *** indicates significance at the 1% level, ** the 5% level and * the 10% level.

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[9] The results for the insignificant behavioral variables are not presented but are available on request. Firms that expand to other sectors and firms the take out patents also experience a positive effect of imports on productivity but this result does not hold when the level of competitiveness of the sector is taken into account.

The next step of our analysis explores the extent to which imports impact on firms through the supply chain. We revert back to our main panel dataset for this analysis and estimate the model given in equation (3), which is a simple extension of our baseline model to include a measure of the proportion of inputs into a sector that are imported. We first estimate the model for the full sample of both import and non-import firms before disaggregating for each type of firm. In each model we also include the upstream concentration differential. As discussed in section 2, this further isolates the effect on productivity of downstream firms in competitive sectors by separating out the impact of imports from upstream concentrated sectors (where productivity spillovers are more likely) from the impact of imports from upstream competitive sectors (where price effects are confounded with productivity effects). The results are presented in Table 7.

As revealed in columns (1) and (2) the proportion of imports into upstream sectors has a positive effect on the productivity of downstream firms. The effect is no different in competitive or concentrated sectors as indicated by the insignificance of the interaction effect between the HHI and our measure of imported intermediates. As discussed in Section 3, a further test to identify productivity gains from importing intermediates is to isolate the impact of an expansion in imports into concentrated upstream sectors and to consider the impact on the productivity of importing firms in downstream competitive sectors. The logic behind this test is that in concentrated sectors an expansion in imports will impact on costs to a lesser extent and so any impacts on downstream firms are likely to be due to physical productivity gains. The relevant coefficients in Table 7 column 3 are those relating to the interaction between the HHI in upstream sectors and the proportion of imports into upstream sectors, pre and post WTO. We find that the positive impact observed in columns 1 and 2 is driven by imports into concentrated upstream sectors and their impact in competitive downstream sectors in the pre-WTO period. This is indicative of physical productivity improvements associated with imported intermediates but only before full trade liberalization took place.

We disaggregate by non-import (column 4) and import (column 5) firms. We find that the impact of upstream imports on the productivity of downstream firms in the pre-WTO period is for non-import only with no impact detected for import firms. Coupled with our finding that in the pre-WTO period the source of productivity improvements from import competition was due to reallocations from less productive to more productive firms, this suggests that downstream users of *domestic* inputs benefitted indirectly from the import-competition induced average improvement in the efficiency of domestic firms in upstream sectors. We observe no effect in the post-WTO period when import competition appears to have led to within-firm efficiency gains for domestic competitors. This suggests that these gains do not pass through the supply chain to users of these imports suggesting that the improvements are likely to be reflected in the market price. Moreover, while firms that import intermediates are more productive than non-import firms, the proportion of imports into upstream sectors does not appear to have any significant effect on the productivity of downstream import firms. As for the lack of evidence for spillover effects from productivity improvements by domestic upstream suppliers, the lack of a well-determined finding on the link between imports upstream and the productivity of downstream import firms suggests that any technology gains, quality or variety improvements due to imported imports are likely to be reflected in the price paid for those inputs and so do not lead to a measured improvement in productivity performance.

Table 7: Imported inputs and the productivity of downstream private domestic firms

Dependent variable: lnva	(1)	(2)	(3)	(4) Non-import	(5) Import
Upstream imports	0.135*	0.144*	0.092	0.087	-0.018
	(0.081)	(0.084)	(0.093)	(0.099)	(0.178)
HHI * Upstream imports	-0.239	-0.236	0.003	-0.186	-1.101
	(0.319)	(0.407)	(0.643)	(0.666)	(1.262)
WTO * Upstream imports		-0.031	-0.027	-0.048	0.138
		(0.046)	(0.061)	(0.060)	(0.107)
HHI * WTO * Upstream imports		-0.068	-0.918	-1.247	4.050**
		(0.488)	(0.814)	(0.829_	(1.602)
HHI_up*Upstream imports			1.057*	1.058*	0.569
			(0.634)	(0.644)	(1.092)
HHI_up*HHI * Upstream imports			-2.547	0.003	11.829
			(7.388)	(7.280)	(13.566)
HHI_up*WTO * Upstream imports			0.008	0.009	0.637
			(0.724)	(0.750)	(1.348)
HHI_up*HHI * WTO * Upstream imp.			12.104	10.681	-21.254
			(9.266)	(9.429)	(17.957)
Production function parameters					
lnlab	0.799***	0.799***	0.799***	0.806***	0.663***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.022)
lncap	0.198***	0.198***	0.198***	0.195***	0.277***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.016)
Firm level controls					
Import Firm	0.054***	0.054***	0.054***		
	(0.009)	(0.009)	(0.009)		
Export firm	0.050***	0.050***	0.052***		
	(0.009)	(0.009)	(0.009)		
Sector level controls					
HHI	0.132	0.088	0.027	0.072	0.288
	(0.159)	(0.193)	(0.289)	(0.305)	(0.532)
Value of imports into sector	0.012**	0.013**	0.013**	0.016**	-0.020
	(0.006)	(0.006)	(0.007)	(0.006)	(0.012)
Value of exports from sector	-0.006	-0.007	-0.007	-0.009	0.017
	(0.005)	(0.006)	(0.006)	(0.006)	(0.013)
Capital-labor ratio	-0.281***	-0.280***	-0.270***	-0.279***	-0.200***
	(0.025)	(0.025)	(0.024)	(0.026)	(0.042)
Size	-0.048**	-0.045**	-0.039*	-0.046**	-0.034
	(0.021)	(0.021)	(0.020)	(0.021)	(0.038)
Concentration of foreign firms	0.037	0.030	0.019	0.041	-0.113
	(0.055)	(0.056)	(0.054)	(0.059)	(0.091)
Concentration of state firms	-0.142***	-0.141***	-0.162***	-0.160***	0.001
	(0.044)	(0.044)	(0.044)	(0.047)	(0.087)
R-squared	0.776	0.776	0.776	0.736	0.814
Firms	70,598	70,598	70,598	68,795	7,452
N	213,936	213,936	213,936	197,609	16,327

Robust standard errors clustered at the sector-year level are presented in parenthesis. Results are also robust to clustering at the firm level. All models include firm, year and sector fixed effects. In columns (3) to (5) each model also includes HHI_up, HHI*HHI_up, HHI_up*wto and HHI*HHI_up*wto as control variables. *** indicates significance at the 1% level, ** the 5% level and * the 10% level.

6. Conclusion

This paper explored the relationship between imports and the productivity of private domestic firms with the aim of disentangling the various mechanisms through which productivity gains are realized. We addressed the potential for both within-sector or horizontal effects and also between-sector or vertical effects through the supply chain. We also disentangled the effects for both non-import firms and import firms to help identify the various mechanisms. We used firm level enterprise survey data from Vietnam for the 2002 to 2011 period and data from a specially designed survey module that allows us to examine firms' behavioral responses that led to within-firm efficiency improvements. Our identification strategy exploits differences in the effects in competitive and concentrated sectors and in the impact of imports from competitive and concentrated upstream sectors. We also consider how these effects differed pre-WTO accession compared with a more liberal regime post-WTO.

We found strong evidence to suggest that imports impact on the productivity of domestic firms, both on competitors and on firms in downstream sectors through the supply chain. Perhaps surprisingly, however, we found that competition from imports is the most important channel through which productivity gains are realized; a combination of reallocations, whereby the least efficient firms exit as a result of competition from imports, and within-firm efficiency improvements through investments in new machinery and process innovations, lead to higher levels of productivity among domestic firms. Our results also suggest that there are spillover effects of productivity gains experienced by upstream domestic firms for downstream firms that use these domestically produced inputs. We find no evidence that domestic firms that import inputs experience any productivity spillovers which is in contrast with much of the theoretical literature on the mechanisms through which trade impacts on domestic productivity.

Future work will further refine our identification strategy extending the IV approach applied to our baseline model to the other models presented in the paper. We will also explore further the reallocation channel using sector level measures of productivity disaggregated into pure productivity and reallocation components and examine the impact of imports on each.

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Appendix

Control Variables:

Firm specific factors:
Import firm
Export firm

Sector specific factors:
Average capital-labor ratio
Average size of firms in sector
Proportion of revenue generated by foreign owned firms
Proportion of revenue generated by state owned firms
Concentration Ratio