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# THE IMPACT OF TRADE LIBERALIZATION ON FIRM PRODUCTIVITY AND INNOVATION

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The Impact of Trade Liberalization on Firm Productivity and Innovation
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## ABSTRACT

This chapter reviews the empirical economics literature on the impact of trade liberalization on firms' innovation-related outcomes. We define and examine four types of shocks to trade flows: import competition, export opportunities, access to imported intermediates, and foreign input competition. Our review reveals interesting heterogeneities at the country and firm levels. In emerging countries, trade liberalization appears to spur productivity and innovation. In developed countries, export opportunities and access to imported intermediates tend to encourage innovation, but the evidence on import competition is mixed, especially for firms in the United States. At the firm level, the positive effects of trade on innovation are more pronounced at the initially more productive firms while the negative effects are more pronounced at the initially less productive firms.



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# 1 Introduction

For the better part of the past several decades, international trade has risen steadily; as a share of world GDP, trade grew from 24 percent to 61 percent between 1960 and 2008 (see Figure 1). Since the onset of the Great Recession in 2008, however, trade activities have slowed; meanwhile, uneasiness about the implications of trade liberalization for local economies has spread in developed economies like the U.S. and the U.K.[1] Although economists have long argued that trade is overall welfare-enhancing, recent events indicate an increasingly cautious view of trade and globalization among policy makers and the general public.

Figure 1: Growth of International Trade, 1960–2016


Source: World Development Indicators (http://databank.worldbank.org/data/reports.aspx?source = world-development-indicators).

How does trade liberalization affect domestic firms' incentives and capabilities to innovate? This question is central to trade policy: innovation is a fundamental driver of economic growth (Romer, 1990; Jones, 2005). A simple Ricardian model would predict that a country gains from trade by specializing in its comparative advantage with respect to productivity. However, trade may also lead to an endogenous change in innovation (and consequently in productivity), which in turn could decrease or increase the gains from

[1] In June 2016, the U.K. electorate voted to withdraw from the European Union. In April 2018, the White House announced new tariffs on more than 1,300 imported goods from China in response to an investigation of China's "unreasonable or discriminatory" trade practices (USTR, 2018). China retaliated by imposing tariffs on some U.S. exports shortly thereafter.

trade. The arrival of new micro data and the various trade-liberalization episodes in recent decades have revived economists' interest in examining the impact of trade liberalization on innovation. This chapter will survey some of the recent empirical literature, introduce a simple framework to categorize the findings by the trade shocks examined, and summarize the broad patterns that have emerged.

Trade liberalization affects the environment in which firms operate in a range of ways. From the perspective of a focal domestic firm, trade liberalization could bring an influx of foreign competitors into domestic markets; it could also provide access to foreign markets. Either the increased competition or the increased access could affect the output market (where the focal firm operates as a seller) and/or the input market (where the focal firm operates as a buyer). We thus define four trade shocks by direction and by target market, as illustrated in Table 1's 2-by-2 matrix.

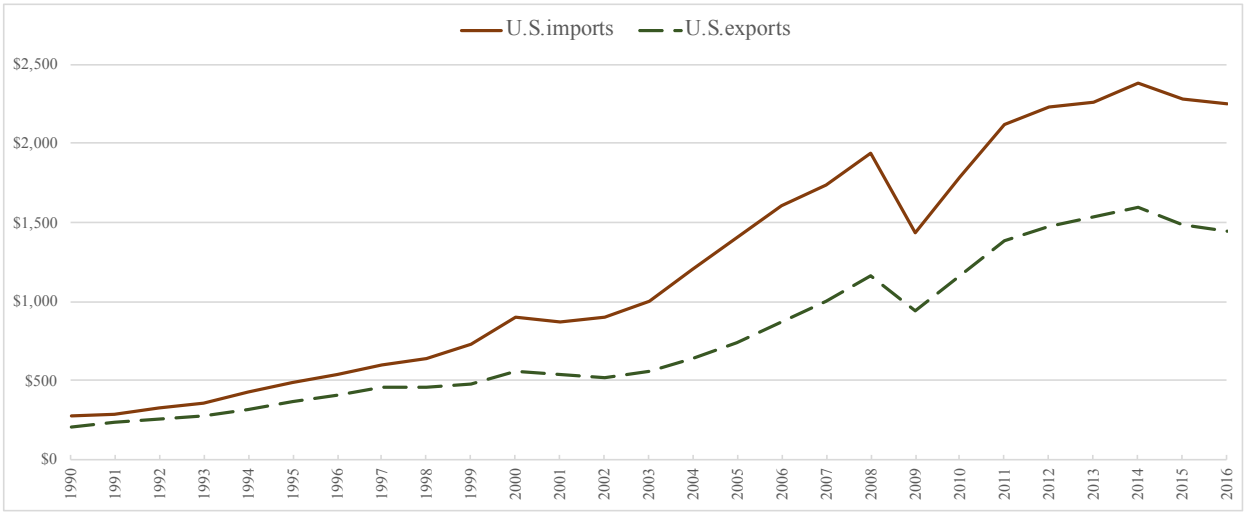
Table 1: A Categorization of Trade Shocks

| | | *Direction* | |
|---|---|---|---|
| | | Increased competition in domestic market | Increased access to foreign market |
| *Target market* | Output market | **Import competition** | **Export opportunities** |
| | Input market | **Foreign input competition** | **Access to imported intermediates** |

The output market is where the focal domestic firm sells its final goods and/or services. **Import competition** obliges the firm to face the entry of a foreign firm into the domestic output market. **Export opportunities** allow the domestic firm to enter a foreign output market to compete with existing foreign firms. Figure 2, Panel A, plots the growth of U.S. imports and that of U.S. exports between 1990 and 2016 (in 2016 dollars). During this period, U.S. imports increased nearly eightfold, from $281 billion to $2,248 billion; U.S. exports increased more than sevenfold, from $204 billion to $1,450 billion. China is a top contributor to the growth of both U.S. imports and U.S. exports.

Figure 2: Growth of U.S. Trade, 1990–2016

A. Total Trade in Goods (in billions of 2016 USD)




B. Share of Intermediate Goods in Total Trade by Value (Percentage)


Source: STAN Bilateral Trade Database by Industry and End-use category (BTDIxE) (http://stats.oecd.org/Index.aspx?DataSetCode=BTDIXE_I4).

The input market is where the focal domestic firm purchases intermediate goods used as inputs into its production. **Access to imported intermediates** allows the focal firm to purchase intermediate goods from a foreign supplier. **Foreign input competition** occurs when a foreign firm purchases its inputs from the domestic focal firm's domestic upstream suppliers, thus increasing demand for those inputs. Figure 2, Panel B, shows that intermediate goods have consistently been a large part of U.S. imports and of U.S.

exports. Though their shares of total trade have declined recently, intermediate goods still accounted for 40 percent of the value of U.S. imports and 48 percent of that of U.S. exports in 2016. It is important to note that imported intermediate goods not only provide access to foreign inputs (when the focal domestic firm imports the goods), they can also generate import competition (when the focal domestic firm and the foreign suppliers of intermediate goods compete to sell to the same downstream domestic customers). Similarly, exported intermediate goods can also provide export opportunities (when the focal domestic firm export the goods) in addition to generating foreign input competition (when the focal domestic firm and the foreign purchasers of intermediate goods compete to buy from the same upstream domestic suppliers).

The focal firm could enter into a foreign market in three ways: it could purchase or sell goods and/or services from an unaffiliated foreign firm where there is no linkage of ownership (i.e., entry via only trade flows); it could purchase or sell goods and/or services from an affiliated foreign firm (i.e., entry via both trade flows and foreign direct investment); or it could establish an affiliated foreign firm with which it does not trade (i.e., entry via only FDI). For the purpose of this review, we focus on understanding the effects of trade flows in the first two scenarios without distinguishing between the two. That is, we do not examine the third scenario or the effects of FDI in the second scenario. Trade flows and FDI have different effects theoretically and empirically, and it would have been impractical for this chapter to cover both in depth.

We use the 2-by-2 framework to organize our review of the empirical literature. In surveying the literature, we focus mainly on reduced-form studies that use trade-liberalization episodes as natural experiments to examine the effects of shocks to trade flows on productivity and innovation outcomes at the firm level. We focus on trade-induced changes within a firm and do not evaluate aggregate productivity changes due to reallocation across firms (Pavcnik, 2002; Melitz, 2003). There are, of course, many more papers on the topics of trade and innovation than our review could possibly cover.[2] The goal of this chapter is not to perform an exhaustive survey, but to identify a representative set of empirical studies and extract key takeaways using our simple framework. We complement the summaries of empirical studies with discussions of the underlying theoretical mechanisms emphasizing the intuition.

We consider both direct and indirect measures of innovation. The direct measures of innovation we consider consist of R&D spending (input into innovation), patents (output of innovation), product mix (e.g., number of products, product quality, and product differentiation), and survey responses on adoption of

[2]In addition to the literature on FDI and firm innovation (e.g., Guadalupe *et al.*, 2012; Fons-Rosen *et al.*, 2018), we also exclude the related literature on technology diffusion (Grossman & Helpman, 1991a), which Keller (2004) summarizes; more recent contributions to this literature include Smarzynska Javorcik (2004); Branstetter *et al.* (2006); Griffith *et al.* (2006); Bloom *et al.* (2013); Keller & Yeaple (2013); Bilir & Morales (2018); Gumpert (2018). Another literature we exclude is the macro trade literature (e.g., Costantini & Melitz, 2008; Atkeson & Burstein, 2010; Perla *et al.*, 2015; Sampson, 2016; Buera & Oberfield, 2016).

new technologies, new management practices, or product or process innovations. The indirect measures of innovation we consider are labor productivity and residual total factor productivity (TFP). We include studies on firm productivity since productivity and innovation are closely related: productivity captures the efficiency of the production process and innovation generates changes in efficiency. Although innovation does not always lead to productivity gains, it is a key determinant of productivity (Hall, 2011; Syverson, 2011). We thus include both types of outcomes to gain a better understanding of how trade liberalization affects firm innovation and the consequences of innovation.

Section 2 examines the impact of import competition on firm productivity and innovation. On the one hand, import competition may decrease a firm's incentives to innovate by reducing the rents that it could capture from innovating. On the other hand, a firm may innovate more in response to increased import competition as a way to "escape competition". In addition, import competition may reduce managerial slack or redeploy factors within the firm, both of which could lead to increased innovation. The current literature finds mixed evidence on the impact of import competition, and the findings differ by region and by firm. There is strong evidence that import competition spurs productivity and innovation for firms in emerging economies and Europe. The evidence is more negative for firms in the U.S. and Canada. Within a country, the impact of import competition tends to be more positive (or less negative) at firms that were initially more productive.

Sections 3 and 4 examine the impact of export opportunities and that of access to imported intermediates, respectively. Unlike import competition, export opportunities and access to imported intermediates are generally found to have positive effects on firm productivity and innovation across different countries. Export opportunities increase the returns to innovating by expanding the output market to which a firm has access, and access to imported intermediates improves the production process. In addition, both trade shocks could induce learning. The positive effects of these two shocks also tend to be more pronounced at firms that were initially more productive.

Since there is little empirical evidence on the impact of foreign input competition, Section 5 discusses the potential mechanisms and empirical designs to measure their relevance. Section 6 concludes.

## 2 Impact of Import Competition on Firm Productivity and Innovation

When foreign firms enter the domestic output market of the focal firm, they generate import competition. A large literature in industrial organization has studied how competition in general—not just import

competition—affects firms' incentives to innovate (Gilbert, 2006; Cohen, 2010); the key mechanisms that it has established serve as a useful foundation for understanding the impact of import competition. On the one hand, competition could reduce the potential rents that a firm could capture from innovating (Schumpeter, 1942). We label this mechanism the "Schumpeterian effect", which predicts that import competition has a negative impact on firm innovation. On the other hand, competition could also increase incentives to innovate by reducing the pre-innovation rents, i.e., the rents a firm can capture without innovating (Arrow, 1962). We label this mechanism the "escape-competition effect", which predicts that import competition has a positive impact on firm innovation. Aghion *et al.* (2005) show in a model that the escape-competition effect dominates when competing firms are neck-and-neck in their levels of technological advancement, whereas the Schumpeterian effect dominates for the laggards who are far behind the leaders at the technological frontier and have a low chance of catching up.[3]

The agency literature introduces another interesting angle for thinking about the impact of competition, which we label the "preference effect". Managers responsible for choosing how much to innovate may not make the choice that maximizes their firms' profits when they draw private benefits simply from their firm's continued existence (Hart, 1983; Schmidt, 1997; Vives, 2008; Raith, 2003). When increased competition threatens the existence of their business and job, they may exert more effort and innovate to avoid losing the private benefits. A related literature on X-efficiency shows that competitive pressure reduces managerial slack in firms (Leibenstein, 1978; Martin, 1978; Martin & Page, 1983; Holmes & Schmitz Jr, 2001). The preference effect implies that import competition has a positive impact on firm innovation.

Although the escape-competition effect and the preference effect both imply a positive innovation response to import competition, the former effect is increasing in a firm's initial productivity, whereas the latter effect is decreasing in a firm's initial productivity (Aghion *et al.*, 2001; Bombardini *et al.*, 2017; Chen & Steinwender, 2017). Initially more productive firms are closer to the technological frontier and thus have stronger incentives to escape competition. They also face lower bankruptcy risk, so the preference effect is less likely to activate.

[3]The Schumpeterian explanation focuses on changed *incentives* to innovate. An alternative way to explain why laggards innovate less in response to import competition is that they become more *constrained* (e.g., credit constrained; Hombert & Matray, 2017).

Table 2: Recent Evidence on the Impact of Import Competition on Firm Productivity and Innovation

| Authorship and Date | Home Country and Sample Period | Source of Trade Shock | Outcomes Examined | Findings |
|---|---|---|---|---|
| Pavcnik (2002) | Chile, 1979–1986 | Unilateral trade liberalization | TFP | Positive |
| Muendler (2004) | Brazil, 1986–1998 | Unilateral trade liberalization and part reversal | TFP | Positive for medium and large firms |
| Schor (2004) | Brazil, 1986–1998 | Unilateral trade liberalization and part reversal | TFP | Positive for medium and large firms |
| Trefler (2004) | Canada, 1980–1996 | CUSFTA | Labor productivity | Positive but statistically insignificant |
| Aghion, Bloom, Blundell, Griffith, and Howitt (2005) | United Kingdom, 1973–1994 | EU Single Market Program (and other domestic policies) | Patents | Positive for less competitive industries; negative for more competitive industries ("inverted-U shape") |
| Schmitz (2005) | United States and Canada (iron ore sector), 1980–1995 | Drop in world prices leading to competition from Brazil | Labor/materials/capital productivity, work practices, technology, skill composition | Positive productivity effects driven by change in work practices |
| Bernard, Jensen, and Schott (2006a) | United States, 1977–1997 | Changes in tariffs and freight rates | Product switching | Positive but statistically insignificant |
| Bernard, Jensen, and Schott (2006b) | United States, 1987–1997 | Changes in tariffs and freight rates | TFP | Positive, less for multinationals |
| Amiti and Konings (2007) | Indonesia, 1991–2001 | Indonesia's entry into WTO | TFP | Positive, stronger for importers, but also positive for non-importers |
| Fernandes (2007) | Colombia, 1977–1991 | Trade liberalization | TFP | Positive; stronger for larger plants and those in less competitive industries |
| Teshima (2009) | Mexico, 2000–2003 | Tariff changes | R&D expenditure, process innovation, product innovation, TFP | Positive (R&D expenditure on process innovation); insignificant (TFP, R&D expenditure on product innovation) |
| Bas and Ledezma (2010) | Chile, 1982–1999 | Trade liberalization | TFP | Positive in export-oriented industries, negative in import-competing industries |
| Dunne, Klimek, and Schmitz (2010) | United States (cement), 1972–1997 | Drop in prices of foreign firms | Labor productivity, flexible work practices | Positive |
| Goldberg, Khandelwal, Pavcnik and Topalova (2010) | India, 1989–1997 | 1991 liberalization episode | Number of products | Insignificant |
| Gorodnichenko, Svejnar, and Terrell (2010) | 27 emerging countries, 2002 & 2005 | n/a (self-reported measure of foreign competition) | Product innovation, technology acquisition | Positive for nearest and furthest tercile from frontier (product innovation); positive without heterogeneity (technology acquisition) |
| De Loecker (2011) | Belgium (textile), 1994–2002 | Import quota removal at EU level | TFP | Positive but statistically insignificant |
| Iacovone, Keller, and Rauch (2011) | Mexico, 1998–2004 | Chinese import penetration; China's entry into WTO | Quality control; reorganization; just-in-time system; job rotation | Positive effects for productive firms; negative effects for unproductive firms |
| Topalova and Khandelwal (2011) | India, 1987–2001 | 1991 liberalization episode | TFP | Positive but only for domestic firms |

| Authorship and Date | Home Country and Sample Period | Source of Trade Shock | Outcomes Examined | Findings |
|---|---|---|---|---|
| Iacovone (2012) | Mexico, 1993–2002 | NAFTA | Labor productivity, R&D expenditure, technology transfers | Positive, especially for frontier firms (labor productivity); insignificant (R&D expenditure, technology transfers) |
| Amiti and Khandelwal (2013) | 56 countries, 1990–2005 | Import tariffs; end of Multi-Fiber Agreement | Product quality estimate | Positive for varieties close to the frontier; negative for varieties far from the frontier |
| Fernandes and Paunov (2013) | Chile, 1997–2003 | Transport cost changes | Product quality (unit values), new products, labor productivity | Positive, and larger for high skilled firms (product quality), positive (new products), insignificant (labor productivity) |
| Bloom, Draca, and Van Reenen (2016) | 12 European countries, 1995–2007 | Multi-Fiber Agreement for imports from China | Patents, investment in IT, R&D expenditure, TFP | Positive |
| Bloom, Sadun, and Van Reenen (2016) | 34 countries, 2004–2014 | Chinese import penetration | Management score | Positive |
| Autor, Dorn, Hanson, Pisano, and Shu (2017) | United States, 1975–2013 | Chinese import penetration; China's entry into WTO | Patents, R&D expenditure | Negative; effects more negative for initially weaker firms |
| Bombardini, Li, and Wang (2017) | China, 2000–2007 | China's entry into WTO | Patents, TFP, R&D expenditure | Positive only for initially most productive firms |
| Brandt, Van Biesebroeck, Wang, and Zhang (2017) | China, 1998–2007 | China's entry into WTO | Productivity | Positive (especially for new entrants) |
| Chakravorty, Liu, and Tang (2017) | United States, 1990–2006 | Chinese import penetration in UK | Patents | Positive (citation-weighted patents), insignificant (patent count); only for capital intensive firms |
| Chen and Steinwender (2017) | Spain, 1993–2007 | EU level tariff reductions | Labor productivity | Positive only for initially unproductive family firms |
| Dang (2017) | Vietnam (SMEs), 2011–2015 | Chinese world exports | Product innovation, process innovation, product improvement | Insignificant |
| Hombert and Matray (2017) | United States, 1991–2007 | Chinese import penetration | Product differentiation | Positive for firms with large R&D stock |
| Kueng, Li, and Yang (2017) | Canada, 1999–2005 | Chinese import penetration | Self-reported product and process innovation outcomes | Negative overall; effects more negative for process innovations |
| Xu and Gong (2017) | United States, 1995–2009 | Chinese import penetration | R&D expenditure | Negative overall; negative for unproductive/low margin firms, positive for productive/high margin firms |
| Bloom, Romer, Terry, and Van Reenen (2018) | 11 European countries, 1995–2005 | Chinese import penetration | Patents | Positive |
| Ahn, Han, and Huang (2018) | South Korea, 1996–2015 | Chinese world exports | Patents | Positive, especially for listed and large firms, especially in high-quality and high-tech sectors |
| Fieler and Harrison (2018) | China, 1998–2007 | China's entry into WTO | TFP | Positive |
| Medina (2018) | Peru (apparel), 2000–2012 | Chinese import penetration in Latin America | Product quality | Positive, especially for large firms |

Table 2 summarizes the recent empirical evidence on the impact of import competition on firm productivity and innovation (published or written after 2000). Several interesting patterns emerge. First, much of the pre-2013 literature use data on Latin American firms, since those countries had experienced arguably exogenous trade-liberalization episodes in the 1980s and 1990s (Pavcnik, 2002; Muendler, 2004; Schor, 2004; Fernandes, 2007; Teshima, 2009; Bas & Ledezma, 2010; Iacovone *et al.*, 2011; Iacovone, 2012; Fernandes & Paunov, 2013). These studies generally find positive effects of import competition on productivity, especially at large firms (Muendler, 2004; Schor, 2004; Fernandes, 2007; Fernandes & Paunov, 2013) and at the most technologically advanced firms (Iacovone *et al.*, 2011; Iacovone, 2012). There is also positive evidence from studies on firms in Asia (Amiti & Konings, 2007 for Indonesia; Topalova & Khandelwal, 2011 for India) and from cross-country studies (Gorodnichenko *et al.*, 2010; Amiti & Khandelwal, 2013). Overall, the pre-2013 literature provides ample support for the escape-competition effect at firms in developing countries.

Evidence on firms in developed countries is more nuanced. In Northern America (i.e., the United States and Canada), the findings from the pre-2013 literature are split between being positive (Schmitz Jr, 2005; Bernard *et al.*, 2006b; Dunne *et al.*, 2010) and being positive but insignificant (Trefler, 2004; Bernard *et al.*, 2006a). In Europe, De Loecker (2011) finds positive but insignificant effects for Belgium. Interestingly, Aghion *et al.* (2005) show that the relationship between import competition and innovation at firms in UK follows an inverted-U pattern: competition increases innovation in industries that are not very competitive, where firms tend to be neck-and-neck in their levels of technological advancement; in contrast, in industries that are already highly competitive and have large technological gaps, competition decreases innovation.

More recent studies have taken advantage of China's drastic and unexpected rise as the world's leading exporter.[4] Again, there are regional differences in the findings on the impact of Chinese import competition on firm productivity and innovation. Chinese import competition is found to increase innovation for firms in Europe (Bloom *et al.*, 2016b, 2018), China (Bombardini *et al.*, 2017; Brandt *et al.*, 2017), South Korea (Ahn *et al.*, 2018), and Peru (Medina, 2018). Bloom *et al.* (2018) propose an alternative mechanism to the escape-competition and preference effects that could also explain the positive findings: import competition may lower the returns to factors that are "trapped" inside of a firm due to firm-specific moving costs, thereby reducing the opportunity cost of using these factors to innovate. Similarly, Medina (2018) argues that import competition could lead to product upgrading by forcing firms to reallocate idle factors that are too costly to eliminate.

[4]See Autor *et al.* (2016) for a description of the rise of Chinese manufacturing exports.

For firms in Northern America, there is a mixture of findings. Chinese import competition has a negative effect on the R&D spending of U.S. firms, which is driven by those with relatively weak initial performances (Autor *et al.*, 2017; Xu & Gong, 2017). It also has a negative effect on the self-reported product and process innovations of Canadian firms (Kueng *et al.*, 2017). At the same time, Chinese import competition has a positive effect on the product differentiation of U.S. firms with large R&D stocks (Hombert & Matray, 2017). Autor *et al.* (2017) and Chakravorty *et al.* (2017) report conflicting findings on the impact of Chinese import competition on U.S. firms' patenting. Using data on U.S. patents granted between 1990 and 2006, Chakravorty *et al.* (2017) find insignificant effects of Chinese import competition on patent count and positive effects on citation-weight patents. Autor *et al.* (2017) find negative effects on both measures using patents granted between 1975 and 2013. Autor *et al.* (2017) show that the estimated effects of Chinese import competition on patents are sensitive to the inclusion of controls for differential time trends across sectors, since there exist confounding pre-trends in technology creation. Taken together, the results from Northern America provide support for both the Schumpeterian and escape-competition effects; the former is more pronounced at the initially less productive firms and the latter is more pronounced at the initially more productive firms.

In summary, the studies in our review find overwhelmingly positive evidence in developing economies, largely positive evidence in Europe, and mixed evidence in Northern America. To our best knowledge, no studies have empirically examined the drivers of these cross-regional differences in the innovation response to import competition.[5] We propose three potential explanations. First, the initial levels of competitiveness of industries might be the lowest in developing countries and the highest in Northern America; Europe would be somewhere in between. In the framework of Aghion *et al.* (2005), developing countries and Europe would thus be on the left side of the inverted-U curve, where more competition would lead to increased innovation; Northern America would be on the right side of the curve with the opposite impact. Second, managerial slack—and hence the preference effect—might be the largest in developing countries and the smallest in Northern America.[6] Third, frictions in the markets might be the highest in developing countries and the lowest in Northern America. As a result, factors are the most likely to be "trapped" at firms in developing countries. We believe that empirically testing these potential explanations would be a valuable contribution to the trade and innovation literature.

[5] Autor *et al.* (2017), Akcigit *et al.* (2017), and Bloom *et al.* (2018) provide informal discussions that focus on reconciling the differential findings between Europe and Northern America.

[6] Using data on Spanish firms, Chen & Steinwender (2017) provide support for the preference effect by showing that import competition has a positive effect only on initially unproductive family firms and not on professionally managed firms.

# 3 Impact of Export Opportunities on Firm Productivity and Innovation

Export opportunities provide domestic firms access to new foreign output markets. From the perspective of the focal domestic firm, there are two important differences between export opportunities and import competition. First, import competition does not change the size of the focal firm's potential output market, whereas export opportunities do; import competition only reduces the effective market size, i.e., the share of the market that the firm is able to capture. The increased size of the potential market increases the rents that a firm could capture from innovating, resulting in a positive impact of export opportunities on innovation (we label this the "market-size effect"). However, a potential indirect effect of having access to a larger market is that entry becomes more attractive, leading to more intensive competition in the domestic output market (Aghion *et al.*, 2017).[7]

The second difference is that import competition affects all domestic firms (though some may be affected more than others), whereas the market-size effect is only relevant to those that choose to export (or have the potential to do so). Standard trade models with heterogeneous firms (e.g., Melitz, 2003) emphasize that only sufficiently productive firms with low marginal cost would export; for others, the fixed and variable cost of exporting would be too high. The induced-competition effect of export opportunities, on the other hand, affects both exporters and non-exporters.

Table 3 summarizes the recent empirical findings on the effects of export opportunities on firm productivity and innovation (published or written after 2000). The first group of studies examines the effects of access to export markets. Most of them find positive effects—at least at some firms (Verhoogen, 2008; Bas & Ledezma, 2010; Lileeva & Trefler, 2010; Aw *et al.*, 2011; Bernard *et al.*, 2011; Bustos, 2011; Iacovone, 2012; Mayer *et al.*, 2016; Aghion *et al.*, 2017; Manova & Yu, 2017; Ahn *et al.*, 2018; Coelli *et al.*, 2018; Munch & Schaur, 2018). Consistent with the market-size effect, the initially most productive and the technologically most advanced firms respond the most favorably to increased access to export markets (Lileeva & Trefler, 2010; Bustos, 2011; Iacovone, 2012; Mayer *et al.*, 2016; Aghion *et al.*, 2017; Ahn *et al.*, 2018). There is also some evidence that the induced competition from export opportunities lead to the Schumpeterian effect (i.e., negative effect on innovation) for non-exporters and the initially least productive firms (Baldwin & Gu, 2009; Aghion *et al.*, 2017).

[7] Note that the indirect competition effect is present even in a unilateral trade liberalization. Import competition may also interact with export opportunities and generate competition against the focal domestic firm in the foreign markets that it exports to. Medina (2018) considers the differential effects of import competition in domestic versus foreign markets and finds no significant effects of import competition in foreign markets.

Table 3: Recent Evidence on the Impact of Export Opportunities on Firm Productivity and Innovation

| Authorship and Date | Home Country and Sample Period | Sources of Trade Shock | Outcomes Examined | Findings |
|---|---|---|---|---|
| ***Effects of having access to export markets*** | | | | |
| Verhoogen (2008) | Mexico, 1984–2001 | Peso devaluation | ISO 9000 certification (proxy for product quality) | Positive |
| Baldwin and Gu (2009) | Canada, 1984–1996 | CUSFTA, NAFTA | Num. products, product diversification (entropy) | Negative only for non-exporters |
| Bas and Ledezma (2010) | Chile, 1982–1999 | Trade liberalization episode | TFP | Positive |
| Iacovone and Javorcik (2010) | Mexico, 1994–2003 | NAFTA | Number of products | Negative (least important products are dropped) |
| Lileeva and Trefler (2010) | Canada, 1984–1996 | CUSFTA | Labor productivity, product innovation, advanced manufacturing technologies | Positive for exporters; only significant for the smaller, least productive exporters |
| Aw, Roberts, and Xu (2011) | Taiwan (electronics industry), 2000–2004 | n/a (structural estimation) | R&D expenditure, TFP | Positive |
| Bernard, Redding, and Schott (2011) | U.S., 1987–1992 | CUSFTA | Number of products, product specialization | Positive (product specialization); negative (number of products) |
| Bustos (2011) | Argentina, 1992–1996 | MERCOSUR accession of Brazil | Technology spending, product and process innovation | Positive; only significant for firms in upper-middle range of firm size |
| Iacovone (2012) | Mexico, 1993–2002 | NAFTA | Labor productivity | Positive; larger for frontier firms |
| Mayer, Melitz, and Ottaviano (2016) | France, 1995–2005 | Foreign demand shocks | Labor productivity, number of products | Positive (labor productivity only significant for multi-product firms) |
| Aghion, Bergeaud, Lequien, and Melitz (2017) | France, 1994–2012 | Foreign demand shocks | Patent applications, R&D investment, # researchers | Positive for the initially most productive firms; negative for the initially least productive firms |
| Manova and Yu (2017) | China, 2002–2006 | End of Multi-Fiber Agreement | Product scope, product quality | Positive for adding new, but lower quality products |
| Ahn, Han and Huang (2018) | South Korea, 1996–2015 | Chinese world imports | Patents | Positive, especially for listed and large firms, especially in high-quality and high-tech sectors |
| Coelli, Moxnes and Ulltveit-Moe (2018) | 60 countries, 1965–1985 and 1992–2000 | Great Liberalization in the 90s | Patents | Positive |
| Munch and Schaur (2018) | Denmark, 2002–2012 | Export promotion | Labor productivity | Positive for small firms |
| ***"Learning by exporting"*** | | | | |
| Van Biesebroeck (2005) | Sub-Saharan Africa, 1992–1996 | before/after firm entry in exporting | TFP | Positive |
| De Loecker (2007) | Slovenia, 1994–2000 | before/after firm entry in exporting | TFP | Positive; larger when exporting to high-income countries |
| Atkin, Khandelwal and Osman (2017) | Egypt, 2011–2014 | Randomized control experiment (access to foreign markets) | Quality, output/hour | Positive |

The second group of studies focuses on a related channel known as "learning by exporting". Learning-by-exporting, like the market-size effect, generates a positive effect on firm productivity and innovation, but the two channels have some conceptual differences. In learning-by-exporting, a firm receives knowledge without necessarily investing in innovation-related activities. The market-size effect by contrast would prompt a firm to intentionally increase innovation in order to reap the benefits of access to an enlarged market. Moreover, in learning-by-exporting, innovation occurs *after* exporting; in the market-size effect, firms may innovate or plan to innovate before export opportunities are realized. We thus categorize the learning-by-doing studies separately. Interestingly, learning-by-exporting happens predominantly at firms exporting to more developed economies (van Biesebroeck, 2005; De Loecker, 2007; Atkin *et al.*, 2017), likely due to such economies offering more scope for firms to learn from technologically advanced buyers.[8]

# 4 Impact of Access to Imported Intermediates on Firm Productivity and Innovation

Access to imported intermediates allows the focal domestic firm to purchase intermediate goods from foreign suppliers. While this also generates import competition for the focal firm's domestic upstream suppliers, in this section we consider the effect on the outcomes of the focal firm. Since we focus on trade flows, we do not consider the case—often casually labeled "outsourcing" or "offshoring"—where the focal firm delegates the entire production process to a foreign firm (affiliated or unaffiliated) with which it does not trade.[9]

[8] One earlier study, Bernard & Jensen (1999), finds no evidence of learning-by-exporting at U.S. firms, who may have a narrower scope for learning.

[9] On the impact of moving production offshore on firm innovation, see Fuchs & Kirchain (2010); Pisano & Shih (2012) for interesting case studies and Andersen (2016), Bena & Simintzi (2017), and Branstetter *et al.* (2017) for recent empirical evidence.

Table 4: Recent Evidence on the Impact of Access to Imported Intermediates on Firm Productivity and Innovation

| Authorship and Date | Home Country and Sample Period | Sources of Trade Shock | Outcomes Examined | Findings |
|---|---|---|---|---|
| Muendler (2004) | Brazil, 1986–1998 | Unilateral trade liberalization and part reversal | TFP | No effect (use of foreign intermediates or equipment) |
| Schor (2004) | Brazil, 1986–1998 | Unilateral trade liberalization and part reversal | TFP | Positive (input tariffs) |
| Amiti and Konings (2007) | Indonesia, 1991–2001 | Indonesia's entry into WTO | TFP | Positive (larger than import competition) |
| Kasahara and Rodrigue (2008) | Chile, 1979–1996 | n/a (structural estimation) | TFP | Positive for importers |
| Teshima (2009) | Mexico, 2000–2003 | Tariff changes | R&D expenditure, process innovation, product innovation, TFP | Insignificant |
| Goldberg, Khandelwal, Pavcnik and Topalova (2010) | India, 1989–1997 | 1991 liberalization episode | Number of products, TFP, R&D | Positive (number of products and TFP), positive only for large firms (R&D) |
| Lileeva and Trefler (2010) | Canada, 1984–1996 | CUSFTA | Labor productivity | Positive for exporters |
| Topalova and Khandelwal (2011) | India, 1987–2001 | 1991 liberalization episode | TFP | Positive (larger than import competition), only for domestic firms |
| Iacovone (2012) | Mexico, 1993–2002 | NAFTA | Labor productivity | Positive, especially for frontier firms |
| Colantone and Crinò (2014) | 25 European countries, 1995–2007 | Transport cost | New domestic products | Positive |
| Bas and Strauss-Kahn (2015) | China, 2000–2006 | Tariff reductions, tariff exemptions | Product quality | Positive |
| Bøler, Moxnes and Ulltveit-Moe (2015) | Norway, 1997–2005 | n/a (structural estimation) | R&D expenditure | Positive |
| Halpern, Koren and Szeidl (2015) | Hungary, 1992–2003 | n/a (structural estimation) | TFP | Positive for importers, especially for foreign owned importers |
| Bloom, Draca and van Reenen (2016) | 12 European countries, 1995–2007 | Multi-Fiber Agreement | Patents, IT investment, TFP | Positive for IT investment and TFP, insignificant for patents |
| Bas and Berthou (2017) | India, 1989–1997 | 1991 liberalization episode | Imported technology | Positive for firms with medium initial productivity |
| Brandt, van Biesebroeck, Wang and Zhang (2017) | China, 1998–2007 | China's entry into WTO | TFP | Positive (stronger for new entrants) |
| Bas and Paunov (2018) | Ecuador, 1997–2007 | WTO accession | Number of products | Positive |
| Fieler and Harrison (2018) | China, 1998–2007 | China's entry into WTO | TFP | Positive |
| Fieler, Eslava and Xu (2018) | Colombia, 1982–1988 | n/a (simulation) | Product quality | Positive |
| Juhász and Steinwender (2018) | 75 countries, 1845–1910 | Roll-out of telegraph network | Technology adoption | Positive |

Access to imported intermediates may lower input costs, increase the quality of inputs, and/or improve the efficiency of the production process (Halpern *et al.*, 2015; Bøler *et al.*, 2015). As a result, the focal firm may produce new and/or higher quality output (Goldberg *et al.*, 2010; Bas & Strauss-Kahn, 2015; Fieler *et al.*, 2018); it may also innovate more due to increased profit margins or more opportunities to learn about new product design, new production processes, new materials or technologies, and even new organizational methods (Ethier, 1982; Markusen, 1989; Grossman & Helpman, 1991b; Rivera-Batiz & Romer, 1991; Coe & Helpman, 1995). At the same time, access to imported intermediates may decrease innovation by reducing the need for process-improving technologies.

Table 4 summarizes the recent empirical findings on the impact of access to imported intermediates on firm productivity and innovation. Except for two studies that find insignificant effects (Muendler, 2004; Teshima, 2009), all other studies report positive and significant results. The vast majority of these studies focuses on estimating the impact on TFP, an indirect measure of innovation (Schor, 2004; Amiti & Konings, 2007; Kasahara & Rodrigue, 2008; Goldberg *et al.*, 2010; Lileeva & Trefler, 2010; Topalova & Khandelwal, 2011; Iacovone, 2012; Halpern *et al.*, 2015; Bloom *et al.*, 2016b; Brandt *et al.*, 2017; Fieler & Harrison, 2018). There is also evidence of positive effects on R&D (Goldberg *et al.*, 2010; Bøler *et al.*, 2015), patenting (Bloom *et al.*, 2016b), product innovation (Goldberg *et al.*, 2010; Bas & Paunov, 2018), and technology adoption (Bas & Berthou, 2017; Juhász & Steinwender, 2018; Bloom *et al.*, 2016b).[10]

Most of the studies focus on firms in developing countries. For these firms, the effects of access to imported intermediates may differ for firms with and without foreign ownership. Topalova & Khandelwal (2011) find that foreign-owned firms in India experience less positive effects than their domestic counterparts, while Halpern *et al.* (2015) find the opposite results in Hungary. Interestingly, Amiti & Konings (2007) find that non-importers can also gain from importers' access to imported intermediates, though the estimated spillover effects for non-importers are smaller than the estimated direct effects for importers.

Fewer studies focus on firms in developed countries. Although they also find positive effects of access to imported intermediates, there are interesting differences in the underlying mechanism: firms in developing economies tend to import high-quality inputs from firms in developed economies (e.g., Goldberg *et al.*, 2010; Bas & Strauss-Kahn, 2015; Fieler *et al.*, 2018), whereas firms in developed countries tend to import cheaper and low-quality inputs (Bloom *et al.*, 2016b). The differential effects of accessing different types of inputs on firm productivity and innovation warrant future research.

[10]Interestingly, Goldberg *et al.* (2010) find that for Indian firms, access to new inputs matters more than access to cheaper existing inputs for driving product innovation. Bas & Paunov (2018), however, find the opposite for Ecuador.

Two studies use tariff changes to compare the impact of import competition and that of access to imported intermediates (Amiti & Konings, 2007; Topalova & Khandelwal, 2011). The same tariff could affect the import competition faced by a firm or the access to imported inputs enjoyed by its downstream customers. In other words, the focal firm's import competition depends on the tariffs imposed in its own industry, and its access to imported intermediates depends on the tariffs imposed in its suppliers' industries. Both studies find that access to imported intermediates has a more positive effect than import competition.

# 5 Impact of Foreign Input Competition on Firm Productivity and Innovation

Foreign input competition means that foreign firms enter the domestic input market as buyers and compete against the focal domestic firm for the same inputs produced by its domestic suppliers. Foreign input competition is thus generated by the increased export opportunities for the focal firms' domestic suppliers. To our knowledge, only one study—Kee (2015)—provides relevant evidence on the impact of foreign input competition by showing that domestic firms in the Bangladeshi garment sector enjoy positive spillovers from sharing the same local suppliers with foreign-owned firms. When a trade policy shock (EU's Everything-But-Arms Initiative) led to an exogenous increase in the demand for local inputs by foreign-owned firms, local suppliers improved their efficiency, product quality and product variety, which in turn increased the productivity and product scope of the domestic firms who were purchasing from the same suppliers. Although Kee (2015) examines foreign entry via FDI, the same mechanism could also apply to entry via trading goods. In other words, foreign input competition could have a positive impact on a focal firm's productivity and innovation when the firm's suppliers start exporting more and consequently improve the attributes of the inputs they supply.

In theory, foreign input competition could also have a negative impact on the focal firm's productivity and innovation by raising the costs of its inputs and reducing its profit margins. To empirically examine the effects of foreign input competition on a firm's outcomes, researchers would need exogenous variations in the export opportunities of its upstream suppliers. The trade-liberalization episodes examined by studies in Section 3 provide a good starting point: instead of calculating changes in the export opportunities of the focal firm, one would use an input-output table to calculate those of its upstream suppliers. Given the importance of intermediate goods as exports (Figure 2), we believe that addressing this gap in the empirical literature is a promising avenue for future work.

# 6 Conclusion

This chapter reviews the recent empirical evidence on the effects of trade liberalization on firm productivity and innovation. We consider the effects of four shocks to trade flows: import competition, export opportunities, access to imported intermediates, and foreign input competition. Overall, the studies in our review find that import competition has mixed effects on firm productivity and innovation while export opportunities and access to imported intermediates have generally positive effects. There is little evidence on the impact of foreign input competition.

Our review points to interesting differences across regions. In emerging economies, such as Latin American countries, most of the evidence shows that trade has positive effects on firm productivity and innovation, especially for the largest and most productive firms. Due to data limitations, however, these studies tend to focus on medium-sized and large firms in the formal economy. Since there is important heterogeneity across firms in their responses to trade shocks, the existing findings may not extend to smaller firms in the informal sector, which play a large role in developing economies.[11] Thus, examining the impact of trade on the outcomes of smaller firms (e.g., entrepreneurship) would be a valuable contribution to the literature.

There are fewer studies on firms in developed economies. Studies on European firms also find positive (but sometimes insignificant) effects of trade liberalization on firm productivity and innovation. In the United States, most of the existing evidence concerns the impact of import competition and finds mixed effects. There is a striking lack of studies on the impact of the other three trade shocks on U.S. firms' innovation-related outcomes.[12] Addressing this gap in the literature is an important area for future research.

Another broad pattern emerging from our review is that larger and more productive firms tend to gain more from trade liberalization in terms of increased productivity and innovation. Standard trade models with heterogeneous firms (e.g., Melitz, 2003) have shown that when each firm's productivity is fixed, aggregate productivity gains from trade are generated by the most productive firms entering a market or the least productive firms exiting it. Our review suggests that there is an additional complementary mechanism of reallocation due to endogenous within-firm changes in productivity and innovation.

Although it is tempting to justify protectionism using the negative evidence on the impact of import competition on firm innovation, our review shows that trade policies have complicated consequences. Tariffs on imports may insulate some domestic firms from import competition, but they may also restrict the

[11] An exception is Nataraj (2011), who shows that import competition caused the average productivity of informal firms in India (which accounts for 80% of employment) to increase, but due to a lack of panel data is not able to attribute this fully to within firm productivity changes.

[12] To the best of our knowledge, Bernard *et al.* (2011) is the only study that uses U.S. data to examine the impact of export opportunities on firm innovation. We found no studies on the effects of access to imported intermediates or foreign input competition.

access to intermediate goods for other domestic firms. Moreover, foreign countries may retaliate by limiting domestic firms' access to export markets. Since a reduction in access to foreign inputs and/or export opportunities is likely to hurt domestic innovation, protectionist policies have clear risks. Akcigit *et al.* (2017) show in a model that import tariffs generate at best short-term gains at the expense of long-term losses, whereas policies that encourage innovations directly (e.g., R&D subsidies) generate substantial long-term gains.

In interpreting the empirical evidence, it is important to keep in mind the limitations of the current literature. First, productivity and innovation are inherently difficult to observe, and the measures we have are imperfect.[13] Second, a trade shock to a domestic firm may generate interesting technological spillovers to other firms, e.g., through vertical linkages, and more empirical evidence on this channel would improve our understanding of its overall impact on productivity and innovation.[14] Finally, most of the studies in this review examine the impact of each trade shock individually. There is more to learn about how the four shocks considered here interact with each other in driving changes in productivity and innovation. While we have made substantial progress of understanding the impact of trade on innovation, there remain many unanswered questions and fruitful areas for future research.

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[13] For instance, changes in residual TFP could be due to changes in markups instead of changes in the actual productivity (TFPQ). For a discussion of the importance of differentiating between TFPQ and markups, see Foster *et al.* (2008); Garcia Marin & Voigtländer (2017); De Loecker & Goldberg (2014); De Loecker & van Biesebroeck (2018). For a discussion of the effects of trade shocks on markups and prices, see De Loecker & Warzynski (2012); Fernandes & Paunov (2013); De Loecker *et al.* (2016); Brandt *et al.* (2017); Feenstra (2018). For a discussion of the issues and best practices of using patents to measure firm innovation, see Lerner & Seru (2017).

[14] Fieler & Harrison (2018); Smarzynska Javorcik (2004); Kee (2015) provide examples of this direction of research.

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