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Dynamic Gains from Trade

THE ROLE OF INTERMEDIATE INPUTS AND EQUIPMENT IMPORTS

Susan Stone, Ben Shepherd

JEL Classification: F10, F13

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Abstract

DYNAMIC GAINS FROM TRADE: THE ROLE OF INTERMEDIATE INPUTS AND EQUIPMENT IMPORTS

by

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Dynamic gains from trade can be an important conduit for increased firm-level innovation and productivity, both key components of economic growth. This paper builds on previous research on the dynamic gains from trade by moving beyond a single country basis to examine impacts on firm-level productivity for a cross-section of countries. It also focuses on productivity gains through the import of intermediate inputs and capital goods and systematically explores the specific impacts of non-trade, or complementary, policies on firms' ability to realise dynamic gains. This paper shows that a range of complementary policies affects a firm's ability to generate productivity gains from intermediate and capital goods imports. Access to skilled labour is a particularly important policy variable with respect to the import of intermediate goods, followed by access to finance, while macroeconomic stability slightly outranks access to finance for capital goods importers. The importance of access to finance has particular policy significance given the wide-spread financial reforms being discussed or underway.

Keywords: Trade, Dynamic Gains, Intermediate Inputs, Capital, Complementary policies.

JEL Classification: F10, F13

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Executive Summary and Findings

The literature on gains from trade is both broad and varied. From a macroeconomic perspective, analysis has tended to focus on connections between trade openness and/or liberalisation and economic growth. Taking advantage of increasing access to firm-level data, recent studies have used microeconomic foundations of the gains from trade to trace more substantial connections between firm productivity and access to international markets. This paper builds on this fundamental research in several substantive ways. First, it moves beyond a single country basis to examine impacts on firm-level productivity for a cross-section of countries. Next, it focuses on a specific channel of productivity gains: that is, through the import of intermediate inputs and capital goods. Finally, it systematically explores the specific impacts of non-trade, or complementary, policies on firms' ability to realise dynamic gains.

At the micro level, the paper finds broad support for the dynamic gains associated with imports of intermediate inputs and capital goods. It shows that dynamic gains from trade can be an important conduit for increased firm-level innovation and productivity gains, both key components of economic growth. Further we find evidence of the importance of efficient resource markets on the realisation of these gains.

Key conclusions include the following.

- Firm level evidence shows a significant and positive impact of intermediate inputs and capital goods imports on firm Total Factor Productivity and underscores the positive role these imports play on firm-level innovation. Specifically, a 1% increase in the share of imported intermediate inputs raises a firm's productivity by 0.3%. Similarly a 1% increase in capital goods imports raises productivity by 0.2%.

- The links from imported intermediates to productivity gains and innovation are stronger in non-OECD countries, which highlight the importance of dynamic gains from trade for overall economic development.

- Results at the sector level show that impacts are not uniform across an economy. A possible explanation is that the intermediate inputs used by firms in some sectors embody more technology than those in other sectors. This result implies that it is not just the amount of intermediate inputs that matters, but the type of goods imported is important as well.

- A range of complementary policies are shown to affect a firm's ability to generate productivity gains from intermediate and capital goods imports. We find that access to skilled labour is a particularly important policy variable with respect to the import of intermediate goods, followed by access to finance, while macroeconomic stability slightly outranks access to finance for capital goods importers. The importance of access to finance has particular policy significance given the wide-spread financial reforms being discussed or underway.

Policy insights that arise from these conclusions are as follows.

- Lowering trade costs can lead to domestic productivity gains at the firm- and sector-levels, particularly in emerging markets.

- Intermediate inputs and capital goods sectors should receive particular attention within a broader policy agenda of trade cost reduction. [1]

- Policies aimed at enhancing resource markets are especially important in helping firms realise dynamic gains from trade.

1. However, policy targeting of specific industries is of limited economic benefit as it is often only in hindsight that those goods and/or services embodying the most beneficial technical advancements can be identified. General well-functioning resource markets are the best guarantee of reaping the economic rewards of technological change.

1. Introduction

Traditional models of international trade, such as those based on Ricardo and Heckscher-Ohlin, focus on the gains in economic efficiency that result from specialization by comparative advantage. These gains are often referred to as the *static* gains from trade, in the sense that they are a one-off effect in improved efficiency brought about, for example by improved resource allocation linked to an increase in trade flows. More recently, attention has turned to the identification and quantification of *dynamic* gains from trade.[2] There are a number of avenues through which such dynamic gains can be realised, including: increased investment rates; technology transfer; spillovers from foreign direct investment; improvements in macroeconomic policies; or offshoring and internationalization of the supply chain.

Early attempts at understanding the dynamic gains from trade focused on identifying aggregate relationships through cross-country econometric analysis. For example, Sachs and Warner (1995) argued that economies with relatively open trade regimes tend to experience higher growth rates than those with relatively closed regimes. Harrison (1996) found a positive relationship between growth and a variety of trade openness measures.

Although intuitively appealing, methodologies applied to measure the relationship between increased trade and economic growth have been subject to extensive criticism (e.g. Rodriguez and Rodrik, 1999). Based on a comprehensive review of the evidence, Nordås *et al.* (2006) conclude that the most convincing examples from this openness and growth literature support the view that a 1% increase in trade openness, defined as an increased share of trade in GDP, can boost per capita GDP by around 1%-2%.

The more recent literature on the dynamic gains from trade takes a different approach rather than broad-based measures of GDP and economic openness (focusing on firm and sector dynamics). On the theory side, the heterogeneous firms models of Melitz (2003) and Chaney (2008) provide a rigorous basis for the existence of a link between trade liberalisation and within-sector productivity gains: as less productive firms exit the market due to stronger competition from imports, resources shift to more productive firms which can then produce and sell more. The net result is an increase in average sectoral productivity. The importance of this mechanism has been confirmed by a wide range of empirical studies using data from thousands of firms in developed and developing economies alike.[3]

This paper expands the existing literature in several directions. First, using detailed micro-founded mechanisms rather than broad, cross-country macro-based correlations allows us to develop insights which will be more effective in addressing policy development. And because the relationships are examined at the firm and sector level, we gain a better understanding of the trade-growth relationship for a more focused policy analysis. Thus, this approach will help ensure that the results, and their policy implications, will be as robust and convincing as possible. Second, analysis on policy

2 We use the term 'dynamic' to refer to changes in productivity and economic growth that are brought about by trade. Differences in productivity account for the lion's share of cross-country differences in per capita income (Jones and Romer 2009).

3 Bernard *et al.* (2007) provide a comprehensive review of the evidence. This literature includes evidence from accession and enhanced engagement economies: e.g. Brazil (Muendler, 2004); Chile (Pavcnik, 2002); and India (Topalova, 2004).

impacts that has been conducted in the literature has tended to focus on tariff and trade cost reduction. However, there is ample evidence that other policies, so-called complementary policies (Nordås *et al.* 2006), will also play a major role in an economy's ability to realize dynamic gains from trade. In this paper we take the investigation beyond tariff policy and focus on measuring the impact of these complementary policies. We also expand the single-country framework of previous firm-level studies to include a number of developed and developing economies. Finally, given the relative scarcity of work on the dynamic gains from trade associated with particular types of imports, namely of intermediates and machinery, we examine these specific avenues of trade-related gains.

The paper will proceed as follows: Section 2 will provide a brief literature review including methodologies applied to examine dynamic gains; Section 3 will outline our approach, data used and expected outcomes; Section 4 presents results at the country-level and firm-level. Finally, section 5 concludes.

2. What do we know about dynamic gains?

There is a large and varied economic literature that examines the links between trade and economic growth, i.e. the "dynamic gains from trade". They are dynamic in the sense that they relate to changing an economy's evolution through time. By contrast, the traditional "static" gains from specialisation by comparative advantage result in a one-off increase in welfare ascribed to a change in price resulting from, for instance, reduced costs from economies of scale or fewer market distortions, but do not necessarily alter the economy's growth path.

Over the last few years the academic literature has made a clean break with the macro-level "openness and growth" literature of the 1990s and early 2000s, to focus on detailed theoretical models with strong microeconomic foundations. This literature has provided a basis for linking trade and growth at the level of individual firms and sectors. In many cases, the main predictions of these models have been extensively tested using large, firm-level datasets from a variety of developing and developed countries. Firm-level empirics offer a number of methodological advantages over cross-country regressions, and for that reason have produced results that are now very broadly accepted in the economic literature. One advantage of firm-level data is the ability to control for country-specific factors that are not easily observed, such as the state of economic and social institutions, or the macroeconomic policy environment. Second, the richness of firm-level data allow researchers to test detailed hypotheses of individual mechanisms linking trade and growth; this approach contrasts with the openness and growth literature, which was sometimes criticized for treating the link between the two as a "black box". Third, focusing on individual countries and, in many cases, well defined episodes of trade liberalization, made it possible for researchers to observe how policy effects have differed in different environments. Results from these studies therefore tend to identify with relative precision the effect of a well-defined policy change on firms in a particular country.

The well-known model of Melitz (2003) shows that lower trade costs can promote the reallocation of resources toward more productive firms. As stated above, the expansion of these more productive firms causes relatively unproductive firms to contract or exit the market entirely, thus raising average sectoral productivity. The model provides micro-foundations for trade as a promoter of Schumpeterian "creative destruction". This model was extended by Melitz and Ottaviano (2008) to demonstrate that lower trade costs

increase competitive pressures in the domestic market and lead to a fall in the markups firms charge over marginal cost. Whereas the standard Melitz (2003) model relies on the reallocation of resources across firms within a sector, the Melitz and Ottaviano (2008) model emphasizes a process in which firms "trim the fat" in their operations: competition induces organizational change and production upgrading which ultimately boosts within-firm productivity. This process is often referred to as reducing so-called "x-inefficiencies".

There are numerous examples of firm level evidence supporting these important processes. For example, Bernard *et al.* (2006) use data from US manufacturing firms to show that industries with relatively large falls in trade costs tend to experience larger increases in productivity. They find support for the intra-sectoral reallocation mechanisms and the reduction of x-inefficiencies. This process has been indentified in emerging economies as well. Muendler (2004) examines firm-level data in Brazil and finds that the most important productivity-enhancing mechanism is the within-firm reductions in x-inefficiencies. Pavcnik (2002) finds strong evidence that trade liberalization in the 1970s and 1980s in Chile led to significant productivity gains. Using firm-level data she finds support for the importance of within-firm and within-sector productivity gains. Iacovone (2009) examines the impact of NAFTA on Mexico and finds that on average a 1% reduction in tariffs led to productivity growth of 4% to 8%. The effect was much stronger for the most technologically advanced firms, with a 1% fall in tariffs associated with productivity gains of 11 to 13%.

The type of goods imported has also been shown to affect the level of productivity gains. Whereas consumer goods embody foreign technology but do not directly alter domestic production processes, foreign machinery and inputs act in the same way as a positive technology shock to domestic industry—manufacturing firms become more productive as they adopt more advanced production technologies. Finally there is also evidence that increased competition causes firms to be more innovative, increasing productivity and growth (see, for example, Teshima 2008 and Sutton 2007).

From this literature we see that one way in which imports can boost the productivity of domestic firms is through their role as a vector of technology transfer. Capital goods (machinery) and imported intermediates are particularly important in this regard. Eaton and Kortum (2001), for instance, find that innovation and capital goods exports are concentrated in a relatively small number of advanced countries. Their model suggests that up to 25% of observed productivity difference across countries is attributable to differences in the prices of capital goods. Around half of the price differences are due to trade barriers, suggesting that liberalization of trade in capital goods could provide a significant boost to productivity. Even more striking is the conclusion of Keller (2004), based on a comprehensive review of the theoretical and empirical evidence: foreign technology—embodied in imported inputs and capital goods—is the *dominant* source of domestic productivity growth, accounting for about 90% of the total. Recent empirical evidence from firm- and industry-level datasets reinforces the findings of Eaton and Kortum (2001), and Keller (2004).

While earlier work by Keller (2000, 2002) provides convincing evidence that foreign technology embodied in imported intermediate inputs plays a major role in spurring productivity growth (perhaps accounting for as much as 20% of observed productivity differences across OECD countries), Acharya and Keller (2007) broadly confirm these results. Miroudot *et al.* (2009) using trade data and national input-output table for the period 1995-2005 show that for 29 industries in 11 OECD economies a higher proportion

of foreign intermediate goods is associated with higher productivity. Part of this effect is due to more advanced technologies embodied in foreign inputs and part is due to reduced production inefficiencies as final good producers move closer to the technology frontier. Thus, all else equal, countries which allow firms access technologically advanced inputs, regardless of where they are produced, will be more productive than those that do not.

Goldberg *et al.* (2009) use a rich dataset of Indian manufacturing firms to examine this aspect of the dynamic gains from trade. A number of their findings confirm and reinforce those from the previous literature cited above. First, they find that India's trade liberalization led to significant falls in the prices of existing imported intermediates; indeed, the effect was stronger than for final goods. Second, they find strong evidence linking tariff cuts in intermediate goods sectors with increased sales and higher productivity in final goods sectors.

Their most interesting findings, however, relate to the role played by new imported intermediates. Their data show that increased openness led to a significant expansion in the range of imported goods available in the Indian market, and that this effect was particularly strong in intermediate goods sectors. Moreover, they find that falls in input tariffs are associated with increases in firm product scope, *i.e.* the introduction of new final goods varieties. This finding is consistent with the mechanism discussed above, in which the introduction of new intermediate goods facilitates innovation in final goods markets. This effect is highly significant from an economic point of view: over the eight year period studied by the authors, firms increased their product scope by, on average, 25%--and declines in input tariffs accounted for nearly one-third of that growth. Since increased product scope accounted for about 25% of total manufacturing growth over that period, the variety of intermediate inputs clearly represents an important source of dynamic gains.[4]

Although Goldberg *et al.* (2009) focus on variety growth in intermediate inputs sectors, their analysis could just as well be applied to capital goods sectors. As long as domestic machinery and imported machinery are imperfect substitutes, an expansion in the range of machinery imports should be associated with an increase in domestic innovation activity and, thus, with productivity gains.

While these studies provide overall evidence of the link between intermediate trade and productivity, they fail to provide the necessary detail to ascertain the relative importance of the different mechanisms through which this takes place. Nor do they explicitly consider the role non-trade specific policies can play in the process. To obtain a fuller understanding of the empirical importance, and particular policy-relevance of, different mechanisms through which open markets can generate dynamic gains, we examine the specific channels of intermediate and capital goods imports across a broad range of countries. We now look at what the relevant literature has to say about the role of policy.

4. These findings contrast with those of Arkolakis *et al.* (2008) for Costa Rica. The likely reason, as Goldberg *et al.* (2009) point out, is probably that intermediate inputs are a relatively minor component of total imports in Costa Rica, whereas they play a much more significant role in India's overall import pattern.

2.1 The role of policy

Despite the important advances that have been made in the recent literature, it is nonetheless striking that the wider policy dimension has been relatively absent. The literature is primarily focused on the technical measurement of dynamic gains, and does not deal extensively with policy implications. However, a number of policy-relevant conclusions can be drawn from this previous work:

- Lowering trade costs can lead to domestic productivity gains at the firm- and sector-levels (e.g. Goldberg *et al.* 2008).
- Intermediate inputs and capital goods sectors should receive particular policy attention in terms of reducing trade costs: the potential gains through domestic productivity improvements and innovation are probably greater than those from reducing trade costs in final goods markets (e.g. Amiti and Konings 2007).[5]

While trade policy has been dealt with, at least on a limited basis, there is a second set of policy issues that has received little, if any, attention in the academic literature. We refer to these as "complementary policies", in the sense that these policies are separate from trade liberalization, but which have the potential to significantly increase the benefits that flow from it.[6] As one example, Goldberg *et al.* (2008) conjecture that India's industrial policy may have inhibited the realization of gains from trade through rationalized within-firm product scope by reducing the incentive of firms to drop established, albeit unprofitable, product lines. Thus, reforms in industrial policy might be an important complement to trade liberalization. Since their analysis uses data for a single country, however, they are unable to test this possibility empirically, nor draw more generalisable conclusions.

In order to help fill this gap, we have identified three complementary policy areas that seem likely to play an important role in realising dynamic gains:

- *Barriers to entrepreneurship and competition policy*: Domestic firms' development of new products using foreign intermediate inputs or machinery is an important way in which trade liberalization can generate dynamic gains. Consequently, economies with barriers to the introduction of new products may have lower innovation rates and experience smaller dynamic gains from a given level of liberalization. Reducing barriers to entrepreneurship, such as the costs and complexity of obtaining licenses and permits, could be one way of making innovation easier, and thereby promoting larger dynamic gains from trade. Competition policy can also play an important role, since anti-competitive practices can discourage innovative firms from entering the market and developing new products.
- *Science, technology, education, and R&D policies*: The ability of domestic firms to take advantage of available new technology can also be crucial to the realization of dynamic gains from trade liberalization affecting markets for intermediates and machinery. Economies in which firms have a relatively high level of absorptive

5. This is not, of course, an argument for tariff escalation. It rather highlights the importance of including intermediate goods sectors within programs of broad-based trade liberalization.

6. Complementary policies, as well as the relationship between trade and financial markets, represent the last two research areas identified by Nordås *et al.* (2006).

capacity can be expected to make fuller use of new technology—and thus experience stronger dynamic gains from trade—than those with a relatively low level of absorptive capacity. As a result, policies that promote technological capacity, such as support for education, training, basic science and R&D, can be expected to play an important role in helping maximize the dynamic gains from trade.

- *Factor market policies*: Regulation of labour and financial markets can also be expected to influence the extent to which an economy can realize dynamic gains from trade liberalization. For example, innovative firms need access to well-functioning financial markets in order to cover the costs of developing new products using foreign intermediates or machinery. They also need access to pools of skilled labour and technical expertise, which they can hire reasonably quickly and cost-effectively.

We explore the degree to which these mechanisms shape dynamic gains as this can have important implications for policy design.

3. Measuring the dynamic effects: methodology and data

As stated above, to help further our understanding of trade's role in growth we are focusing on the role that imports of intermediate inputs and capital goods can play as a source of dynamic gains from trade,. While we know that differing productivity levels play a role in trade (Trefler 1993 and Davis and Weinstein 2001, for example), we want to examine the role trade in fact plays in productivity and growth. By interacting policy variables with the trade variables, we can also determine the extent to which policy influences and enables (or hinders) a country's ability to benefit from these potential gains.

This work examines the relationship between growth and productivity at the firm level. Pursuing this approach adds value by making the results more robust and thorough than results based on macro-level analysis or single country studies. For instance, firm-level data can be highly effective in establishing relations that hold for a particular country, and can easily take account of unobservable and immeasurable country characteristics. However, generalization of these results can be problematic. By contrast, it is more challenging to control for unobserved country heterogeneity in a multi-country framework, yet covering a wide variety of countries lends weight to a claim that the results are of broad applicability.

Specifically, we address the question, on a firm-level basis for a variety of countries: what is the impact of imported intermediates and capital goods on productivity? We know that for individual countries examined, improved access to imported inputs raises productivity. However, we have not observed to what extent these results hold more broadly and outside a specific episode of trade liberalization or other specific trade-policy event. There are a number of theoretical papers which have emphasized the importance of intermediate inputs for productivity growth (e.g. Markusen (1989), Romer (1990) Grossman and Helpman (1991)) along with substantial empirical evidence that new product additions by firms account for a sizable share of sales growth in several countries. For example, Bernard, Redding and Schott (2010) find that large changes in firm scope (i.e. product adding and dropping) led to more efficient resource use and higher productivity while Goldberg *et al.* (forthcoming) find that new imported intermediates, i.e. extensive margin growth, contributed significantly to manufacturing output growth in

India. However, to go beyond the more general concept of extensive margins to examine the potential gains from imports of intermediates and machinery, we need to look at productivity at the firm level. We do this by measuring the impact of these imports on total factor productivity (TFP) of firms.

Finally, we know that innovation by firms promotes both productivity and growth. Therefore it is important to examine the extent to which growth in imported intermediates and capital goods promotes innovation at the firm level. Innovation is proxied using a measure of R&D spending by firms. This is consistent with other approaches used in the literature. For example, Sharma (2007), using a cross-section of 57 countries shows that financial market developments spur innovation in small firms using a measure of research and development (R&D) as an indication of innovation.

3.1 Data[7]

Firm-level data on performance and the use of intermediate inputs and machinery are sourced from the World Bank's *Enterprise Surveys* dataset. That source currently has data on over 100,000 firms from 115 mostly developing and transition economies, including all five enhanced engagement countries. As stated above, following Sharma (2007) we use R&D spending by firms as an indication of innovation. TFP is estimated from the survey data. The variety of imports is not available at the firm level, thus we rely on measures of import shares in total use of intermediates. The surveys report to what extent a firm relies on imports for its intermediate inputs and whether they import equipment.

We also use the World Bank's *Enterprise Surveys* as a source of policy data for the firm-level regressions. This data indicate the extent to which, for example, firms perceive labour market regulation, entry barriers, or access to finance as obstacles to doing business. Combining these various measures makes it possible to measure complementary policies across a range of countries, thereby lending greater weight to the conclusions of this research.

4. Results

Applying the approach outlined above, we find strong support for dynamic gains at the firm level. In addition, investigations for various firm-level sector groupings show that these results are not uniform across sectors. We also find that the links among imported intermediate goods, productivity, and innovation appear to be stronger in non-OECD countries: they are thus particularly important from a development point of view.

4.1 Impacts on productivity and innovation

As stated above, we utilise two measures to determine the impact of imports using the firm level data: TFP and R&D spending (to proxy innovation). The results of interest are presented in Table 1 (complete tables are reported in the Technical Annex). Using the share of imported inputs in total inputs we find a positive and significant effect on both

7. This sub-section provides an overview of data used in the study. Details of databases and variables used can be found in the Data Annex. We use econometric methods to control implicitly for all other influences at the country-sector level, including the impact of macroeconomic factors such as the balance of payments position and exchange rate policies.

TFP and innovation, providing robust evidence of dynamic gains at the firm level across a broad cross-section of economies.

For the level of TFP (columns 1 and 2), we find strong evidence of productivity effects from importing intermediates and capital goods: in both cases, the relevant coefficients are positive and 1% significant. These effects are quantitatively important: assuming constant returns, a firm that increases imports of its inputs by 1% increases TFP by around 0.3%; and a firm that increases it imported capital goods by 1% is around 0.2% more productive than one that increases from domestic sources only.

The smaller impact of capital goods imports on TFP could be due to several factors. One is the difference in the timing of effects. Intermediate inputs have a more immediate impact while gains from capital investment tend to be had in the longer term. Also, it is plausible that our data tend to over-sample foreign-owned firms engaged in assembly and re-exporting activities, which may not be in the best position to reap benefits from capital goods imports.

Table 1. Selected firm-level results: TFP, and innovation *vs*. imports of intermediates and capital goods[a]

	(1)	(2)	(3)	(4)
Dependent Variable	**TFP**	**TFP**	**R&D Spending**	**R&D Spending**
Imports / Total Inputs	0.298***		0.181**	
	(0.070)		(0.086)	
Capital goods Importer		0.167***		0.059
		(0.059)		(0.094)
Foreign	0.214***	0.308***	-0.018	-0.155
	(0.040)	(0.056)	(0.076)	(0.154)

Estimation is by OLS in columns 1-2 and by conditional fixed effects logit in columns 3-4. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

a. The table reports variables of interest. Complete regression results can be found in Technical Annex.

Source: Authors' calculations.

Turning to the results for capital goods, we see that there is evidence, at the firm level, of a positive and significant impact on TFP. The result is positive but not significant on R&D spending. We hypothesize that being a foreign affiliate may account for the lack of a significant relationship between capital good importers R&D spending. Theoretical work by Rodriguez-Clare (1996) shows that foreign affiliates increase a host country's access to specialized varieties of intermediate inputs, and this access to improved knowledge raises the TFP of domestic producers as well. Empirical findings which validate this relationship can be found, for example, in Haskel, Pereir and Slaughter (2007) who report evidence for such a relationship for US manufacturing firms and Djankov and Hoekman (1999) who find that foreign investment has a positive impact on firm level TFP in the Czech Republic.

Including a variable for foreign affiliates has a positive and significant effect on the relationship with firm-level TFP, but not R&D spending.[8] The apparently limited role of capital goods imports at the firm level, on innovation (as measured by R&D spending) remains.

The lack of significance of capital goods imports on firm-level innovation may be due to the type of firms involved in both R&D and capital goods importing. Firms importing capital goods (whether they be foreign affiliates or domestic firms) are usually applying adapted technology to a manufacturing process. This implies that often the R&D expenditures are made elsewhere (in the case of foreign affiliates, the home country). While there is a trend toward the increasing internationalization of R&D activities, as of 2007, more than 78% of R&D spending still took place in OECD economies, 32% of that in the United States alone (UIS, 2010). This significant relationship between imported intermediates and R&D spending may be driven by the type of R&D spending, especially, if it differs in both substance and nature to that associated with capital goods.[9]

To see if these findings differ across countries, we break the sample into OECD and non-OECD countries (see results in the Technical Annex). Since the *Enterprise Surveys* data focus more on developing and transition economies than on OECD members, our OECD sample is necessarily small.[10] Indeed, there are insufficient data available to run regressions using capital equipment imports for OECD countries, and so we present split-sample results using imported intermediates data only. It is therefore important to be cautious in interpreting these results. Nonetheless, two aspects of our analysis suggest that the link between imported intermediates on the one hand, and productivity and innovation on the other, is particularly strong in non-OECD members. First, the coefficient on imported intermediates is noticeably larger in the non-OECD regression using TFP as the dependent variable (Table 2). In addition, only the non-OECD regression has a statistically significant coefficient on imported intermediates when we use R&D spending as the dependent variable. Both findings highlight the importance of imports of intermediate inputs regardless of the stage of development. However, the stronger results for developing countries show the major scope for leveraging imported intermediates as a source of productivity and innovation gains that can help drive the development process.

To gain additional perspective, we again break the sample into sub-groupings; this time by sector. The five sector groupings are textile, leather and garments; food and beverage; heavy manufacturing; light manufacturing; and electronics. These broad industry classifications tend to capture the bulk of industries engaging in manufacturing trade and production fragmentation. We present our results for firm-level TFP in Table 3.

8 Due to limitations in the *Enterprise Surveys* data, it is not possible to code the foreign variable more finely to distinguish between, for example, foreign investment designed to serve the domestic market versus FDI aimed at exporting to nearby markets. The data only identify those firms that are foreign-owned.

9 For example, if inputs are imported to an established laboratory or research facility versus importing capital goods in an effort to establish such a facility. An investigation of the type of R&D spending by firm and import type is beyond the scope of this paper.

10 The OECD sample includes only firms from the following countries: Chile, Czech Republic, Germany, Greece, Hungary, Ireland, Mexico, Poland, Portugal, Slovak Republic, Slovenia, Korea, Spain, and Turkey.

Table 2. Selected firm-level regression results for OECD vs non-OECD countries: TFP, and innovation vs. imports of intermediates and capital goods

Dependent variable	(1) TFP - OECD	(2) TFP – non-OECD	(5) R&D spending - OECD	(6) R&D spending – Non-OECD
Imports / Total Inputs	0.213*	0.300***	0.112	0.208**
	(0.115)	(0.077)	(0.196)	(0.095)
Foreign	0.195	0.215***	0.043	-0.034
	(0.118)	(0.043)	(0.185)	(0.083)

*Estimation is by OLS in columns 1-2 and by conditional fixed effects logit in columns 3-4. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Source: Authors' calculations.

Table 3. Sector level results for TFP at firm level[a]

	Textiles Leather & Garments	Food & Beverages	Heavy Manufacturing	Electronics	Light Manufacturing
Dependent variable: TFP Index					
Imports / total inputs	0.098	0.566***	0.270***	0.241**	0.622***
	(0.079)	(0.124)	(0.069)	(0.063)	(0.148)
Employees[b]	0.426***	0.669***	0.289**	0.486***	0.622***
	(0.032)	(0.036)	(0.087)	(0.041)	(0.078)
Foreign affiliate	0.260***	0.321**	0.108	0.281**	0.168
	(0.051)	(0.097)	(0.063)	(0.074)	(0.108)
Equipment importer	0.158**	0.303*	0.102	0.336*	0.063
	(0.058)	(0.138)	(0.109)	(0.152)	(0.22)
Employees[b]	0.348***	0.635***	0.271**	0.417***	0.292***
	(0.035)	(0.063)	(0.093)	(0.048)	(0.073)
Foreign affiliate	0.243***	0.46	0.296*	0.453***	0.186
	(0.055)	(0.274)	(0.107)	(0.045)	(0.165)

*Robust standard errors reported (in parentheses). * p<0.10; ** p<0.05; *** p<0.01.*

a. The table reports variables of interest. Complete regression results can be found in Technical Annex.

b. Variables controlling for total number of employees, logged.

Source: Authors' calculations.

We find that the imported intermediate share of total inputs has a positive and significant effect in all industry segments' TFP with the exception of the textiles grouping. It is likely this has more to do with the nature of the inputs to the textile sector than the quantity of those imported inputs. We know that the textile sector imports more intermediate inputs than, say, the food and beverages sector, yet the imported inputs share shows a relatively large (second only to light manufacturing) impact on TFP of food and beverage firms and not, as stated, on textiles. Thus, it is not just the volume of imported intermediates that is determining its impact on productivity but instead is more likely a function of the type of intermediate inputs that are imported. Much of the intermediate

imports for the textile sector are raw materials which may not have the level of embedded technology as the imported intermediate inputs of other sectors do. In food and beverages, by contrast, products such as fertilizers and high-yield crop varieties can have a direct effect on productivity.

The especially strong results for light manufacturing may be explained by an economy's ability to adopt the imported technology, if we argue that the intermediate imports of the electronics sector require more skill in integrating than those in light manufacturing. We see a positive and significant coefficient for the electronics sector, but the size of the impact is smaller than for light manufacturing (1% increase in imported intermediates share leads to an increase of 0.62% in light manufacturing TFP versus 0.24% in electronics.). We present evidence below that access to skilled labour influences a firm's ability to generate TFP gains. It could be that the type of intermediate inputs imported for light manufacturing are more easily adapted and dispersed through a greater number of entities than the technology embodied in electronics.

While imported intermediates shares are not significant in the textiles grouping, equipment imports are. This is in contrast to the other four sectors examined, each of which show much stronger results for imported intermediate share. This implies that many textiles operations import more specialized (and thus not easily adapted and dispersed for wider gains) equipment to be used with domestically sourced (usually less-skilled) labour and may also further explain the lack of a relationship with TFP.

Table 4 repeats the sector-specific regressions using innovation as the dependent variable. Again, results differ considerably across sectors. We find that imported intermediates have a particularly strong effect in the electronics sector, and discernable impacts in the food/beverage and light manufacturing sectors. These results are not dissimilar to those for productivity, reported above. In the case of innovation, however, we do not find any significant impact of equipment imports.

Table 4. Sector level results for innovation at firm level[a]

	Textiles leather & garments	Food & beverages	Heavy manufacturing	Electronics	Light manufacturing
Dependent variable: R&D spending					
Imports / total inputs	-0.214*	0.496*	0.472**	0.727**	0.146
	(0.106)	(0.219)	(0.145)	(0.231)	(0.189)
Employees[b]	0.428***	0.530***	0.614***	0.476***	0.587***
	(0.036)	(0.055)	(0.054)	(0.139)	(0.051)
Foreign affiliate	-0.314*	0.237	-0.081	0.222	0.056
	(0.132)	(0.144)	(0.126)	(0.277)	(0.197)

*Robust standard errors reported (in parentheses). * p<0.10; ** p<0.05; *** p<0.01.*

a. The table reports variables of interest. Complete regression results can be found in Technical Annex.

b. Variables controlling for total number of employees, logged.

Source: Authors' calculations.

4.2 Results including complementary policies

Table 5 presents selected outcomes from the regression analysis of the relationship between firm-level TFP and intermediate imports including interaction with a variety of complementary policies. The policy-influenced variables are based on indicators reported in the World Bank's *Enterprise Surveys*. These questions deal with the ability of firms to operate given a country's regulatory environment, financing availability, workforce and macroeconomic conditions.[11] Questions in the survey were phrased in the negative thus we identify them in the table as 'business obstacles'. We test a number of potential policy variables and report those where significant results are found.

Table 5. Relationship of TFP to imports of intermediates and capital goods, including interaction terms with complementary policies, selected results

	(1)	(2)	(3)	(4)	(5)	(6)
Policy variable:	**Barriers to Entrepreneur-ship**	**Access to finance**	**Access to Finance**	**Labour regulations**	**Macro-economic instability**	**Access to skilled labour**
Dependent variable: TFP Index						
Imports / total inputs	0.339***	0.380***		0.332***		0.346***
	(0.075)	(0.071)		(0.076)		(0.078)
Imports share* Business obstacle[b]	-0.142*	-0.171**		-0.140*		-0.203**
	(0.081)	(0.084)		(0.076)		(0.080)
Capital goods importer			0.241***		0.238***	
			(0.075)		(0.072)	
Equipment importer* Business obstacle[b]			-0.169**		-0.189***	
			(0.068)		(0.067)	
Business obstacle[b]	0.082*	0.036	-0.007	0.016	0.129***	0.071
	(0.044)	(0.036)	(0.029)	(0.038)	(0.039)	(0.045)

Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.
a. The table reports variables of interest. Complete regression results can be found in Technical Annex.
b. Business obstacle refers to the policy variable listed in the column heading.
Source: Authors' calculations.

We measure the influence of each policy variable (i.e. business obstacle) on the firm's ability to realize productivity gains through the share of imported intermediate inputs and capital goods. A significant interaction of the policy variables with the import measure suggests that policy plays an important role in the ability of a firm to gain from trade.

First we note that when the barriers to entrepreneurship, access to finance and labour market regulations are interacted with import shares, the effect on TFP is both negative and significant. We show that imports – both intermediate share and equipment imports – are associated with smaller productivity gains when the policy environment is viewed as restrictive. That is, the more firms identify regulation (labour market and licensing and permit procedures in particular) as a business constraint, the less is their ability to realize TFP gains through imports of intermediate goods and equipment.

11. Other factors reported in the survey included corruption, crime, infrastructure and gender.

As hypothesized above, the results also show that access to resources plays a major role in realising dynamic gains. Having limited, or no, access to financing and to skilled labour impedes productivity gains available to firms through intermediate imports.

Turning to capital goods imports we see that macroeconomic stability and access to financing are major policy variables affecting these firms' ability to realise gains. This result is not surprising given that capital imports tend to be long-term investments sensitive to financing, including prevailing interest rates and longer term economic viability.

There are several policy implications from these results. First, the importance of a properly functioning financial market affects a firm's productivity through both intermediate imports and capital goods imports. It is, thus far, the only policy variable affecting both of the measured sources of dynamic gains from trade. This outcome is especially significant given the current debate on financial market reform. We show another avenue through which this reform impacts economic activity and further highlights to need for carefully crafted regulation.

Besides financial markets, an efficient labour market, supplying enough skilled labour, is also a notable policy variable. Investment in education continues to be a key for productivity growth in an economy. The importance of relatively short-term policy variables (such as barriers to entrepreneurship) versus the longer term environmental variables (such as macroeconomic stability) affect a firm's productivity through both its day-to-day activities (sourcing inputs) as well as its long term planning horizon (purchasing capital equipment). Undue attention to one set of variables risks forsaking sources of growth across the entire spectrum of potential dynamic gains from trade.

In general, we find extensive evidence that some sectors respond more strongly than others to particular changes in the policy environment. From a policy perspective, the most interesting result is that industries that are important from a development point of view — such as textiles, food and beverage, and light manufacturing—tend to respond to a range of complementary policies. Indeed, at least one of these crucial sectors responds significantly to each of the complementary policies we have data on. These results suggest that getting the right complementary policies in place should be a particular priority for developing countries.

While the Technical Annex provides further details on the extent to which the impact of complementary policies differs across sectors, we present two tables for illustrative purposes: the results for significant sectors for macroeconomic stability) and access to skilled labour are shown below (Table 6).

The sometimes unexpected role of policy is highlighted by the sector results presented below. As shown in Table 3, firm-level TFP was not significantly affected by equipment imports in heavy manufacturing and the effect was only just significant in the electronics sector. When the macro policy variable is included however, results for these sectors are positive and significant. Indeed, the interaction term shows that an unstable macro environment reduces equipment imports thus reducing potential TFP gains in these sectors. Textiles is the only sector with a significant relationship between R&D spending and the macroeconomic policy environment. The results also show a positive and significant relationship between R&D spending and foreign affiliates in this sector. This may indicate that a stable macroeconomic environment is more important for innovation among foreign firms than domestic.

As shown in Table 5, policies affecting resource markets are a key element in realising the dynamic gains from trade. This comes through again in Table 7, where access to skilled labour is important to realising both sources of gains (TFP and innovation) in the electronics sector. Only the gains in the heavy manufacturing and textile sectors appear to be unaffected by the availability of skilled labour.

Table 6. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with macroeconomic policy as a complementary policy

	(1)	(2)	(3)	(4)
Sector:	Electronics	Heavy Manufacturing	Light Manufacturing	Textiles
Dependent variable	TFP	TFP	TFP	Pr(R&D)
Imports / total inputs			0.800***	-0.005
			(0.154)	(0.168)
Imports * macro policy			-0.346*	-0.480*
			(0.200)	(0.267)
Equipment importer	0.508**	0.249**		
	(0.167)	(0.106)		
Equipment * macro policy	-0.428**	-0.328**		
	(0.146)	(0.137)		
Macro policy	0.227***	0.169*	0.046	0.268**
	(0.064)	(0.098)	(0.089)	(0.111)
Foreign	0.449***	0.284**	0.176	-0.311**
	(0.035)	(0.108)	(0.107)	(0.134)

*Estimation in columns 1 -3 is by OLS. Estimation in column 4 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*
Source: Authors' calculations.

Table 7. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with access to skilled labour as a complementary policy

	(1)	(2)	(3)	(4)	(5)
Sector:	**Electronics**	**Electronics**	**Electronics**	**Food & Beverage**	**Light Manufacturing**
Dependent variable	**TFP**	**TFP**	**Pr(R&D)**	**TFP**	**Pr(R&D)**
Imports / total inputs	0.249***			0.633***	
	(0.034)			(0.149)	
Imports * skilled labour	-0.428**			-0.503*	
	(0.179)			(0.287)	
Equipment importer		0.364*	0.177		0.256
		(0.160)	(0.288)		(0.206)
Equipment * skilled labour		-0.215**	-0.505***		-0.631*
		(0.087)	(0.180)		(0.326)
Skilled labour access	0.216*	-0.091*	0.213***	0.078	0.536***
	(0.109)	(0.048)	(0.054)	(0.105)	(0.167)
Foreign	0.356**	0.471***	-1.037***	0.349***	0.089
	(0.113)	(0.036)	(0.122)	(0.107)	(0.229)

Estimation in columns 1, 2 and 4 is by OLS. Estimation in columns 3 and 5 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.
Source: Authors' calculations.

5. Conclusion

This report provides evidence of dynamic gains from trade through intermediate and capital goods imports, at the firm level. We show that the results are stronger for non-OECD economies, implying that imports can act as an important and positive boost to economic development. Further, we find that these gains can differ across sectors and that they are subject to the policy environment. The paper provides insight into the types of policies that can be addressed to ensure these gains are realized and how these policies potentially interact in different industries. Thus, to further the outcomes of trade liberalisation in intermediates and capital goods, we present evidence that a wide range of complementary policies can help make the dynamic gains from trade even stronger. Examples include competition policy, lowering the entry barriers facing new firms, building human capital and improving access to skilled labour, improving access to factor markets (labour and capital), improving the macroeconomic environment, and reducing policy uncertainty.

A number of issues arose in the course of this work deserve further attention. For example, what is the relationship between capital imports and innovation? We used R&D spending as a proxy for innovation, however, there may be other approaches which would provide better insight into this relationship. Also, we found that being a foreign affiliate was a significant determinant in the relationship between imports and firm level productivity but not innovation. Is this a function of the proxy, or is there simply no relationship? This information is of value to policy makers because the economic impact of foreign affiliates can be an important political issue. For instance is there a difference in the impact of investments made as part of a value chain, and hence meant for export, and those primarily serving the domestic market? Finally, given improvements in the data, expanding the number of sectors covered, as well as the country groupings beyond OECD and non-OECD, may provide further insights into the actual mechanisms of the productivity transfer.

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DATA ANNEX

Variable	Description	Time Period	Source
Business Obstacle	Dummy variable equal to unity if a firm indicates that the listed factor is a “major” of “very severe” obstacle to doing business.	Various	Enterprise Surveys
Capital Goods Importer	Dummy variable equal to unity for firms that 1) purchase equipment, and 2) import some or all of it.	Various	Enterprise Surveys
Employees	Total number of employees.	Various	Enterprise Surveys
Foreign	Dummy variable equal to unity for firms that are foreign owned.	Various	Enterprise Surveys
Imports/Total Inputs	Percentage by value of intermediate inputs that are imported.	Various	Enterprise Surveys
TFP	Firm total factor productivity estimated using the Levinsohn-Petrin methodology.	Various	Enterprise Surveys

TECHNICAL ANNEX

I. Imports, productivity, and innovation

As discussed in the main text, the first stage in identifying dynamic gains from trade in an econometric model is to test the following hypotheses, which flow from the theoretical and empirical work cited in the literature review:

- Greater imports of foreign intermediates and capital goods are associated with higher productivity levels.
- Greater imports of foreign intermediates and capital goods are associated with a higher rate of domestic innovation, as indicated by spending on research and development.

Regressions using firm-level data

We use the World Bank's *Enterprise Surveys* to test these hypotheses using firm-level data. The first stage in the analysis is to estimate productivity (TFP) for each firm. To do this, we use the methodology of Levinsohn and Petrin (2003) applied to each sector separately.[1] The output variable is total sales, deflated by the local GDP deflator and converted to US dollars at market rates. TFP levels are averaged for each firm over the (maximum three) periods for which data are available. The Levinsohn and Petrin (2003) approach enables us to control for unobserved productivity shocks using data on raw materials inputs. We prefer this methodology to Olley and Pakes (1996) because raw materials use is likely to be better measured than investment in the *Enterprise Surveys* data.

To examine the effects of imported intermediates and capital goods on the level of firm productivity, and on innovation (proxied by R&D expenditure), we use the following specifications:

(1) $$log(tfp_{cif}) = d_{ci} + b_1 imports_{cif} + b_2 log(employees_{cif}) + b_3 foreign_{cif} + e_{cif}$$

(2) $$\Pr(R\&D\ Spending_{cif}) = d_{ci} + b_1 imports_{cif} + b_2 log(employees_{cif}) + b_3 foreign_{cif} + b_4 products_{cif} + e_{cif}$$

where: *c*, *i*, and *f* index countries, industries, and firms respectively; *tfp* is our productivity index; *R&D Spending* is a dummy variable equal to unity if a firm engages in research and development spending; *imports* is sequentially the percentage of the total value of intermediate inputs that is accounted for by imports, and a dummy variable for

1 These estimation results are omitted in the interests of brevity. They are available on request.

firms that purchase capital goods from overseas;[2] *employees* is the total number of employees, as a proxy for firm size; and *foreign* is a dummy for firms that are foreign owned, and which are expected to be more productive than local establishments. Equation 1 is estimated by OLS, and equation 2 uses conditional fixed effects logit. We control for unobserved country-industry heterogeneity using fixed effects (*d*). Technology shocks that are specific to a particular sector-country pair are captured by this approach, as is the sector-specific impact of national macroeconomic fluctuations.

Results for the basic specifications are in Table A1.[3] To provide further detail on these results, we also run regressions separately for different sectors. To preserve an adequate number of data points for each regression, we group Enterprise Survey industries into five sectors: textiles, leather, and garments; food and beverages; heavy manufacturing (metals and machinery, chemicals and pharmaceuticals, and automobiles); electronics; and light manufacturing (wood and furniture, non-metallic and plastic materials, paper, and other manufacturing).

To investigate the general applicability of these results, we broke the sample into two groups: OECD and non-OECD. [4] The results are presented in Table A2. The number of OECD countries is limited to the 14 participating in the survey process. These are Chile, Czech Republic, Germany, Greece, Hungary, Ireland, Mexico, Poland, Portugal, Slovak Republic, Slovenia, Korea, Spain, and Turkey. The results show that while the gains are significant and positive for both groupings, the effects are stronger in non-OECD countries, indicating a greater potential for these countries to gain from imports.

Table A3 shows that imported intermediates have a particularly strong impact on productivity in the light manufacturing and food/beverage sectors. There is also a discernable but weaker impact in electronics and heavy manufacturing. Imported capital goods, by contrast, have a strong impact on productivity in two sectors only: textiles, leather, and garments; and food/beverages (Table A4). When using the probability of engaging in R&D spending (innovation) as the dependent variable, we find that imported intermediates have a particularly strong effect in the electronics sector, and discernable impacts in the food/beverage and light manufacturing sectors (Table A5). Imported

2. In the equipment specifications, the sample is limited to only those firms that have purchased some equipment. The reason for this approach is to ensure that our results are capturing the differential impact of purchasing foreign, rather than domestic, equipment.

3. In additional results, available on request, we also interact the import variables with the foreign dummy variable, in order to examine the possible complementarities between trade and FDI. In the case of equipment imports, the interaction term is always statistically insignificant. However, the interaction term with intermediate inputs is negative and statistically significant for TFP and R&D spending. These results tend to suggest that foreign owned firms are less likely to engage in research activity for a given level of imports. One reason might be that the Enterprise Survey data perhaps over-sample foreign-owned firms engaged largely in assembly or re-export operations.

4. We have also done separate regressions pooling across sectors but splitting the data by World Bank geographical region (results available on request). In most cases, the much smaller sample sizes involved fail to yield meaningful results. We find evidence of a significant link between imported intermediates or capital goods and TFP in East Asia and the Pacific, Eastern Europe and Central Asia, Latin America and the Caribbean, and South Asia. In addition, imported intermediates and capital goods both have significant effects on innovation behavior in Latin America and the Caribbean, and that the former is also the case in the Middle East and North Africa.

capital goods, by contrast, do not have a significant effect on R&D behaviour in any sector (Table A6).

II. The Role of Complementary Policies

Regressions using firm-level data

We use interaction terms to investigate the role of complementary policies in facilitating dynamic gains from trade. We identify complementary policies using Enterprise Surveys data on business constraints. Firms are asked to indicate the extent to which particular factors—such as macroeconomic instability, barriers to entrepreneurship, access to finance and skills, and labour regulations—represent an obstacle to doing business. These factors are potentially relevant as complementary policies because they affect the ability of firms to: overcome human and financial constraints in accessing foreign inputs and capital goods; overcome constraints in using imported inputs and capital goods; introduce new and innovative products into the marketplace; and reorganize for maximum productivity following technological change.

We code dummy variables equal to unity if a firm identifies each factor as a "major" or "very severe" obstacle. Given this coding pattern, we expect negative coefficients on the interaction terms: for a given change in trade patterns, a less facilitating business climate should be associated with smaller dynamic gains because it inhibits firm growth and innovation. The equations we estimate take the following general form, where *obstacle* is defined as above, and all other variables are as in equations (1) and (2):

$$(3)\ \log(tfp_{cif}) = d_{ci} + b_1 imports_{cif} + b_2 log(employees_{cif}) + b_3 foreign_{cif} + b_5 * imports_{cif} * obstacle_{cif} + e_{cif}$$

$$(4)\ \Pr(R\&D\ Spending_{cif}) = d_{ci} + b_1 imports_{cif} + b_2 log(employees_{cif}) + b_3 foreign_{cif} + b_4 products_{cif} + b_5 * imports_{cif} * obstacle_{cif} + e_{cif}$$

Results are in Table A7; only regressions with significant results are reported. Of the factors investigated, four have an impact on productivity gains realized through the imported intermediates channel: barriers to entrepreneurship, access to finance, labour regulations, and access to skilled labour. In addition, access to finance and macroeconomic instability affect dynamic gains occurring through the imported capital goods channel. Creating a more facilitating business environment in any of these areas can increase an economy's ability to benefit from the dynamic gains from trade.

Only one complementary policy produced significant results using innovation (the probability of R&D expenditure) as the dependent variable (Table A8). The interaction between imports of capital goods and barriers to entrepreneurship is negative and 1% significant. Governments can therefore facilitate innovation that relies on imported capital goods by lower entry barriers in the domestic marketplace. This result suggests that R&D expenditure is more profitable in a low entry barrier environment—and thus more common—because firms can easily introduce new products into the marketplace. In environments where new products face substantial hurdles, the return to innovation is less, and it is harder for firms to make use of imported capital goods to innovate.

We also use the data to examine the potential for sector-specific effects in terms of the links between complementary policies and the dynamic gains from trade (Tables A9-

A15). There is indeed considerable variation across sectors in terms of the types of policies that are significantly associated with enhanced dynamic gains. We find that better competition policy is associated with stronger dynamic gains in the textiles sector. Lowering the barriers to starting a business is associated with stronger dynamic gains in electronics, heavy manufacturing, and textiles. Access to finance is an important complementary policy in electronics, food and beverage, and textiles. Labour regulations are associated with stronger dynamic gains in electronics and heavy and light manufacturing. Better macroeconomic policies are associated with stronger dynamic gains in electronics, heavy and light manufacturing, and textiles. Increasing policy certainty is an important complementary policy for electronics, food and beverage, and heavy industry. Improving access to skilled labour can help boost the dynamic gains from trade in electronics, food and beverage, and light manufacturing.

Annex Tables

Table A1. Firm-level regression results: TFP, and innovation vs. imports of intermediates and capital goods

	(1)	(2)	(5)	(6)
Dependent variable	TFP	TFP	R&D Spending	R&D Spending
Imports / total inputs	0.298***		0.181**	
	(0.070)		(0.086)	
Capital goods importer		0.167***		0.057
		(0.059)		(0.096)
Log(employees)	0.523***	0.380***	0.530***	0.384***
	(0.032)	(0.037)	(0.026)	(0.034)
Foreign	0.214***	0.308***	-0.018	-0.155
	(0.040)	(0.056)	(0.076)	(0.154)
N	7365	4352	14800	6997
Number of Groups	230	122	406	161
R2 / *Pseudo-R2*	0.13	0.11	*0.08*	*0.04*
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry

Estimation is by OLS in columns 1-2 and by conditional fixed effects logit in columns 3-4. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table A2. Firm-level regression results for OECD vs non-OECD countries: TFP, and innovation vs. imports of intermediates and capital goods+

	(1)	(2)	(5)	(6)
Dependent variable	TFP - OECD	TFP – Non-OECD	R&D Spending - OECD	R&D Spending – Non-OECD
Imports / Total inputs	0.213*	0.300***	0.112	0.208**
	(0.115)	(0.077)	(0.196)	(0.095)
Log(Employees)	0.452***	0.545***	0.707***	0.472***
	(0.074)	(0.034)	(0.070)	(0.024)
Foreign	0.195	0.215***	0.043	-0.034
	(0.118)	(0.043)	(0.185)	(0.083)
N	1411	5954	2973	11827
Number of groups	33	197	103	303
R2 / *Pseudo-R2*	0.10	0.15	*0.17*	*0.06*
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry

Estimation is by OLS in columns 1-2 and by conditional fixed effects logit in columns 3-4. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table A3. Firm-level regression results by sector: TFP vs. imports of intermediates

	(1)	(2)	(3)	(4)	(5)
Sector:	Textiles leather & garments	Food & beverages	Heavy manufacturing	Electronics	Light manufacturing
Imports / Total Inputs	0.098	0.566***	0.270***	0.241**	0.622***
	(0.079)	(0.124)	(0.069)	(0.063)	(0.148)
Log(Employees)	0.426***	0.669***	0.289**	0.486***	0.622***
	(0.032)	(0.036)	(0.087)	(0.041)	(0.078)
Foreign	0.260***	0.321**	0.108	0.281**	0.168
	(0.051)	(0.097)	(0.063)	(0.074)	(0.108)
N	2214	1917	1235	246	1753
Number of Groups	49	54	33	8	86
R2	0.312	0.203	0.028	0.615	0.112
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry	Country-Industry

*Estimation is by OLS. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A4. Firm-level regression results by sector: TFP vs. imports of capital go

	(1)	(2)	(3)	(4)	(5)
Sector:	Textiles leather & garments	Food & beverages	Heavy manufacturing	Electronics	Light manufacturing
Equipment importer	0.158**	0.303*	0.102	0.336	0.063
	(0.058)	(0.138)	(0.109)	(0.152)	(0.220)
Log(Employees)	0.348***	0.635***	0.271**	0.417***	0.292***
	(0.035)	(0.063)	(0.093)	(0.048)	(0.073)
Foreign	0.243***	0.460	0.296*	0.453***	0.186
	(0.055)	(0.274)	(0.107)	(0.045)	(0.165)
N	1696	501	1053	607	495
Number of groups	38	17	24	8	35
R2	0.095	0.26	0.177	0.533	0.057
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry	Country-Industry

*Estimation is by OLS. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A5. Firm-level regression results by sector: Innovation vs. imports of intermediates

	(1)	(2)	(3)	(4)	(5)
Sector:	Textiles leather & garments	Food & beverages	Heavy manufacturing	Electronics	Light manufacturing
Imports / total inputs	-0.214*	0.496*	0.472**	0.727**	0.146
	(0.106)	(0.219)	(0.145)	(0.231)	(0.189)
Log(Employees)	0.428***	0.530***	0.614***	0.476***	0.587***
	(0.036)	(0.055)	(0.054)	(0.139)	(0.051)
Foreign	-0.314*	0.237	-0.081	0.222	0.056
	(0.132)	(0.144)	(0.126)	(0.277)	(0.197)
N	4282	2934	4030	483	3071
Pseudo-R2	0.045	0.107	0.124	0.083	0.088
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry	Country-Industry

*Estimation is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A6. Firm-level regression results by sector: Innovation vs. imports of capital goods

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Sector:	Textiles leather & garments	Food & beverages	Heavy manufacturing	Electronics	Light manufacturing
Equipment importer	0.060	0.170	0.109	0.036	0.026
	(0.166)	(0.160)	(0.223)	(0.303)	(0.196)
Log(Employees)	0.246***	0.363**	0.510***	0.415***	0.485***
	(0.053)	(0.114)	(0.056)	(0.081)	(0.077)
Foreign	-0.201	0.696*	-0.059	-0.943***	0.105
	(0.182)	(0.281)	(0.174)	(0.155)	(0.225)
N	2361	986	1796	733	1121
Pseudo-R2	0.017	0.063	0.068	0.066	0.056
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry	Country-Industry

*Estimation is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A7. Firm-level regression results for TFP vs. imports of intermediates and capital goods, including interaction terms

	(1)	(2)	(3)	(4)	(5)	(6)
Policy variable:	Barriers to entrepreneurship	Access to finance	Access to finance	Labour regulations	Macro-economic instability	Access to skilled labour
Dependant variable : TFP Index						
Imports / total inputs	0.339***	0.380***		0.332***		0.346***
	(0.075)	(0.071)		(0.076)		(0.078)
Imports * Business obstacle	-0.142*	-0.171**		-0.140*		-0.203**
	(0.081)	(0.084)		(0.076)		(0.080)
Capital goods importer			0.241***		0.238***	
			(0.075)		(0.072)	
Equipment * Business obstacle			-0.169**		-0.189***	
			(0.068)		(0.067)	
Business obstacle	0.082*	0.036	-0.007	0.016	0.129***	0.071
	(0.044)	(0.036)	(0.029)	(0.038)	(0.039)	(0.045)
Log(Employees)	0.525***	0.519***	0.378***	0.526***	0.379***	0.523***
	(0.032)	(0.031)	(0.037)	(0.032)	(0.036)	(0.031)
Foreign	0.209***	0.215***	0.307***	0.218***	0.307***	0.216***
	(0.042)	(0.042)	(0.058)	(0.042)	(0.056)	(0.042)
N	6963	7100	4319	6995	4290	7257
Number of groups	223	230	122	221	121	227
R2	0.13	0.13	0.11	0.13	0.12	0.13
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry	Country-industry	Country-industry

*Estimation is by OLS. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A8. Firm-level regression results for innovation vs. imports of capital goods, including interaction terms with complementary policies

	(1)
Policy variable:	Barriers to entrepreneurship
Dependent variable:	Pr (R&D Spending)
Capital goods importer	0.153*
	(0.090)
Equipment * business obstacle	-0.370**
	(0.153)
Business obstacle	0.336***
	(0.100)
Log(Employees)	0.392***
	(0.032)
Foreign	-0.177
	(0.159)
N	6773
Pseudo-R2	0.05
Fixed effects	Country-Industry

*Estimation is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A9. Sector-specific firm-level regression results for innovation vs. imports of intermediate goods, including an interaction term with competition as a complementary policy

	(1)
Sector:	Textiles
Dependent variable:	Pr(R&D)
Imports / total inputs	-0.079
	(0.141)
Imports * business obstacle	-0.453*
	(0.258)
Business obstacle	0.395***
	(0.134)
Log(Employees)	0.436***
	(0.036)
Foreign	-0.314**
	(0.136)
N	3992
Pseudo-R2	0.049
Fixed effects	Country-Industry

*Estimation is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A10. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with business permits as a complementary policy

	(1)	(2)	(3)	(4)	(5)
Sector:	Electronics	Electronics	Heavy Manufacturing	Heavy Manufacturing	Textiles
Dependent variable:	TFP	Pr(R&D)	TFP	Pr(R&D)	Pr(R&D)
Imports / total inputs	0.326***	0.686**	0.335***		
	(0.075)	(0.332)	(0.076)		
Imports * business obstacle	-0.212*	-0.871***	-0.303**		
	(0.110)	(0.287)	(0.131)		
Equipment importer				0.207	0.251**
				(0.246)	(0.111)
Equipment * business obstacle				-0.517**	-0.559**
				(0.248)	(0.259)
Business obstacle	0.241	1.311***	-0.061	0.107	0.512***
	(0.156)	(0.287)	(0.089)	(0.219)	(0.177)
Log(Employees)	0.474***	0.547***	0.298***	0.520***	0.264***
	(0.052)	(0.099)	(0.088)	(0.057)	(0.046)
Foreign	0.356**	-0.133	0.105	-0.047	-0.256
	(0.109)	(0.225)	(0.062)	(0.175)	(0.195)
N	203	440	1196	1776	2238
R2 / *Pseudo-R2*	0.576	*0.112*	0.18	*0.072*	*0.025*
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry	Country-Industry

*Estimation in columns 1 and 3 is by OLS. Estimation in columns 2, 4, and 5 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A11. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with access to finance as a complementary policy

.	(1)	(2)	(3)	(4)
Sector:	Electronics	Food & Beverage	Textiles	Textiles
Dependent variable	TFP	TFP	TFP	Pr(R&D)
Imports / total inputs	0.369***	0.686***	0.228**	
	(0.093)	(0.133)	(0.091)	
Imports * business obstacle	-0.403**	-0.307**	-0.221**	
	(0.147)	(0.135)	(0.105)	
Equipment importer				0.253
				(0.191)
Equipment * business obstacle				-0.374**
				(0.178)
Business obstacle	0.298*	-0.003	0.045	0.385***
	(0.149)	(0.050)	(0.062)	(0.131)
Log(Employees)	0.486***	0.660***	0.422***	0.252***
	(0.039)	(0.035)	(0.032)	(0.053)
Foreign	0.353**	0.332***	0.243***	-0.173
	(0.111)	(0.100)	(0.054)	(0.191)
N	230	1866	2128	2344
R2 / *Pseudo-R2*	0.601	0.196	0.294	*0.02*
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry

*Estimation in columns 1-3 is by OLS. Estimation in column 4 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A12. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with labour regulation as a complementary policy

	(1)	(2)	(3)
Sector:	Electronics	Heavy manufacturing	Light manufacturing
Dependent variable	TFP	TFP	TFP
Imports / total inputs			0.708***
			(0.155)
Imports * business obstacle			-0.364**
			(0.173)
Equipment Importer	0.480**	0.156	
	(0.138)	(0.120)	
Equipment * business obstacle	-0.345**	-0.333*	
	(0.118)	(0.187)	
Business obstacle	-0.030	-0.015	0.041
	(0.058)	(0.063)	(0.067)
Log(Employees)	0.419***	0.272***	0.609***
	(0.050)	(0.092)	(0.078)
Foreign	0.469***	0.306***	0.170
	(0.036)	(0.105)	(0.108)
N	586	1033	1721
R2	0.528	0.186	0.111
Fixed effects	Country-Industry	Country-Industry	Country-Industry

Estimation is by OLS. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. p<0.10; ** p<0.05; *** p<0.01.*

Table A13. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with macroeconomic policy as a complementary policy

	(1)	(2)	(3)	(4)
Sector:	Electronics	Heavy Manufacturing	Light Manufacturing	Textiles
Dependent variable:	TFP	TFP	TFP	Pr(R&D)
Imports / total inputs			0.800***	-0.005
			(0.154)	(0.168)
Imports * business obstacle			-0.346*	-0.480*
			(0.200)	(0.267)
Equipment importer	0.508**	0.249**		
	(0.167)	(0.106)		
Equipment * business obstacle	-0.428**	-0.328**		
	(0.146)	(0.137)		
Business obstacle	0.227***	0.169*	0.046	0.268**
	(0.064)	(0.098)	(0.089)	(0.111)
Log(Employees)	0.414***	0.273***	0.617***	0.416***
	(0.046)	(0.089)	(0.077)	(0.035)
Foreign	0.449***	0.284**	0.176	-0.311**
	(0.035)	(0.108)	(0.107)	(0.134)
N	598	1041	1739	4199
R2 / *Pseudo-R2*	0.535	0.179	0.118	
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry

*Estimation in columns 1-3 is by OLS. Estimation in column 4 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A14. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with policy uncertainty as a complementary policy

	(1)	(2)	(3)	(4)
Sector:	Electronics	Food & beverage	Food & beverage	Heavy manufacturing
Dependant variable	TFP	TFP	Pr(R&D)	TFP
Imports / total inputs	0.279***	0.674***	0.779***	
	(0.064)	(0.153)	(0.203)	
Imports * business obstacle	-0.216**	-0.232*	-0.828**	
	(0.076)	(0.129)	(0.406)	
Equipment importer				0.211**
				(0.080)
Equipment * business obstacle				-0.244*
				(0.140)
Business obstacle	0.314**	0.104**	0.254*	0.111
	(0.097)	(0.045)	(0.150)	(0.072)
Log(Employees)	0.491***	0.660***	0.539***	0.276**
	(0.045)	(0.036)	(0.052)	(0.098)
Foreign	0.440***	0.406***	0.226	0.319***
	(0.080)	(0.068)	(0.143)	(0.111)
N	200	1809	2843	975
R2 / *Pseudo-R2*	0.662	0.194	*0.11*	0.186
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry

*Estimation in columns 1, 2, and 4 is by OLS. Estimation in column 3 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*

Table A15. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with access to skilled labour as a complementary policy

	(1)	(2)	(3)	(4)	(5)
Sector:	Electronics	Electronics	Electronics	Food & beverage	Light manufacturing
Dependent variable	TFP	TFP	Pr(R&D)	TFP	Pr(R&D)
Imports / total inputs	0.249***			0.633***	
	(0.034)			(0.149)	
Imports * business obstacle	-0.428**			-0.503*	
	(0.179)			(0.287)	
Equipment importer		0.364*	0.177		0.256
		(0.160)	(0.288)		(0.206)
Equipment * business obstacle		-0.215**	-0.505***		-0.631*
		(0.087)	(0.180)		(0.326)
Business obstacle	0.216*	-0.091*	0.213***	0.078	0.536***
	(0.109)	(0.048)	(0.054)	(0.105)	(0.167)
Log(Employees)	0.480***	0.418***	0.418***	0.665***	0.483***
	(0.043)	(0.050)	(0.084)	(0.034)	(0.080)
Foreign	0.356**	0.471***	-1.037***	0.349***	0.089
	(0.113)	(0.036)	(0.122)	(0.107)	(0.229)
N	228	599	725	1882	1117
R2 / *Pseudo-R2*	0.607	0.533	*0.072*	0.203	*0.064*
Fixed effects	Country-Industry	Country-Industry	Country-Industry	Country-Industry	Country-Industry

*Estimation in columns 1, 2, and 4 is by OLS. Estimation in columns 3 and 5 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.*