CHAPTER 2

GLOBAL TRADE: WHAT'S BEHIND THE SLOWDOWN?

Trade growth has slowed since 2012 relative both to its strong historical performance and to overall economic growth. This chapter finds that the overall weakness in economic activity, in particular in investment, has been the primary restraint on trade growth, accounting for up to three-fourths of the slowdown. However, other factors are also weighing on trade. The waning pace of trade liberalization and the recent uptick in protectionism are holding back trade growth, even though their quantitative impact thus far has been limited. The decline in the growth of global value chains has also played an important part in the observed slowdown. The findings suggest that addressing the general weakness in economic activity, especially in investment, will stimulate trade, which in turn could help strengthen productivity and growth. In addition, given the subdued global growth outlook, further trade reforms that lower barriers, coupled with measures to mitigate the cost to those who shoulder the burden of adjustment, would boost the international exchange of goods and services and revive the virtuous cycle of trade and growth.

Global trade growth has decelerated significantly in recent years. After its sharp collapse and even sharper rebound in the aftermath of the global financial crisis, the volume of world trade in goods and services has grown by just over 3 percent a year since 2012, less than half the average rate of expansion during the previous three decades. The slowdown in trade growth is remarkable, especially when set against the historical relationship between growth in trade and global economic activity (Figure 2.1). Between 1985 and 2007, real world trade grew on average twice as fast as global GDP, whereas over the past four years, it has barely kept pace. Such prolonged sluggish growth in trade volumes relative to economic activity has few historical precedents during the past five decades.

The reasons for the weakness in global trade growth are still not clearly understood, yet a precise diagnosis is necessary to assess if and where policy action may help.[1] Is the waning of trade simply a symptom of the generally weak economic environment, or is it a consequence of a rise in trade-constricting policies? Private investment remains subdued across many advanced and emerging market and developing economies (see Chapter 4 of the April 2015 *World Economic Outlook* [WEO]), and China has embarked on a necessary and welcome process of rebalancing away from investment and toward more consumption-led growth.[2] Many commodity exporters have cut capital spending in response to persistently weak commodity prices. Since investment relies more heavily on trade than consumption, Freund (2016) argues that an investment slump would inevitably lead to a slowdown in trade growth (see also Boz, Bussière, and Marsilli 2015 and Morel 2015, for example).

Additional contributors to the trade slowdown are also possible. The waning pace of trade liberalization over the past few years and the recent uptick in protectionist measures could be limiting the sustained policy-driven reductions in trade costs achieved during 1985–2007, which provided a strong impetus to trade growth (Evenett and Fritz 2016; Hufbauer and Jung 2016). Lower trade costs, as well as advances in transportation and communication, also supported the spread of global value chains, in which the fragmentation of production processes boosted trade growth as intermediate goods crossed borders multiple times. The formation of cross-border production chains may have slowed—possibly because their growth matured or because the cost of trade fell more modestly, or both—implying a slower expansion

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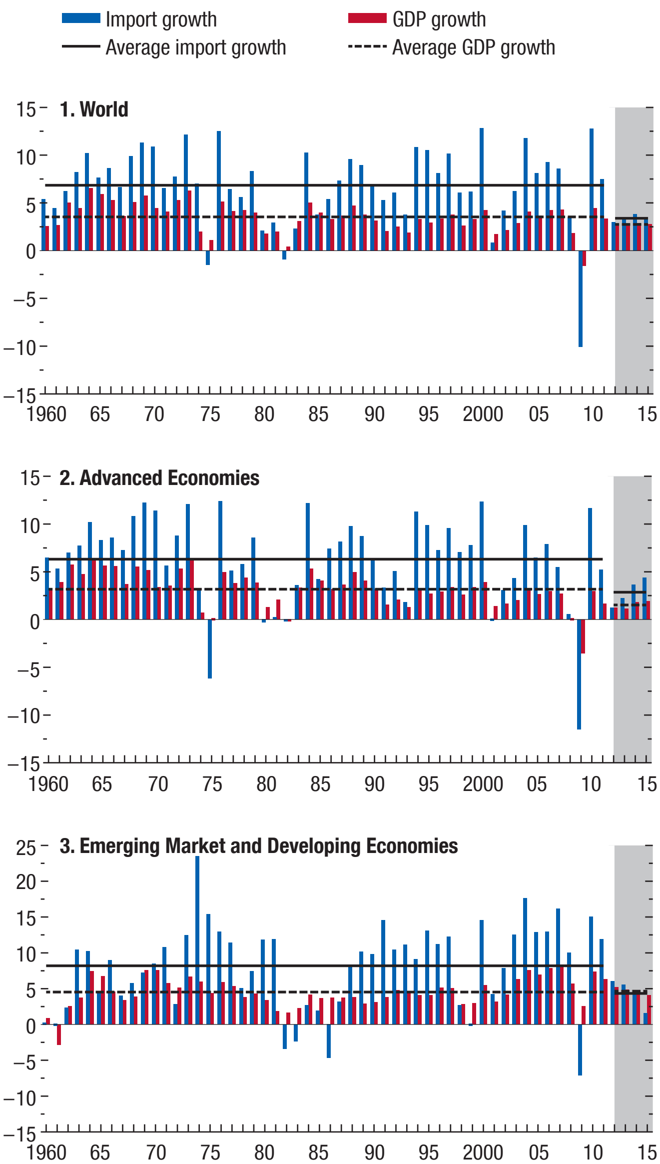
[1]See Hoekman (2015) and papers therein for an analysis of the global trade slowdown. Relative to the studies in Hoekman (2015), the chapter's approach allows for a more comprehensive horse race among the various hypotheses for a large number of economies and using a range of analytical approaches.

[2]Chapter 4 of this WEO report discusses the global spillovers from China's rebalancing, including through trade.

Figure 2.1. World Real Trade and GDP Growth in Historical Perspective
(Percent)

The decline in real trade growth since 2012 has been remarkable, especially when set against the historical relationship between growth in trade and global economic activity.



Source: IMF staff calculations.
Note: Imports include goods and services. The charts are based on an unbalanced sample of 100 countries in 1960 and 189 in 2015. Annual aggregate import (GDP) growth is calculated as the weighted average of country-specific real import (GDP) growth rates, where nominal import (GDP at market exchange rates) shares are the weights used.

in such supply chain-related trade (Constantinescu, Mattoo, and Ruta 2015).[3,4] Other causes of a decline in goods trade growth could be more evolutionary in nature, such as an increase in the relative demand for nontradables in response to growing wealth or aging populations.

The 1985–2007 period witnessed substantial globalization and rapid economic growth. There is strong consensus among economists that international trade contributed to the rise in overall prosperity, notwithstanding the often considerable adjustment costs faced by some workers. International trade allows economies to specialize in producing goods and services in which they have a comparative advantage and to exploit the resulting economies of scale and scope. But trade can also boost economic growth by spreading knowledge and technology and by fostering the development of new products and, ultimately, productivity.[5] In light of the synchronized slowdown in productivity growth in many economies, there may be a strong case for reviving the virtuous cycle of trade and growth through a concerted effort by policymakers to open markets and reduce trade costs further.[6]

To contribute to our understanding of the drivers of the sharp slowdown in trade since the end of 2011 and the design of an appropriate policy response, the chapter focuses on the following questions:

- How widespread is the post-2011 decline in the growth of international trade? Have the dynamics of trade differed among economies? Has the trade slowdown varied by type of trade and product group?
- How much of the slump in trade growth reflects weakness in economic activity and changes in the composition of growth? In particular, how much of

[3]Constantinescu, Mattoo, and Ruta (2015) argue that the growth of global supply chains, particularly those involving China, had weakened even before the global financial crisis. See Kee and Tang (2016) for further evidence on the evolution of China's value chains during 2000–07.

[4]If, indeed, the observed slowdown in trade simply marks the end of a period of unusually rapid trade growth, due to some of the factors listed above, then the global economy could be returning to a steady state in which, as theory predicts, trade grows at the same rate as output. In such a steady state, trade costs, the structure of individual economies, and production, sourcing, and trade patterns across countries would be constant. See, for example, Dixit and Norman (1980) or Ethier (1985).

[5]See, for example, Krugman (1979), Grossman and Helpman (1991), Young (1991), Lee (1993), Frankel and Romer (1999), and Bernard and others (2003), among others.

[6]See Goldberg and Pavcnik (2016) for a review of the literature on the effects of trade policy on trade volumes, productivity, labor markets, and growth.

the 2012–15 slowdown in trade growth relative to the period before the global financial crisis can be attributed to subdued growth? To what extent is the trade slowdown relative to GDP growth attributable to compositional changes in demand?

- What role have other factors—beyond output—played in holding back trade growth? Is the slowdown a consequence of policy distortions, such as a deceleration in trade liberalization or a rise in protectionism? Or does it reflect a maturation of global supply chains?

The chapter starts by documenting the evolution of trade growth across various dimensions. It then employs three complementary analytical approaches to analyze the factors behind the recent slowdown. The first part uses a standard empirical model of import demand to determine whether import growth at the country level has slowed by more than changes in aggregate demand components and relative prices would predict in recent years. The second part complements the empirical analysis by estimating a structural multicountry, multisector model, which quantifies the importance of changes in the composition of demand and other factors, such as trade costs. The third part of the analysis uses highly disaggregated data to shed light on the role of trade policies and global value chain participation.

The chapter's main findings are as follows:

- The decline in real trade growth has been broad based. Few countries were spared the 2012–15 slowdown in trade growth, either in absolute terms or relative to GDP growth. Likewise, trade growth fell for both goods and services, although services trade slowed less. Among goods, trade growth fell for 85 percent of product lines, with the sharpest slowdown observed in trade in capital and intermediate goods.
- The overall weakness in economic activity and, in particular, the slowdown in investment growth appear to be key restraints on trade growth since 2012. Empirical analysis suggests that, for the world as a whole, up to three-fourths of the decline in real goods import growth between 2003–07 and 2012–15 can be traced to weaker economic activity, most notably subdued investment growth. A general equilibrium model similarly finds that changes in the composition of demand explain about 60 percent of the slowdown in the growth rate of the nominal goods imports-to-GDP ratio.
- Other factors, however, are also weighing on trade growth. The slowdown in the pace of trade liberalization and the recent uptick in protectionist measures are holding back international trade in goods, even if their quantitative impact thus far has been relatively limited. The apparent decline in the growth of global value chains has also played an important part in the observed slowdown. Overall, factors beyond the level and composition of economic activity have shaved about 1¾ percentage points off global annual real import growth since 2012.

The key finding of the chapter—that weak trade growth is largely a symptom of the synchronized slowdown in economic activity across advanced and emerging market and developing economies—implies that policies to address the constraints to growth, and in particular investment where it is depressed, should take center stage in the effort to improve global economic health. Such policies, by lifting trade indirectly, will generate positive spillovers as trade linkages transmit and mutually reinforce each country's economic expansion. Yet, precisely because trade can strengthen productivity and boost growth, policies directly aimed at reducing trade costs and reinvigorating trade remain important in light of the subdued global outlook and unfavorable productivity trends. Many emerging market and developing economies maintain or face trade barriers that inhibit their entry into global markets and participation in global production chains; a coordinated effort to remove such barriers could kick off a new round of integration and global value chain development and provide firms with greater incentives to invest (Freund 2016). More broadly, avoiding protectionist measures and reviving the process of trade liberalization through trade reforms that lower barriers, coupled with measures that mitigate the cost to those who shoulder the burden of adjustment, would boost growth in the international exchange of goods and services and ultimately strengthen global activity.

It is important to emphasize from the outset that providing a precise quantification of the role of economic activity, trade policies, and global value chains in the evolution of trade flows is inherently a difficult task. Demand for traded goods is clearly a function of economic growth, but international trade and trade policies can also shape economic activity by influencing firms' investment decisions, their access to intermediate inputs, production processes, and productivity.

For example, the fading pace of trade liberalization since the early 2000s may have contributed to slow productivity growth, weak investment, and lackluster output growth in recent years. As in the vast majority of the trade literature, this chapter's empirical analysis focuses only on part of this complex web of relationships, as its primary goal is to establish whether recent trade dynamics are consistent with the observed level and composition of output growth, the evolution of trade policies, and global value chain integration given historical patterns of association. The structural analysis takes a more holistic approach as, in general equilibrium, the level of economic activity, production structure, and trade patterns are jointly determined by trade costs, preferences, and productivity. However, due to its stylized representation of the real world, the model is unable to capture all the channels through which trade may affect output.

The Implications of Trade for Productivity and Welfare: A Primer

While the primary focus of the chapter is to diagnose the drivers of the recent decline in trade growth, understanding its potential implications for productivity and growth is important in the context of a subdued global outlook and unfavorable productivity trends. To this end, this section provides a brief review of the key channels through which the opening of a closed economy to trade or further boosting international trade by reducing trade barriers can benefit the macroeconomy as well as the challenges it may pose.[7]

Trade liberalization can improve productivity, raise overall living standards, and promote economic growth through a number of channels. The best-known benefit from trade is that it induces factors of production, such as capital and labor, to be used more efficiently. When economies open up to international trade, they can specialize in the goods and services for which they have comparative advantage, thereby improving their overall productivity (Ricardo 1817). Trade liberalization could also enhance productivity in each sector by reallocating resources toward more productive firms that are better placed to expand their activities in export markets (Melitz 2003) and exploit the resulting economies of scale (Box 2.1).[8]

Beyond the productivity gains from reallocation, trade can also lead to productivity improvements for individual firms. Exporting offers businesses the opportunity to learn from foreign markets, for example, through their relationship with particular buyers (De Loecker 2013), and the expanded market access provides greater incentives for investment in technology (Bustos 2011; Lileeva and Trefler 2010). Firms that face foreign competition in domestic markets may be forced to lower price-cost margins and move down their average cost curve (Helpman and Krugman 1985), focus on their core competency products (Bernard, Redding, and Schott 2011), and reduce managerial slack and generate efficiency gains (Hicks 1935). Trade liberalization has also been found to stimulate innovation by firms as reflected in their research and development spending and patenting as they attempt to increase their presence in the world marketplace (Bloom, Draca, and Van Reenen 2016). Finally, firms benefit from the larger variety, cheaper, and potentially higher-quality intermediate inputs international trade can offer (Grossman and Helpman 1991; Rivera-Batiz and Romer 1991).

Both consumers and producers broadly benefit from the international exchange of goods and services and the efficiencies it creates. Trade lowers the prices faced by consumers and producers, thereby raising real incomes. It also increases the variety of products available to consumers and producers (Broda and Weinstein 2006). Both of these channels can significantly boost welfare (Box 2.3). Economic theory also suggests that the consumption gains and the more efficient use of resources generated by trade should boost GDP even if a robust causal relationship between trade and growth is difficult to detect in cross-country data.[9]

[7]It is important to note that, in most cases, theory predicts benefits from trade to arise from the removal of distortions that limit greater trade flows. The Council of Economic Advisers (2015) provides a comprehensive review of the benefits from trade in the case of the United States.

[8]For a discussion of the impact of trade on intra-industry reallocation and productivity, see, for example, Melitz (2003); Bernard, Jensen, and Schott (2006); and Melitz and Ottaviano (2008). Lileeva and Trefler (2010) and Bustos (2011) present evidence of export-induced technology investments, while De Loecker (2007, 2013) and Atkin, Khandelwal, and Osman (2014) study the "learning-by-exporting" channel. Pavcnik (2002), Erdem and Tybout (2003), Amiti and Konings (2007), and Topalova and Khandelwal (2011) examine the productivity effects of trade liberalization, including through the intermediate inputs channel.

[9]Frankel and Romer (1999) provide some of the first estimates of the causal effects of trade on income; for a more recent analysis, see Feyrer (2009a, 2009b). Rodríguez and Rodrik (2001) instead conclude that the nature of the relationship between trade policy and economic growth remains ambiguous on empirical grounds.

However, while trade increases the size of the pie, its benefits may not often be evenly distributed—a source of much of the public opposition against increased trade openness. Trade has a distributional impact within an economy through two distinct channels. It differentially affects the earnings of workers across sectors and skills (see, for example, Stolper and Samuelson 1941).[10] It can also differentially impact the cost of living faced by different consumers through its effects on the relative prices of goods and services.

Numerous studies have examined the effect of trade on the distribution of earnings.[11] On one hand, sectors and firms that expand in response to greater foreign market access create new and often higher-quality employment opportunities.[12] On the other hand, the earnings and employment prospects of workers in sectors and firms competing with foreign imports may be adversely affected, and these adverse effects could be long lasting if expanding firms and sectors cannot promptly absorb the dislocated workers due to the nature of their skills or geographical location. A widely cited study by Autor, Dorn, and Hanson (2013) on the impact of Chinese import competition on the U.S. labor market finds that rising imports from China have led to higher unemployment, lower labor force participation, and reduced wages in local labor markets with import-competing manufacturing industries.[13]

Trade can also have a distributional effect as consumers enjoy different baskets of goods whose prices are differentially affected by trade-induced relative price changes. In a recent study, Fajgelbaum and Khandelwal (2016) develop a framework to isolate precisely this effect and simulate the gains from reducing trade costs in a large number of economies. They find that the benefits of trade from lower prices tend to favor those at the bottom of the income distribution because the poor spend a larger share of their income on heavily traded goods.

In sum, greater trade integration can strengthen productivity and growth, raising overall welfare. However, there are winners and losers from increasing trade openness, especially in the short term. The adjustment costs that further trade liberalization entails for certain workers should not be underestimated and call for complementary policy measures to ensure trade integration works for all (see also Box 2.2).

The Slowdown in Trade Growth: Key Patterns

An investigation into the evolution of global trade in recent years yields two strikingly different pictures, depending on whether trade is measured in real or nominal U.S. dollar terms. In real terms, world trade growth has slowed since the end of 2011; in nominal U.S. dollar terms, it has collapsed since the second half of 2014 (Figure 2.2, panels 1 and 2). The value of goods and services trade fell by 10½ percent in 2015, driven by a 13 percent drop in the import deflator as oil prices fell sharply and the U.S. dollar appreciated; the pace of decline has moderated in recent months.[14] The volume of goods and services trade continued to grow throughout this period, albeit at the relatively low rate of just over 3 percent a year, with no sign of acceleration.[15] Because much of the decline in nominal trade is due to the sharp drop in the price of oil and the strength of the U.S. dollar, the rest of the stylized facts and several of the analytical approaches focus on the evolution of trade volumes—that is, trade in real terms.[16]

Across economies, the slowdown in real trade growth is widespread, both in absolute terms and

[10]See also Jones (1971) and Mussa (1974) for discussions of the Stolper-Samuelson theorem and the specific-factors model of trade. Levchenko and Zhang (2013) provide a quantitative assessment of the differential effects of the trade integration of China, India, and central and eastern Europe on real wages across countries and sectors.

[11]See Goldberg and Pavcnik (2004, 2007) and World Bank (2010), and references therein, for a review of the evidence on the distributional consequences of trade in developing economies. For the United States, see Ebenstein and others (2014). For recent theory and evidence on the link between inequality and trade, see Helpman and others (forthcoming).

[12]A large number of studies document the higher wages paid to workers employed in exporting industries or exporting plants in the United States, with estimates for this export wage premium ranging from 1¾ percent to 18 percent (see, for example, Bernard and Jensen 1995, Bernard and others 2007, and Table 4 of Council of Economic Advisers 2015).

[13]See also Lawrence (2014), who argues that while manufactured imports from China have significantly raised the standard of living overall in the United States, for some U.S. workers and regions, the expansion of Chinese trade has meant costly and painful adjustment. In Europe, rising Chinese import competition also led to declines in employment and the share of unskilled workers (Bloom, Draca, and Van Reenen 2016).

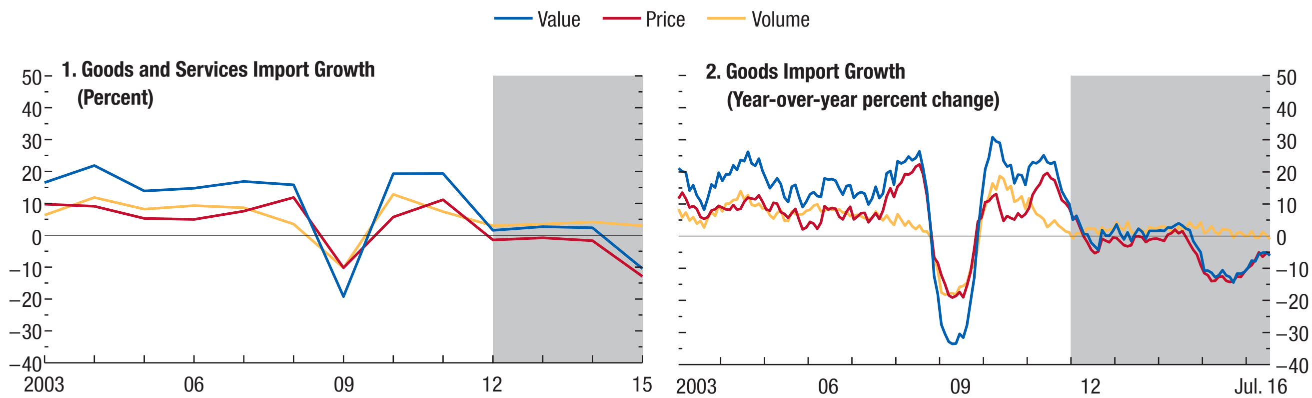
[14]See Chapter 3 of this WEO for a discussion of the effect of import prices on global inflation.

[15]In fact, according to the CPB *World Trade Monitor*, as of July 2016, global merchandise trade volumes have remained almost flat since the end of 2014.

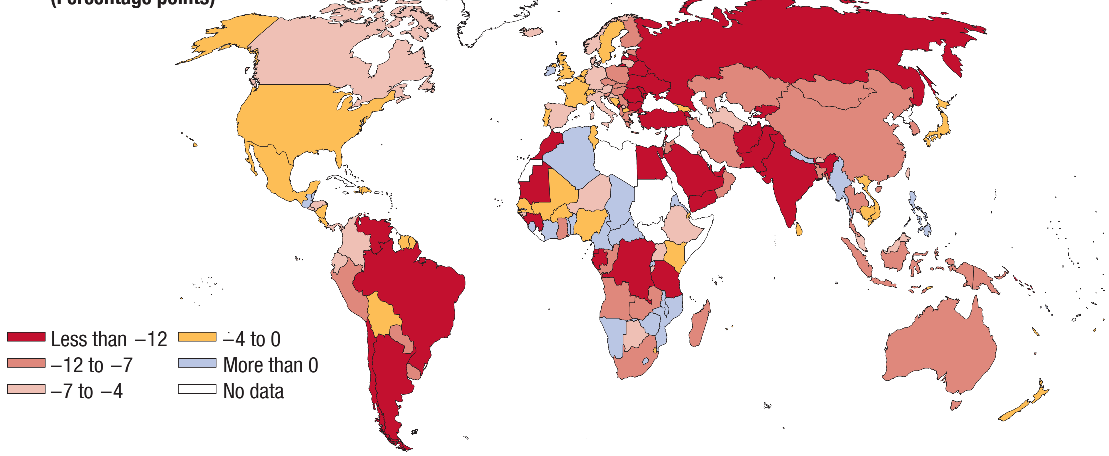
[16]The general equilibrium analysis examines the evolution of nominal values of trade relative to nominal GDP. Similarly, the gravity model, also discussed in this chapter, studies nominal bilateral sectoral trade flows.

Figure 2.2. World Trade in Volumes, Values, and across Countries

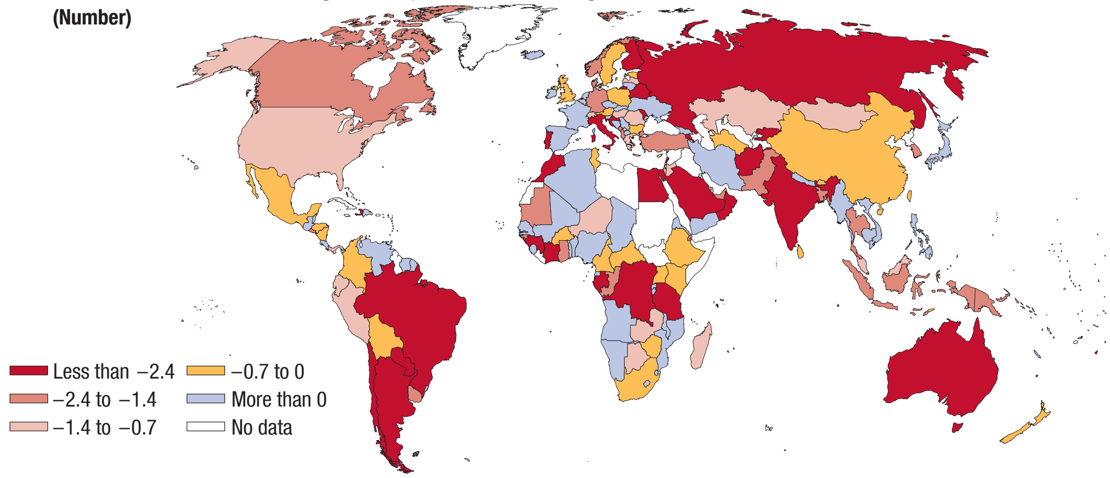
In real terms, world trade continued to grow since the end of 2011, albeit at a much lower rate, whereas in nominal U.S. dollar terms, it has collapsed since the second half of 2014. Across economies, the slowdown in real trade growth is widespread, both in absolute terms and relative to GDP growth.



3. Difference in Average Real Import Growth between 2003–07 and 2012–15[1]
(Percentage points)



4. Difference in the Ratio of Average Real Import Growth to Average Real GDP Growth between 2003–07 and 2012–15[1]
(Number)



Sources: CPB Netherlands Bureau for Economic Policy Analysis; and IMF staff calculations.
[1]Different intervals, shown as different shades, correspond to quartile ranges that are calculated based on the distribution across countries that experienced a decline in real import growth (panel 3) or in the ratio of average real import growth to average real GDP growth (panel 4).

relative to GDP growth (Figure 2.2, panels 3 and 4). Compared with the five years leading up to the global financial crisis, growth of goods and services imports during 2012–15 slowed in 143 of 171 countries. When measured relative to GDP growth, the slowdown occurred in 116 countries.

The contours of the 2012–15 slowdown in the growth of real imports varied by broad country group (Figure 2.3) and sector (Figure 2.4). For advanced economies, the slowdown was sharp at the outset of the period following the euro area debt crises, but import growth picked up thereafter in line with the modest recovery in those economies. In emerging market and developing economies, the slowdown was initially milder, but became more severe during the past two years. This was driven by weaker imports in China and macroeconomic stress in a number of economies, including commodity exporters affected by sharp declines in their export prices (see also Chapter 1 of the April 2016 WEO).

As was the case during the global financial crisis, services trade has been more resilient than trade in goods (Figure 2.4, panel 1). Services and goods trade volumes grew at an annual rate of about 9½ percent and 9 percent, respectively, during 2003–07, but during 2012–15 the growth rate for services fell to 5½ percent. For goods, it dropped much more, to just under 3 percent.[17] Many have argued that the growth in services trade may be even stronger than is reflected in these numbers.[18] New business models and advances in information and communications technology have rapidly expanded trade in digital services, including in digitally enabled data and services delivered free of charge (for example, e-mail, social media, maps, and search engine services). Measuring such trade, however, will remain a challenge until important conceptual and methodological issues are resolved.[19]

Across goods, the trade slowdown during the past four years has been broad based (Figure 2.4, panels 2 and 3). The analysis for this chapter uses a novel data set to separately compute import price and volume indices by product and end-use categories using disaggregated data for about 5,300 products for 52 countries.[20] This novel data set suggests that the entire distribution of trade volume growth across the roughly 100 separately analyzed product lines shifted to the left during 2012–15 relative to the distribution of growth rates observed in 2003–07. More than 85 percent of product lines experienced a decline in the average trade volume growth rates between the two periods, including oil-related products, which account for more than 10 percent of total trade.

However, the severity of the slowdown in goods trade growth varied across types of products. Trade in nondurable consumption goods held up relatively well. Trade growth in capital goods declined the most, followed by primary intermediate goods, durable consumption goods, and processed intermediate goods (Figure 2.4, panel 4). The sharper slowdown of trade in capital and durable consumption goods (including cars and other nonindustrial transportation equipment), which is a large part of investment expenditures, points to the potential role of investment weakness in holding back global trade growth in recent years.

Understanding the Slowdown in Trade Growth

Assessing the appropriate policy responses to the weakness in trade requires a clear diagnosis of its causes. Has trade growth been held back primarily by the protracted weakness in the global economic environment? If so, policymakers may best focus their attention on reinvigorating growth, and in particular on strengthening investment where it is particularly depressed. Or do the causes lie with other types of impediments, such as a slower pace of trade reform, which would suggest a different set of actions?

This analysis starts by quantifying the influence of the overall economic environment and the composition of growth in the trade growth slowdown, using both an empirical and a model-based approach. Since both methodologies suggest that output, and its composition, cannot fully predict the observed weakness in trade since 2012, the analysis moves on in the subse-

[17]Services trade has remained relatively robust compared with goods trade since 2012, so trade refers specifically to goods trade for the remainder of the chapter, unless specified otherwise.

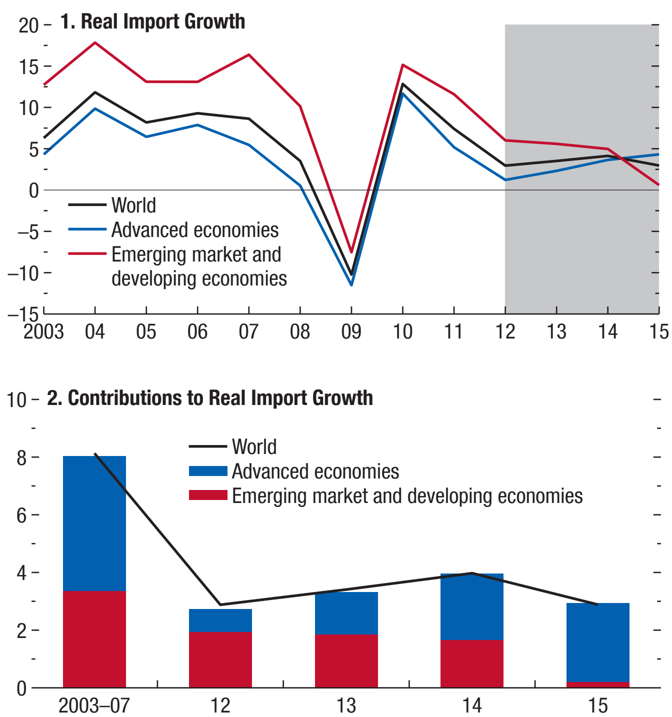
[18]A closer examination of nominal services trade across sectors reveals that trade in information and communication technologies, travel, and financial services has been significantly more resilient than trade in other services. (See Annex 2.1.)

[19]Magdeleine and Maurer (2016) provide an overview of the statistical challenges of measuring trade in "digitized ideas." A recent report by the McKinsey Global Institute (Manyika and others 2016) also discusses the impact of an increasingly digital era of globalization on trade, arguing that cross-border data flows generate more economic value than traditional flows of traded goods.

[20]United Nations Comtrade International Trade Statistics provide information on the nominal value and quantity of goods imports, so it is possible to compute unit value changes for each product over time. (See Annex 2.2 and Boz and Cerutti (forthcoming) for more details.)

Figure 2.3. Trade Dynamics across Broad Country Groups
(Percent)

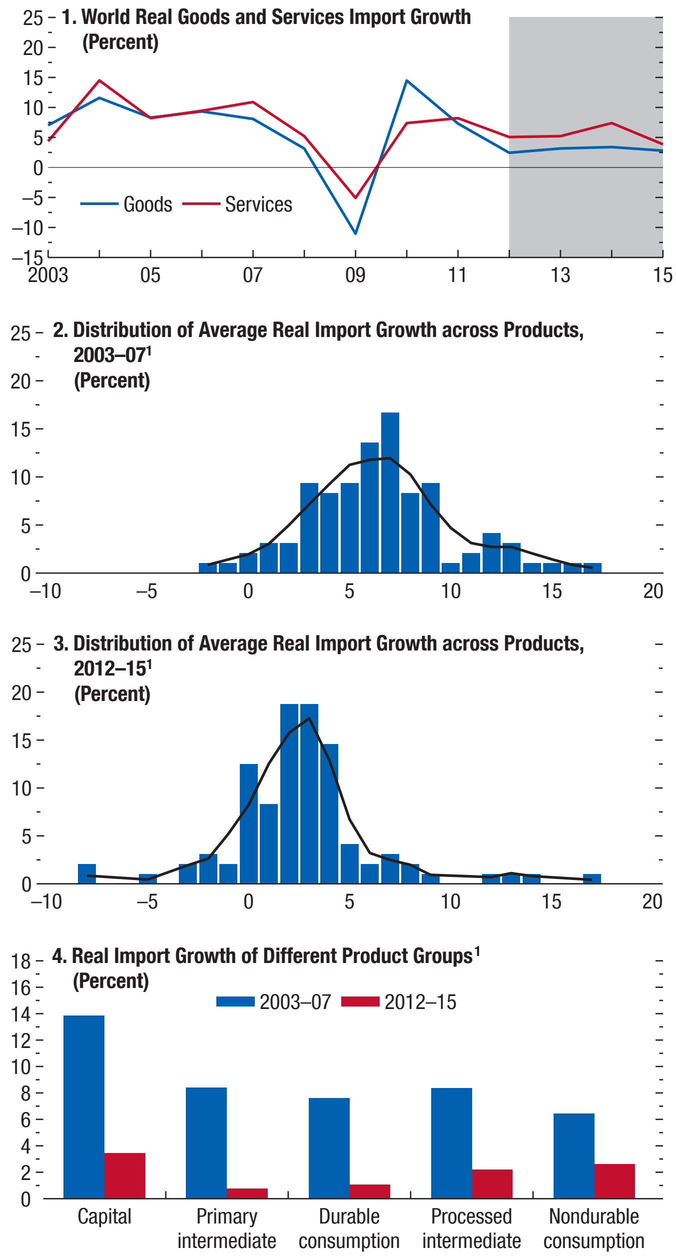
Not all economies experienced the slowdown in trade at the same time. In advanced economies, import growth fell sharply in 2012. In emerging market and developing economies, the decline in import growth became more severe in 2014 and 2015.



Source: IMF staff calculations.
Note: Imports include goods and services. Annual aggregate import growth is calculated as the weighted average of country-specific real import growth rates, where nominal import shares are the weights used.

Figure 2.4. Trade Dynamics across Types of Trade and Products

Services trade has been more resilient than goods trade. Among goods, the trade slowdown has been broad based with imports of capital goods experiencing the most pronounced decline in growth.



Sources: United Nations Comtrade; and IMF staff calculations.
Note: Panels 2–4 are computed using import volume indices constructed from quantity and value trade data at HS 6-digit level for 52 economies. See Boz and Cerutti (forthcoming) and Annex 2.2 for more details.
[1]Goods only.

quent sections to disentangle the role of other factors—trade policies and changes in the pace of global value chain expansion—using disaggregated product and bilateral-sectoral trade flows.

The Role of Output and Its Composition: Insights from an Empirical Investigation

To gauge the role of economic activity and shifts in its composition, this section examines the historical relationship between import volumes of goods and services and aggregate demand during 1985–2015 to predict a country's import growth from observed fluctuations in its domestic expenditures, exports, and relative prices. This predicted import growth is then compared with actual trade dynamics to assess whether trade has been unusually weak since 2012 given its historical relationship with economic activity.

For each of the 150 countries in the sample, the chapter estimates a standard import demand model that links import volume growth of goods and services separately to growth in demand, controlling for relative import prices.[21] Most studies use a country's GDP as a proxy for absorption. In contrast, the analysis here follows the innovation of Bussière and others (2013) and computes the import-intensity-adjusted aggregate demand (IAD) as a weighted average of traditional aggregate demand components (investment, private consumption, government spending, and exports). The weights used are the import content of demand computed from input-output tables.[22,23] The approach explicitly accounts for differences in the import content of the various aggregate demand components and captures the effect of changes in the overall strength of economic activity and across its drivers. The latter is especially important. Investment, together with exports, has a particularly rich import content, and it has been weak in many advanced economies still recovering from the global financial and European debt crises. It has also decelerated significantly in many emerging market and developing economies, including in China, which is undergoing a necessary and welcome rebalancing of its economy away from investment as discussed in Chapter 4 of this WEO.

In addition to the measure proposed by Bussière and others (2013), the chapter estimates two alternative models of import demand using: (1) IAD including only the domestic components of aggregate demand (domestic IAD) and (2) domestic IAD and exports predicted by trading partners' domestic IAD. These alternative models are useful given the global nature of the trade slowdown: they help focus more precisely on the dynamics of import growth driven only by domestic demand at home and domestic demand in trading partners (rather than exports, which are the sum of the imports of trading partners). A single country can take external demand for its goods and services as given, but for the world as a whole, only the sum of individual countries' domestic demand determines global import growth.

The empirical model closely tracks the dynamics of import growth (Figure 2.5), particularly when predicted values are calculated using the IAD measure based on all four aggregate demand components instead of only those for domestic demand. This is to be expected as country-level imports and exports are increasingly linked given the rise in the internationalization of production (Bussière and others 2013).

The model does reveal, however, that predicted versus actual trade growth for goods differed from that of services during 2012–15. For services, the actual and predicted import growth series are close to each other for the entire estimation period. In contrast, the annual growth of goods imports was, on average, significantly lower than predicted for 2012–15. For the average economy, the "missing" goods import growth averaged 1 percentage point over the past four years according to the model using all four components of aggregate demand to predict imports. The two alternative models suggest an even larger gap between actual and predicted goods import growth, of about 2¼ and 1¾ percentage points, respectively (Figure 2.6, panel 1).[24]

The results are also consistent with the time profile of the trade slowdown across countries discussed in the previous section. For advanced economies, the unpre-

[21]An import demand equation, which relates growth in real imports to changes in absorption and relative price levels, can be derived from virtually any international real business cycle model. The exact empirical specification estimated is

$$\Delta \ln M_{c,t} = \delta_c + \beta_{D,c} \Delta \ln D_{c,t} + \beta_{P,c} \Delta \ln P_{c,t} + \varepsilon_{c,t},$$

in which $M_{c,t}$, $D_{c,t}$, and $P_{c,t}$ denote, respectively, real imports, aggregate demand, and relative import prices of country c in year t. As in Bussière and others (2013), the baseline specification assumes that import growth depends only on contemporaneous growth of the explanatory variables; however, the findings discussed in the chapter are robust to the inclusion of lags of the dependent and explanatory variables growth rates to allow for richer dynamics. See Annex 2.3 for the estimation results.

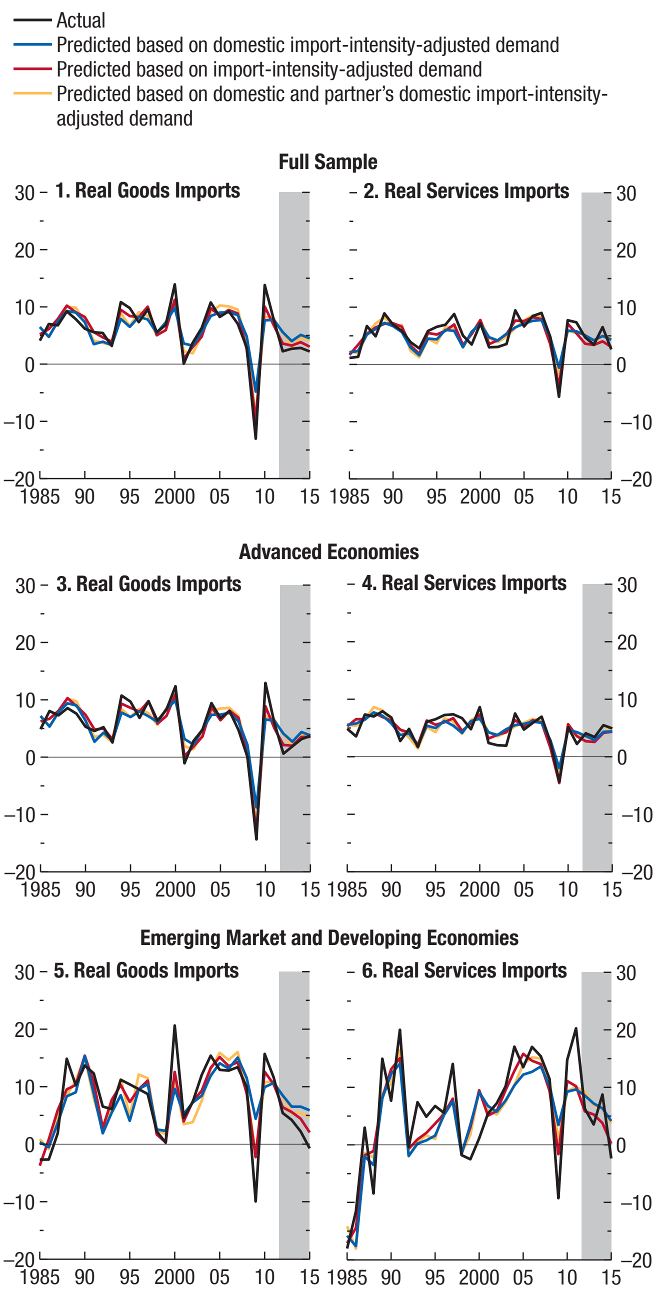
[22]Import-intensity-adjusted demand is computed as $IAD_t = C_t^{\omega_C} G_t^{\omega_G} I_t^{\omega_I} X_t^{\omega_X}$, in which ω_k is the import content of each of the expenditure components for $k \in \{C, G, I, X\}$, normalized to sum to 1. Import content is computed from the Eora Multi-Region Input-Output country-specific tables, averaged over 1990–2011. Note that if import intensity were perfectly measured in each period and the import intensity weights were allowed to vary over time, the model would be able to fully account for the level of imports (although not their growth rates). This chapter uses the 1990–2011 average import intensity, recognizing that the change in import intensity over time may be a consequence of changing trade costs and international production fragmentation, factors that are examined separately in this chapter.

[23]See Hong and others (2016), IMF (2015e), Jääskelä and Mathews (2015), Martinez-Martin (2016), and Morel (2015) for further examples of analysis of trade growth based on IAD, with substantially smaller samples of countries.

[24]These findings are robust to controlling for the role of uncertainty, global financial conditions, and financial stress in the economy when analyzing the import demand model residuals. (See Annex 2.3.)

Figure 2.5. Empirical Model: Actual and Predicted Evolution of Real Import Growth
(Percent)

Post 2012, predicted import growth is consistently above actual for trade in goods, especially in emerging market and developing economies. For services, actual and predicted import growth track each other closely.



Source: IMF staff calculations.
Note: Actual and predicted lines display the average of country real import growth rates, weighted by import shares. Predictions are based on an import demand model, estimated country by country, linking real import growth to growth in import-intensity-adjusted demand and relative import prices. See Annex 2.3.

dicted slowdown in import growth occurred in 2012. Since then, goods import growth has recovered and is close to model-predicted values on average (Figure 2.6, panel 2). For emerging market and developing economies, the missing goods import growth is larger and has become more pronounced over time (Figure 2.6, panel 3).

Overall, these results suggest that the strength of economic activity and its composition are unable to fully account for the slowdown in goods import growth beginning in 2012, especially in emerging market and developing economies.

But how large is the missing goods import growth compared with the overall decline in import growth? To answer this question, the chapter decomposes the observed slowdown in goods import growth rates prior to and following the global financial crisis. The analysis takes both a long view (1985–2007) and a short view (2003–07) of the precrisis period, comparing each of these intervals with the 2012–15 period to establish what share of the slowdown the empirical model could and could not match (Figure 2.7). It further allocates the predicted slowdown into the shares attributable to the different aggregate demand components. Two findings stand out:

- From an individual country's perspective, the unpredicted portion of the goods import growth slowdown is relatively small when compared with the overall decline in import growth. Comparing 2012–15 with 2003–07, the model, using all four aggregate demand components to predict import growth, can account for 85 percent of the slowdown for the average economy in the full sample.[25]
- The declines in investment and export growth account for the lion's share of the slowdown in trade growth, especially relative to 2003–07, when capital spending in many emerging market and developing economies, including China, was growing at an unusually brisk pace.

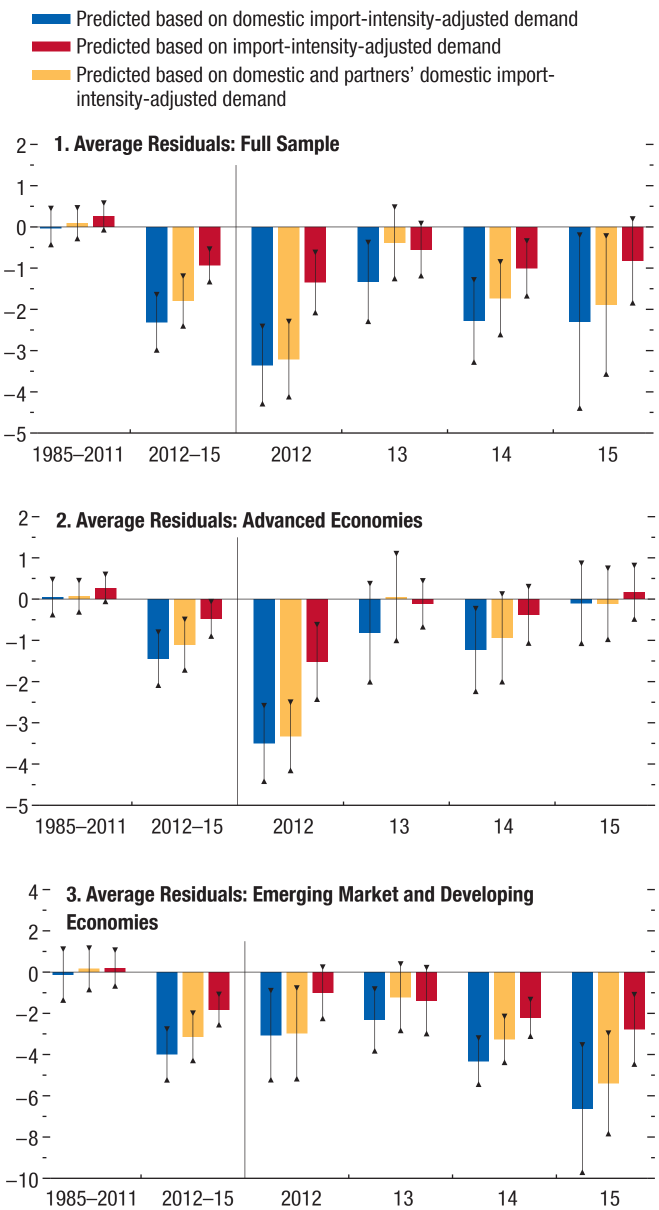
Regarding the second result, the extent to which the decline of exports underlies the slowdown of import growth in individual economies reflects two factors: (1) the tight linkages between a country's imports and exports as production processes become increasingly fragmented across borders and (2) the

[25]The unpredicted portion is larger if the change in import growth relative to 1985–2007 is considered, especially for emerging market and developing economies.

Figure 2.6. Empirical Model: Difference between Actual and Predicted Growth of Real Goods Imports

(Percent)

In advanced economies, "missing" goods import growth during 2012–15 is smaller than in emerging market and developing economies. For the former, the largest unpredicted component occurred in 2012, with real goods import growth subsequently recovering to levels predicted by the model. For the latter, missing goods import growth has instead become more pronounced over time.

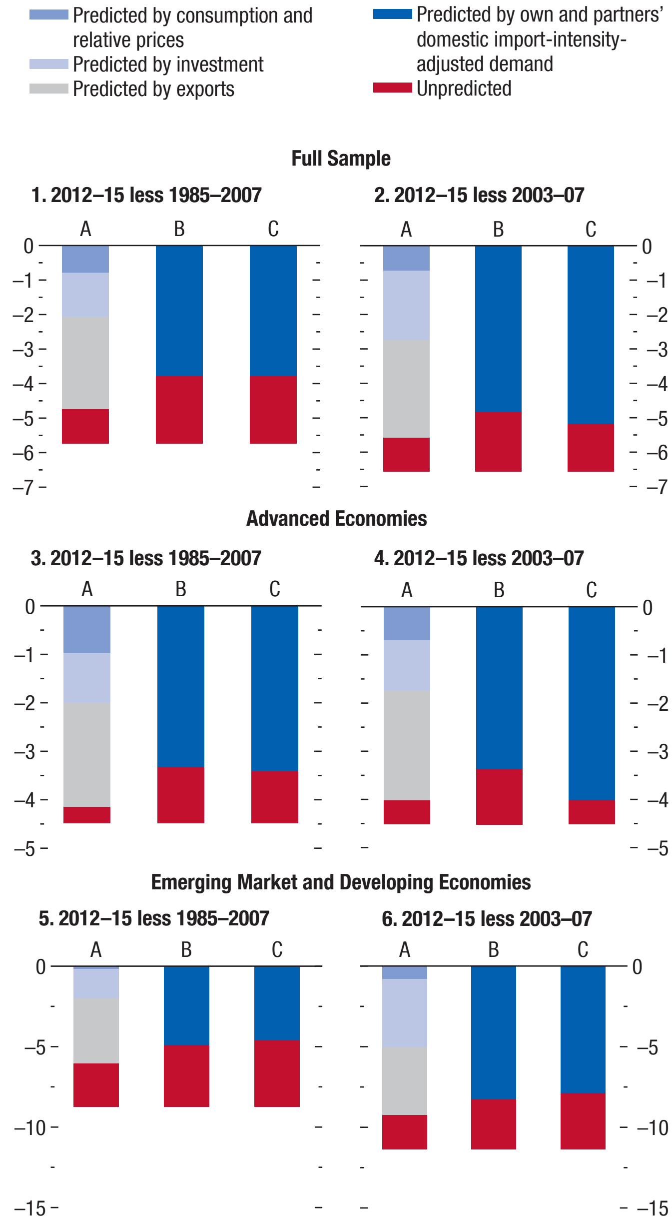


Source: IMF staff calculations.
Note: Bars display the average residuals, weighted by import shares, from an import demand model, estimated country by country, linking real import growth to growth in import-intensity-adjusted demand and relative import prices. Black markers denote the 90 percent confidence interval. See Annex 2.3.

Figure 2.7. Empirical Model: Decomposing the Slowdown in Real Goods Import Growth

(Percentage points)

The empirical model can predict a sizable fraction of the difference in average real goods import growth between 1985–2007 or 2003–07 and 2012–15. The lion's share of the slowdown in import growth can be attributed to the weakness in investment and external demand.



Source: IMF staff calculations.
Note: Bar A decomposes the difference in average real goods import growth between the two periods into portions predicted by consumption and relative prices, investment, exports, and an unpredicted residual. Bar B apportions the component predicted by exports into what can and cannot be predicted by domestic demand from trading partners, using an iterative procedure. Bar C decomposes the difference into the sum of domestic demand and external demand predicted by trading partners' domestic demand.

globally synchronized weakness in economic growth in recent years. These two factors have contributed to the widespread nature of the trade growth slowdown across countries and have amplified its magnitude.

To trace the role of domestic demand in the global trade slowdown, the analysis breaks down for each country the share of the decline in import growth accounted for by its exports into: (1) the predicted value of its trading partners' import demand, attributable to domestic demand; (2) the predicted value of its trading partners' import demand, attributable to exports; and (3) a residual portion unaccounted for by the model. Iterating in this fashion, it is possible to fully allocate the global goods import slowdown to domestic demand components and an unpredicted portion as depicted in the middle bar of each panel of Figure 2.7. This procedure reveals that, for the world as a whole, changes in economic activity can account for about three-fourths of the decline in the global goods import growth rate. The unpredicted portion of the slowdown in global goods import growth is larger than for the average economy, as impediments to trade at the individual country level are compounded in the aggregate. Using the import demand model based on domestic IAD and exports predicted by partners' domestic IAD yields a very similar pattern, as revealed in the right bar of the panels in Figure 2.7.

Ultimately, the slowdown in goods import growth during 2012–15 is not just a symptom of weak activity. About three-fourths of the global trade slowdown can be traced to the combined effect of slower overall growth, a change in the composition of economic activity away from more import-intensive components—namely, investment—and the synchronized nature of the growth slowdown across countries, which may be in part effected via trade. However, at the global level, goods import growth rates during 2012–15 have fallen short by about 1¾ percentage points on average relative to what would be expected based on the historical relationship between trade flows and economic activity. This is not a trivial amount: the level of real global goods trade would have been 8 percent higher in 2015 had it not been for this missing trade growth.

The empirical approach described above is well established in the literature, but carries two important caveats.[26] First, as previously discussed, it focuses narrowly on only one side of the relationship between economic activity and trade: the link from the former to the latter. Other factors can simultaneously affect economic activity and trade, in particular, trade policies. Not taking these into account would likely lead to an upward bias in the estimated role of economic activity in predicting trade flows. As demonstrated in Annex 2.3, this bias, however, is relatively small.[27]

Second, as a partial equilibrium analysis—the empirical model takes each country's external demand as given—it is insufficient on its own to analyze a synchronized trade slowdown across many countries. To overcome the second limitation, the chapter uses a multicountry general equilibrium structural model, which is described in the next section. The general equilibrium approach also allows for an endogenous response of the level of economic activity and output to changes in trade patterns and trade costs through their effect on intermediate and consumption goods' prices, thus addressing partially the first limitation of the empirical approach as well.[28]

The Role of Demand Composition and Trade Costs: Insights from a Structural Investigation

This section examines the slowdown in the growth of trade in goods relative to GDP growth in nominal terms by adapting the multisector, multicountry, static model of production and trade in Eaton and others (2010).[29] Since this is a general equilibrium

[26]Some recent examples of studies that recover trade wedges—that is, components of trade growth that cannot be explained by models of trade demand, based on the one-way relationship from demand and relative prices to imports—include Levchenko, Lewis, and Tesar (2010); Alessandria, Kaboski, and Midrigan (2013); and Alessandria and Choi (2016). See also Bussière and others (2013); Constantinescu, Mattoo, and Ruta (2015); Ollivaud and Schwellnus (2015); and the studies cited in footnote 23.

[27]Purging growth in aggregate demand components from the effects of policy-driven changes in trade costs before constructing IAD yields slightly larger "missing" trade growth during 2012–15. For the average economy, the share of the decline in import growth predicted by changes in economic activity—by construction orthogonal to trade policies—and relative prices is 79 percent, compared to the 85 percent using the baseline specification.

[28]As is the case with most general equilibrium models of trade, certain channels through which trade affects output, for example, the dynamic productivity gains from greater trade openness, are not captured.

[29]This model incorporates the canonical Ricardian trade model of Eaton and Kortum (2002). Eaton and others (forthcoming) extend the static model of their 2010 work to explicitly model the role of investment in a dynamic framework. However, the dynamic version of the model has a heavier data and computational requirement, making its estimation for a large number of emerging market and developing economies not feasible for this study.

model, which endogenously computes equilibrium wages and prices, the main object of interest is nominal import growth in relation to GDP growth. In this framework, countries trade to exploit their comparative advantage in goods production. However, international trade is costly: it involves transportation costs and man-made trade barriers, such as tariffs. Countries weigh these trade-related costs against the efficiency gains from trade to determine whether and how much to produce, export, and import. The model also includes a rich input-output structure allowing the output from each sector—durable, nondurable manufacturing, and commodities and a residual sector that mostly includes nontradables—to be used as an input to other sectors.

According to the model, observed trade dynamics can be attributed to changes in four specific factors, or "wedges": (1) composition of demand, (2) trade costs (or frictions), (3) productivity, and (4) trade deficits. These time-varying wedges act as shocks to preferences, cost of trade, productivity, and trade deficits, thereby influencing agents' economic decisions, including whether to trade. When the observed patterns of sectoral trade, production, and prices are analyzed through the lens of the model, the model endogenously allocates changes in actual trade flows to these four wedges so that the implied trade dynamics match those in the data exactly. The four factors are sector and country specific and are identified within the framework as follows:

- The *demand composition* wedge captures changes in the share of a sector's output in total final demand. For example, if weak investment reduces demand for durable manufactured goods disproportionately more than the demand for other goods, changes in trade flows will be attributed to this wedge.
- The *trade costs* wedge accounts for changes in preferences between domestically produced and imported goods that are not due to relative price changes. For example, if prices in all countries remain fixed, but a country consumes more domestically produced durables than imported durables, this would be attributed to rising trade costs. These trade costs may include tariffs, subsidies for domestic production, nontariff barriers, cross-border transportation costs, and so forth.[30]
- The *productivity* wedge reflects countries' comparative advantage. As a country becomes more productive in a particular sector, it exports more output from this sector to its trading partners and consumes more of this sector's output domestically.
- The *trade deficit* wedge is necessary to ensure that the model can perfectly match imports and exports for countries that run trade deficits or surpluses.

Many of the key hypotheses about the causes of the slowdown in global trade relative to GDP can be mapped to these factors. A slowdown in trade growth, which mostly reflects shifts in the composition of economic activity, will be captured in the demand composition wedge. On the other hand, if the erection of trade barriers or a slower pace of trade liberalization underpins the slowdown, the model would attribute this to a rise in the trade cost wedge. By generating counterfactual scenarios in which only one factor is allowed to change, the model can quantify the role of these wedges in the current trade slowdown in a general equilibrium setting. For example, in the scenario with only the demand composition wedge active, the model allows the demand composition to change as observed in the data but keeps trade costs, productivity, and trade deficits constant. For the purposes of this chapter, only the results of the counterfactual scenarios for the first two wedges (demand composition and trade costs) are presented.[31]

The analysis here uses annual sectoral data on production, bilateral trade, and producer prices for 2003–15 to apply the accounting procedure for 34 advanced and emerging market and developing economies (accounting for 75 percent of world trade), thus extending both the geographical and temporal coverage of Eaton and others (2010).[32] Furthermore, the chapter enriches the model's structure by explicitly modeling a commodity sector in addition to the

[30]The model does not feature any nominal rigidities or variations in the length of global value chains. This implies that observed fluctuations in trade flows due to these two factors will be imperfectly attributed to one of the four wedges. For example, the recent depreciation of stressed emerging market and developing economies' currencies appears to have boosted the trade cost wedge as trade values declined more than domestic absorption and production in U.S. dollars due to incomplete exchange rate pass-through. Similarly, changes in global value chain growth also tend to be absorbed by the trade cost wedge as exemplified by significant declines in measured trade costs for Vietnam.

[31]The trade deficit wedge played a negligible role during the recent trade slowdown. The productivity wedge exhibits some interesting dynamics, but they can be ascribed mostly to the recent supply-side-induced price changes in the commodity sector.

[32]The very large data requirement precludes the application of the procedure over a longer historical period for a large number of economies. See Annex 2.4 for a description of the data and parameters used in this exercise.

three sectors included in the original setup. This is an essential addition in light of recent price shifts in this sector, which affect the ratio of trade growth to GDP growth.[33] However, the model does not separate investment from consumption, and the findings on the role of demand composition should be interpreted in light of this limitation.

Comparing the results from the two counterfactual scenarios with the actual data on the gross growth of nominal imports-to-GDP ratio for 2003–15 (Figure 2.8, panels 1, 3, and 5) yields the following insights:

- During 2003–07, nominal goods trade grew faster relative to GDP because of both shifts in the composition of demand and reduced trade costs. In advanced economies, these two factors were about equal in importance; in emerging market and developing economies, falling trade costs took a leading role, particularly for China, which is consistent with its accession to the World Trade Organization in 2001.
- The 2012–15 slowdown in the growth of the nominal goods import-to-GDP ratio was characterized by a shift in demand toward nontradables and by a shift within tradables toward nondurable manufactured goods. For the world, the expenditure shares of all three tradable sectors declined; the share of commodities fell more than others given that sector's price declines. The further decline in 2015 in the ratio of nominal import growth to GDP growth was mostly due to the decline in commodity prices.
- The model attributes that largely to wedges in the commodity sector. However, other wedges played a role, too, with their relative contribution varying across countries. For example, China stands out in terms of a rise in trade costs. Although it is difficult to pinpoint the driver of this finding, it may be indicative of the flattening of global value chains. Brazil experienced a significant decline in the share of durable manufacturing goods in its expenditures, which depressed the growth of imports.

Comparing results of the alternative scenarios for 2003–07 with those for 2012–15 reveals that changes in demand composition alone accounted for almost 60 percent of the slowdown in world trade growth relative to GDP growth (Figure 2.8, panels 2, 4, and 6). In addition, the shift in the composition of demand has been more important in advanced economies than in emerging market and developing economies. For the world, trade costs also played a nonnegligible role: the model attributes close to 25 percent of the slowdown in the growth of nominal imports-to-GDP ratio to changes in this factor. Reductions in trade costs boosted trade in 2003–07, while their pace of decline fell considerably in 2012–15. When combined—that is, when changes in the composition of demand and in trade costs are allowed to shape trade flows simultaneously—the model can account for close to 80 percent of the slowdown.[34]

Despite their significant differences, the two analytical approaches deliver a consistent message. The global slowdown in trade reflects to a significant extent, but not entirely, the weakness of the overall economic environment and compositional shifts in aggregate demand. According to both methodologies, demand composition shifts have played a larger role in the slowdown in advanced economies' trade, relative to that in emerging market and developing economies. And, finally, both the structural model and the reduced-form approach suggest a role for other factors, including trade costs, in the observed slowdown in trade.

The Role of Trade Costs and Global Value Chains: Insights from Disaggregated Trade Data

Motivated by the findings of the first two analytical exercises of the chapter, this section examines the role of trade costs and changes in global production processes in the recent trade slowdown. Since many trade policies—for example, tariffs and nontariff barriers—are set at the product level, and global value chain participation varies significantly across sectors within the same economy, properly disentangling their role requires the use of disaggregated data.[35] To do so, this section follows a three-step approach.

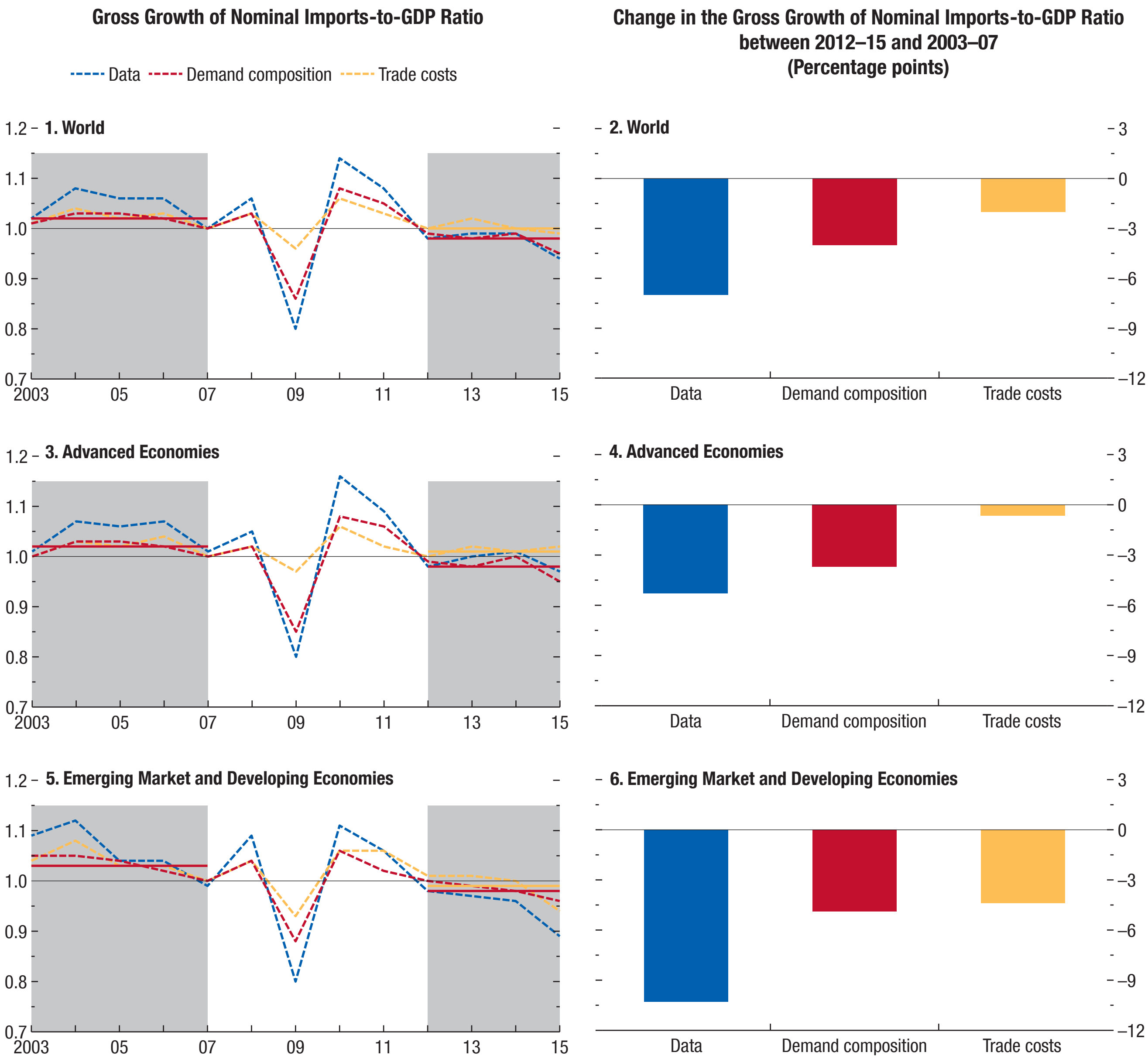
[33]In this Ricardian model of trade, trade in commodities occurs as a result of differences in the efficiency of production. This can be mapped to the real world—for example, oil importers have reservoirs deep underground and extraction is more inefficient than for oil exporters.

[34]Adding up the results under four counterfactual scenarios, each featuring a different wedge, does not necessarily yield the scenario containing all wedges at the same time. The wedges can amplify or dampen each other when they are present simultaneously, so that the sum of the fraction of the data they can account for individually can be greater or less than one.

[35]Analysis performed at the aggregate (country) level may fail to uncover the association between these factors and trade growth since it cannot account for a large part of the variation in the data (across products and sectors).

Figure 2.8. Structural Model: Actual and Model-Implied Evolution of Nominal Import-to-GDP Ratio

During 2003–07, nominal imports grew faster than GDP due to both shifts in the composition of demand and reductions in trade costs. During the slowdown period of 2012–15, however, changes in demand composition played a more prominent role relative to trade costs, particularly in advanced economies.



Source: IMF staff calculations.
Note: Actual and simulated lines in panels 1, 3, and 5 display the ratio of gross growth of nominal goods imports to gross growth of nominal world GDP, $(M_t/M_{t-1})/(Y_t/Y_{t-1})$, and their period averages (solid lines). A value of 1 indicates that nominal imports and GDP grow at the same rate. The simulated effect of demand composition and trade costs are obtained through counterfactual exercises in which only the corresponding wedge is allowed to operate, holding all other factors affecting production and trade constant. A decline in trade costs corresponds to an increase in the depicted trade wedge as it boosts model-implied trade values. Bars in panels 2, 4, and 6 display the difference in the average growth of the imports-to-GDP ratio described above between 2003–07 and 2012–15 implied by: (1) the data; (2) the model with the demand composition wedge only; and (3) the model with the trade cost wedge only, that is, the differences in the period averages depicted in panels 1, 3, and 5. See Annex 2.4 for further details of country coverage, data sources, and methodology.

First, it presents comprehensive evidence on how trade costs and production chains have evolved over time. Second, it analyzes disaggregated trade flows and measures of trade costs and global value chain participation at the country-product level to estimate the elasticity of real import growth with respect to these factors. Third, the analysis combines the first two steps to obtain an estimate of how much each potential factor can account for in the slowdown in trade growth during 2012–15. It should be emphasized that this analysis does not attempt to identify causation, only association; the ultimate goal is to uncover how much of the import growth decline can be predicted by the behavior of the various correlates.

The Evolution of Trade Costs and Global Value Chains

Overall Trade Costs

The term "trade costs" typically encompasses a broad range of factors that drive a wedge between the producer price of the exporter and the consumer prices in the importing country. Factors can include measurable components, such as transportation costs and tariffs, availability and cost of trade credit, and other harder-to-quantify elements, such as language barriers, regulations, and other informational asymmetries.[36]

To get a bird's eye view of how trade costs in the broadest sense have evolved, the analysis infers them from the patterns of observed bilateral trade, production, and absorption across countries, following Head and Ries (2001) and Novy (2012). Intuitively, if bilateral trade flows increase relative to domestic trade flows (proxied by gross sectoral output less total exports), the methodology concludes that it must have become easier for the two countries to trade with each other, and therefore trade costs must have fallen.[37]

Global average manufacturing trade costs vis-à-vis the world's 10 largest importers declined significantly during 1990–2008, spiked with the retrenchment in international trade during the global financial crisis, and flattened thereafter (Figure 2.9, panel 1).[38] The same pattern can be observed across economies and across sectors (Figure 2.9, panel 2). While more dispersed, the decline in trade costs was substantially larger for emerging market and developing economies—which face significantly higher trade costs—than for advanced economies over this period (Figure 2.9, panels 3 and 4). What halted the decline of trade costs? The following subsections examine the role of some specific influences on trade costs: tariffs, nontariff barriers, free trade agreements, and transportation and logistics.[39]

Tariffs

Import tariffs are the most easily observable and measurable form of trade cost. Trade negotiation and unilateral trade liberalization lowered the import-weighted average tariff rates for all economies by almost 1 percentage point a year between 1986 and the conclusion of the Uruguay Round in 1995, with a significant narrowing in the dispersion of tariffs across countries and products (Figure 2.10, panels 1 and 2). Subsequently, tariff reductions continued, albeit at a more moderate rate of ½ percentage point a year until 2008. In the absence of tariff agreements since then, tariff declines have been minimal.[40]

Nontariff Barriers

Nontariff barriers are arguably the most difficult to measure. As the name suggests, they cover any nontariff measure that restricts trade flows, such as quotas, bailouts, state aid, and trade defense measures, as well as mandated preferences for local over foreign products.

Two complementary sources of data, the Centre for Economic Policy Research Global Trade Alert initiative and the World Bank Temporary Trade Barriers data-

[36]Trade costs can be fixed (for example, institutional and behind-the-border barriers, which force a firm to pay a fixed cost to access a new market) or variable (such as transportation costs, import tariffs, costs linked to trade logistics, and facilitation services). See Annex 2.5 for details on the construction of the index of trade costs and Arvis and others (2013) for a discussion of trade costs in the developing world.

[37]Trade costs calculated this way are conceptually the same as the trade cost wedges recovered from the general equilibrium model previously described.

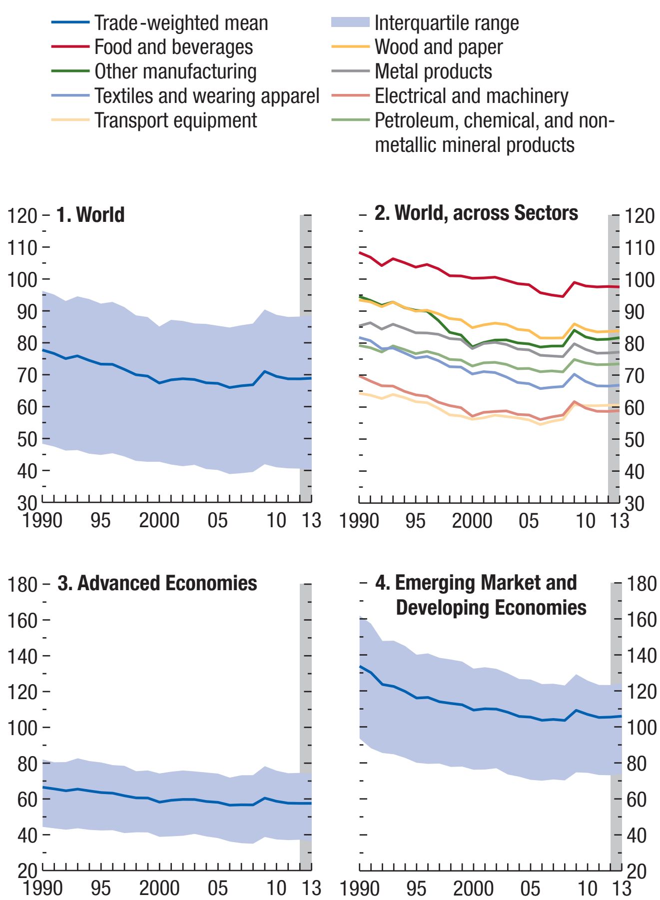
[38]The 10 largest importers include Canada, China, France, Germany, Italy, Japan, Korea, Mexico, the United Kingdom, and the United States.

[39]The availability and cost of trade finance are also an important part of trade costs faced by businesses, and could limit trade growth, as witnessed during the great trade collapse (Chor and Manova 2012). However, anecdotal evidence on the availability of trade finance suggests that it is unlikely to play a major role in the current trade slowdown (International Chamber of Commerce 2015). Annex 2.5 presents some survey data on trends in the availability of trade credit lines offered by banks.

[40]It is important to note that the continuous decline in average tariffs occurred even though the sample of countries grew significantly over time and included increasing numbers of developing economies, which tend to have higher import tariffs.

Figure 2.9. Trade Costs in Historical Perspective: A Top-Down Approach
(Percent)

Trade costs fell somewhat consistently up until the global financial crisis but have since flattened. The same pattern can be observed across advanced and emerging market and developing economies and globally across sectors.



Sources: Eora Multi-Region Input-Output database; and IMF staff calculations.
Note: The index follows the Head and Ries (2001) and Novy (2012) methodology to understand how trade costs in a broad sense have evolved over time. These costs are inferred from the patterns of observed bilateral trade, production, and absorption across countries. See Annex 2.5 for a detailed description of country coverage, data sources, and methodology.

base, show a steady increase in protectionist measures (Figure 2.10, panels 3 and 4).[41] The stock of three specific temporary trade barriers (antidumping, countervailing duties, and safeguards) suggests that while temporary barriers affect only a small share of products (2½ percent in 2015), the share of products affected by them has grown since 1990, with a significant uptick in 2014 and 2015. The Global Trade Alert, currently the most comprehensive database for all types of trade-related measures imposed since the global financial crisis, also shows a steady increase in protectionist measures since 2012, with 2015 recording the largest number of harmful trade measures. While the limited time coverage of the Global Trade Alert precludes a more rigorous analysis, there is clear evidence that the real import growth of products subject to trade discriminatory measures experienced a deeper decline in 2012–15 relative to 2003–07 (Figure 2.10, panel 5).

An additional indication of the extent to which trade issues have become a concern for businesses can be gleaned from firms' lobbying activity (Ludema, Mayda, and Mishra 2015).[42] According to U.S. firms' mandatory lobbying disclosure reports, there has been a steady increase in lobbying on trade issues since 2009 (Figure 2.10, panel 6). These trends may be part of the reason for the halt in the decline of overall trade costs.[43]

Free Trade Agreements

Free trade agreements can also reduce trade costs, not only by curtailing tariff and nontariff barriers but also by including provisions on various other issues that may impede trade in goods and services, such as, for example, regulatory cooperation. The proliferation of free trade agreements was particularly strong in the 1990s, averaging nearly 30 signed agreements a year according to the Design of Trade Agreements database. In the run-up to the global financial crisis, the number dropped slightly (to 26) but, since 2011, the rate has fallen sharply to about 10 agreements signed a year (Figure 2.10, panel 7).

However, compared with earlier pacts, recent agreements are deeper—they cover a much broader spectrum of measures than tariffs alone. And unlike earlier arrangements, they include more trading partners—

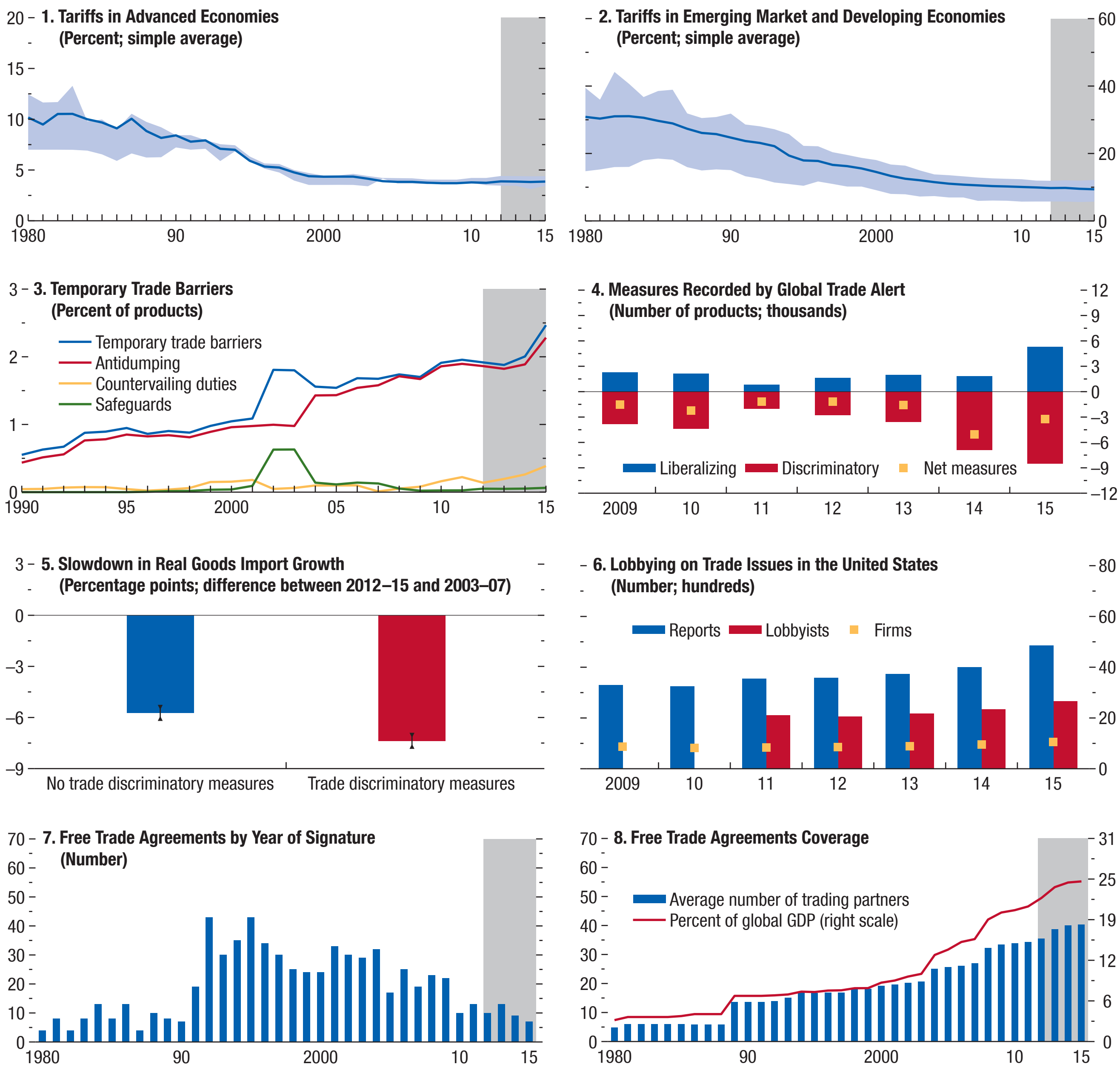
[41]We thank Chad Bown, Simon Evenett, and Johannes Fritz for generously sharing their databases on nontariff barriers. The Global Trade Alert database has the most comprehensive coverage of all types of trade-discriminatory and trade-liberalizing measures, although it only begins in 2008 (Evenett and Fritz 2015). The World Bank data generally cover a longer period but only for national governments' use of three specific policies: antidumping, countervailing duties, and safeguard measures (Bown 2016).

[42]We thank Prachi Mishra for updating and sharing her database on firms' lobbying activity.

[43]Henn and McDonald (2014) find that the trade-restrictive measures captured in the Global Trade Alert database as of 2010 had a sizable adverse effect on product-level trade flows during 2008–10, although their aggregate impact was muted by their limited adoption during the sample period.

Figure 2.10. Trade Policies in Historical Perspective

The pace of tariff reduction and the coverage of free trade agreements has slowed. There are signs that protectionism is on the rise.



Sources: Bown 2016; Design of Trade Agreements database; Evenett and Fritz 2016; Global Trade Alert database; Ludema, Mayda, and Mishra 2015; United Nations Conference on Trade and Development Trade Analysis and Information System; World Bank Temporary Trade Barriers database; World Trade Organization (WTO) Tariff Download Facility; WTO Regional Trade Agreements database; and IMF staff calculations.
Note: Blue shaded areas in panels 1 and 2 denote the interquartile ranges. See Annex 2.5 for a detailed description of country coverage, data sources, and methodology of each indicator.

for example, the recently concluded megaregional Trans-Pacific Partnership, the Regional Comprehensive Economic Partnership, and the Transatlantic Trade and Investment Partnership, which are still being negotiated. Such arrangements encompass large groups of countries with a major share of world trade and foreign direct investment. Such deeper and larger agreements tend to have a bigger impact on trade growth.[44]

To calculate the coverage of these agreements, the analysis measures the average number of trading partners with which a representative country is in a free trade agreement and the average share of world GDP of those trading partners. On that measure, free trade agreements' coverage continues to increase, albeit at a slightly slower rate more recently (Figure 2.10, panel 8).

Transportation and Logistical Costs of Trade

International transportation costs and costs associated with domestic transportation and border and documentary compliance have been shown to hurt trade flows (Hummels 2007a; Djankov, Freund, and Pham 2010). However, according to most available measures, such costs have been continuously declining since 2006. Both the monetary cost in connection with the logistics of trade, such as documentary compliance fees and movement of goods to ports and borders, and the time involved in this process have significantly fallen in emerging market and developing economies since 2006 (Figure 2.11, panels 1 and 2). These costs have remained flat in advanced economies at their already low levels. Countries are also increasingly connected to global shipping networks, as reflected in such measures as the size of their maritime fleets, container-carrying capacity, and so forth (Figure 2.11, panel 3). An exception to this pattern is air freight costs, which rose more or less steadily between 2002 and 2012, but have since fallen during the trade slowdown on the back of lower oil prices. The decline in oil prices since 2014 has likely lowered the cost of other modes of transport as well. The time pattern of international transportation and logistical costs of trade suggests that they probably did not contribute to the decline in the growth rate of global trade.

Global Value Chains

In addition to trade costs, some have argued that the dispersion of production across countries in the 1990s and early 2000s, which resulted from the creation or extension of global value chains and boosted gross trade flows, may have run its course.[45] The claim is hard to assess, however. Information on the degree of production sharing is typically available only with a significant time lag.[46] And the cause of any detected slowdown in global value chains would be hard to assign: it could stem from deceleration in the decline in trade costs, higher obstacles to cross-border investment, or inherent maturation.[47]

A standard measure of participation in global value chains calculates the sum of: (1) the domestic content in a country's exports that is reused in the exports of its trading partners and (2) its exports' foreign value added as a share of gross exports (see, for example, Koopman, Wang, and Wei (2014) for a discussion of vertical specialization measurement). On this measure, there is wide variation in participation in global value chains across countries, with many emerging market and developing economies yet to fully integrate into global production processes (IMF 2015a, 2015d). Participation rose steadily across both advanced and emerging market and developing economies until the global financial crisis (Figure 2.12, panels 1, 2, and 3). A notable exception is China, where participation peaked during the second half of the 2000s (Figure 2.12, panel 4). However,

[44]For more recent evidence on the trade-creation effect of trade agreements, see, for example, Carrère (2006); Baier and Bergstrand (2007, 2009); and Cipollina and Salvatici (2010) for a meta-analysis. Osnago, Rocha, and Ruta (forthcoming) demonstrate that deeper trade agreements also contribute to greater vertical foreign direct investment between countries, potentially fostering firms' integration into global value chains. More recently, Conconi and others (2016) find evidence that preferential rules of origin embodied in free trade agreements can instead increase the level of protectionism faced by nonmember countries.

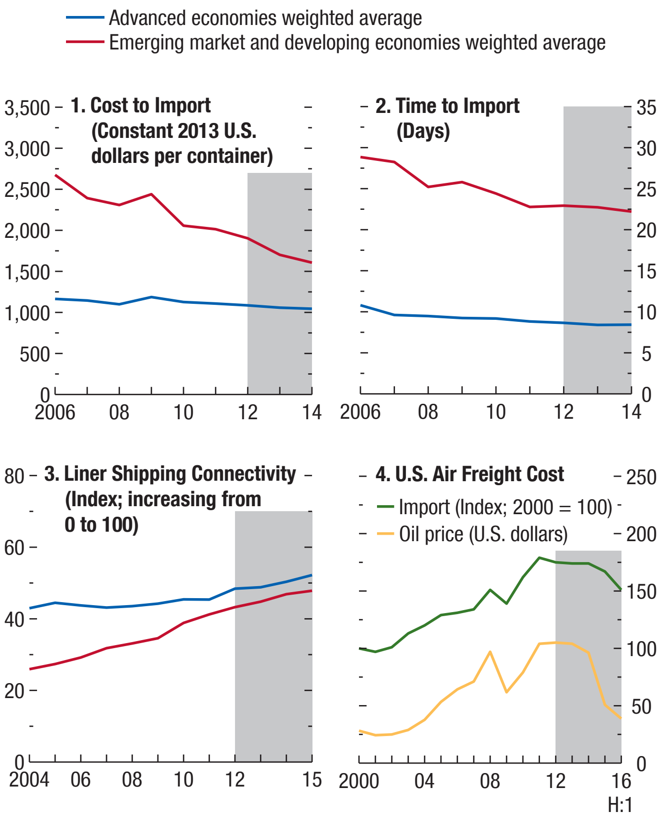
[45]See, for example, Constantinescu, Mattoo, and Ruta (2015); Crozet, Emlinger, and Jean (2015); and Gangnes, Ma, and Van Assche (2015).

[46]The timeliest source at publication is the Eora Multi-Region Input-Output set of global input-output matrices, which covers 26 sectors for 173 countries in the IMF World Economic Outlook database sample for 1990–2013. See Lenzen and others (2013) for a detailed description of the database.

[47]An example of maturation would be a rise in productivity and skilled labor in China, which could cause companies to bring back some production that previously took place abroad. Trade barriers, on the other hand, can lead to a similar outcome, as the costs associated with goods that must cross borders many times as part of the supply chain could become prohibitive. Yi (2003, 2010) and Koopman, Wang, and Wei (2014) discuss the magnifying impact of trade costs in multistage production, while Evenett and Fritz (2016) summarize the evidence on the proliferation of trade-diverting localization requirements, which can also restrict the development of cross-border production.

Figure 2.11. Logistics and Transportation Costs of Trade in Historical Perspective

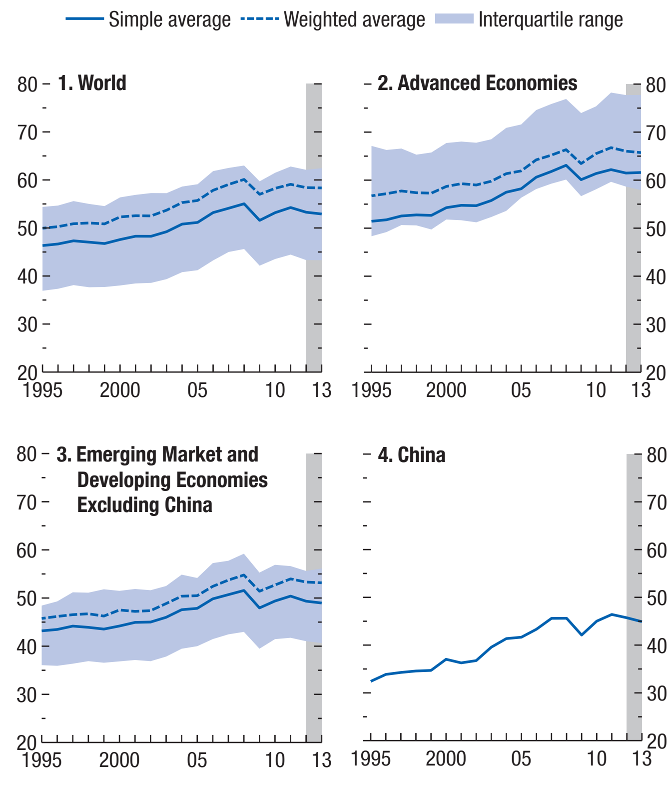
Monetary and time costs associated with domestic transport and border and documentary compliance for importing goods have been continuously declining, particularly in emerging market and developing economies. Countries are increasingly more connected to global shipping networks. Air freight costs have also fallen during the trade slowdown period amid lower oil prices.



Sources: United Nations Conference on Trade and Development (UNCTAD); U.S. Bureau of Labor Statistics; World Bank, *Doing Business Indicators*; and IMF staff calculations.
Note: The cost and time indicators measure the cost (excluding tariffs) and time associated with three sets of procedures—documentary compliance, border compliance, and domestic transport—within the overall process of importing a shipment of goods across a balanced sample of 161 economies. The UNCTAD Liner Shipping Connectivity Index captures how well countries are connected to global shipping networks based on five components of the maritime transport sector: number of ships, their container-carrying capacity, maximum vessel size, number of services, and number of companies that deploy container ships in a country's ports.

Figure 2.12. Global Value Chains in Historical Perspective
(Percent)

Global value chain participation rose in both advanced and emerging market and developing economies until the global financial crisis. Since 2011, participation appears to have plateaued across both country aggregates.



Sources: Eora Multi-Region Input-Output database; and IMF staff calculations.
Note: Global value chain participation denotes the sum of the domestic content in a country's exports—which is reused in the exports of its trading partners—and the foreign value added of its exports as a share of gross exports. See Annex 2.5 for a detailed description of country coverage, data sources, and methodology of each indicator.

since 2011, participation seems to have leveled off across all country aggregates.

The Role of These Other Factors: Insights from Product-Level Data

To explore the historical association of trade costs and global value chains with trade growth, this section draws on the novel data set described earlier in the chapter for real import flows of 700 products.[48] The analysis estimates the elasticity of import volumes of noncommodity products with respect to four of the factors discussed above—tariffs, free trade agreement coverage (as a share of world GDP), temporary trade barriers, and global value chain participation, con-

[48]These volume series were computed for imports starting in 2003 for 52 countries, which, as of 2015, accounted for more than 90 percent of both world imports and GDP. The data set is for products at the four-digit level under Revision 2 of the Standard Industrial Trade Classification. The nominal value of imports of these products was adjusted with import price deflators constructed at the Harmonized System two-digit level, with the same deflator applied to all Standard Industrial Trade Classification four-digit products that map to a particular Harmonized System two-digit code.

trolling for sectoral domestic demand, relative prices of imported goods, and country-product and time fixed effects (see Annex 2.5 for details on estimation, specification, and robustness). Given the steady decline in the logistical costs of trade since 2006 and the limited availability of time-series data on these costs, the chapter does not investigate their role in the trade slowdown.

The estimated elasticities of import growth with respect to the various measures of trade costs are outlined in Table 2.1. The estimates are highly statistically significant and of the expected sign.[49] The greater incidence of trade barriers is associated with lower import volume growth, although the estimated elasticity of imports to tariffs is smaller than estimates from other studies. Likewise, expanding the set of trading partners with which a country is in a free trade agreement is associated with higher growth of import volumes.

Higher participation in global value chains is also associated with higher growth of import volumes: a 10 percentage point increase in participation is associated with a 1 percentage point increase in import growth (Table 2.1, column 5). As noted, whether such participation is also capturing additional policy effects is difficult to know; therefore, this estimate likely represents an upper bound.

As a cross-check of the disaggregated product level analysis, the chapter examines the relationship between the country-specific residuals discussed earlier (the difference between the actual and model-predicted growth of aggregate real imports) and the same four factors. The point estimates are similar to those from the product-level regressions, but not as precisely estimated due to the more aggregated nature of the data (Table 2.1, column 8). Overall, these results suggest that the imposition of trade-distorting policy measures hurts trade growth. At the same time, slower growth in the coverage of free trade agreements and a slower pace of global value chain participation are associated with lower import growth.

Combining the estimated elasticities of import growth with the differences in the growth rate of the different factors between 2012–15 and 2003–07 allows for an estimation of their relative contribution. This exercise reveals that a sizable share of the trade slowdown not accounted for by weak economic activity and its composition is attributable to changes in trade policy and to the slowing expansion of global value chains (Figure 2.13 and Annex 2.5).

The Connection between Trade and Global Value Chains: Insights from the Gravity Model

The final piece of analysis uses a gravity model of trade at the sectoral level to highlight the role of global value chains during the slowdown. The gravity model is widely used to explain the level of bilateral trade flows on the basis of individual characteristics of each country and the characteristics of the country pair that capture trading costs, such as distance between the countries or whether they share a common border, language, or currency.

Estimated at the sectoral level, the gravity model has two advantages that make it an especially useful tool to isolate the importance of global value chain participation in trade growth: (1) it controls for compositional changes in trade flows across sectors and partners (unlike the aggregate import demand analysis reported earlier in the chapter), and (2) it exploits the heterogeneity in the degree of production linkages across trading partners (unlike the product-level analysis reported earlier).

The analysis is performed in three stages (see also Annex 2.6). The first stage involves estimating a gravity model at the sectoral level to provide a benchmark for bilateral-sectoral trade. The model is estimated separately for each year between 2003 and 2014 and for each of the 10 traded sectors in the Eora Multi-Region Input-Output database. In addition to the standard gravity variables, the estimated specification controls for importer and exporter fixed effects.[50] These fixed effects control for all sectoral source and destination characteristics, such as sectoral demand and supply,

[49]The literature provides a very wide range of estimates for the elasticity of trade with respect to trade policy. Studies based on cross-sectional data, typically thought of as capturing the long-term elasticity, tend to find much higher elasticities. Studies based on time-series variation, capturing the short-term effects of changing trade costs, yield much lower estimates for the trade elasticity. The approach used here is in the spirit of the latter strand of literature. See Hillberry and Hummels (2013) and Goldberg and Pavcnik (2016) for a review of the literature.

[50]See Feenstra, Markusen, and Rose (2001) or Feyrer (2009b) for other examples of gravity models estimated separately for different years and sectors. The results from the gravity estimations (available from the authors upon request) are strictly in line with those of the literature. The coefficients on the bilateral measures of trade costs (such as distance, common language, common borders) have the correct signs and are highly significant and stable across time. Such stability indicates that bilateral trade flows have not become more sensitive to bilateral trade costs.

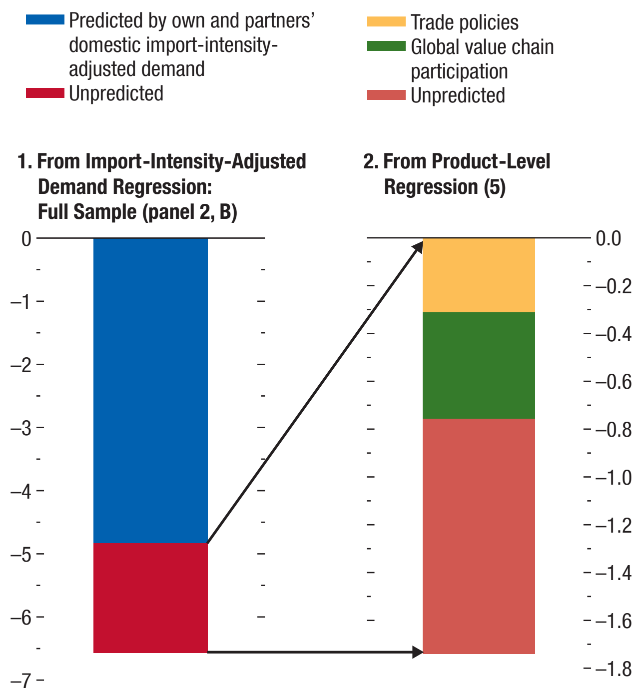
Table 2.1 Historical Association among Real Import Growth at the Product Level, Trade Policies, and Participation in Global Value Chains

	A. Product and Country							B. Country
Sample Period	2003–15	2003–15	2003–15	2003–13	2003–13	1990–2013	2003–13	Import-Intensity-Adjusted Demand Residual
Dependent Variable: Import Growth	Real					Nominal		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Growth of:								
Temporary Trade Barriers	–0.024***				–0.031***	–0.028***	–0.029***	–0.253
	(0.008)				(0.009)	(0.006)	(0.007)	(0.196)
Tariffs		–0.008			–0.016**	–0.021***	–0.034***	–0.015
		(0.007)			(0.008)	(0.005)	(0.007)	(0.018)
Free Trade Agreement Coverage			0.119**		0.106**	0.139***	0.205***	0.227***
			(0.048)		(0.054)	(0.040)	(0.055)	(0.056)
Global Value Chain Participation				0.066*	0.095**	0.192***	0.170***	0.083*
				(0.038)	(0.041)	(0.029)	(0.041)	(0.043)
Country x Product Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	...
Country Fixed Effects	...	...	...	...	...	...	...	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.264	0.266	0.265	0.295	0.293	0.324	0.407	0.504
Adjusted R^2	0.193	0.190	0.192	0.212	0.208	0.281	0.338	0.449
Number of Observations	316,840	341,553	371,622	315,636	258,196	472,178	270,587	464

Source: IMF staff calculations.
Note: Global value chain participation is a measure of backward participation: foreign value added in exports as share of gross exports. In the product-country level regressions, this variable is calculated at the sectoral level. Standard errors are clustered at the product-country level for regressions A and at the country level in regression B. Columns (1)–(7) control for growth in sectoral demand and growth in relative prices.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Figure 2.13. Contribution of Trade Policies and Global Value Chains to the Slowdown in Real Goods Import Growth
(Percent)

The decline in global value chain participation and changes in trade policy are weighing on trade growth, although their quantitative contribution is limited.



Source: IMF staff calculations.
Note: The figure combines the estimated historical association between real import growth and growth in trade costs and global value chain participation, and the differences in the growth rate of these factors between 2003–07 and 2012–15 to compute their contribution to the observed trade slowdown. See Annex 2.5 for a detailed description of country coverage, data sources, and methodology.

and all country sectoral time-varying characteristics, such as prices and trade costs, that do not vary across trading partners in a particular year. The fixed effects also control for the so-called multilateral resistance term (Anderson 2011)—the barriers to trade that each economy faces with respect to all its trading partners. In the second stage, the residuals obtained from the gravity estimation are collected and differenced when in levels to obtain the growth of bilateral sectoral trade that is unexplained by the gravity model. The third step examines whether the degree of production linkages between the two countries in this particular sector—measured as the share of foreign value-added component in bilateral-sectoral gross exports—is associated with trade growth between the two countries in this sector, after controlling for all standard determinants of trade growth.[51] The findings of the gravity model analysis suggest that greater production linkages between countries are indeed positively associated with growth of trade between them, corroborating the product-level analysis presented earlier.

Indeed, during 2003–07, country-pair trade in sectors that were in the top quartile of global value chain participation grew on average 1¼ percentage points faster than the rest (Figure 2.14). During 2012–14, however, trade in these country-pair sectors was not significantly different from trade in the rest. This further supports the hypothesis that higher-value-chain participation significantly boosted trade growth in the period leading up to the global financial crisis. However, since 2012, there is little evidence of such a boost.

Summary and Policy Implications

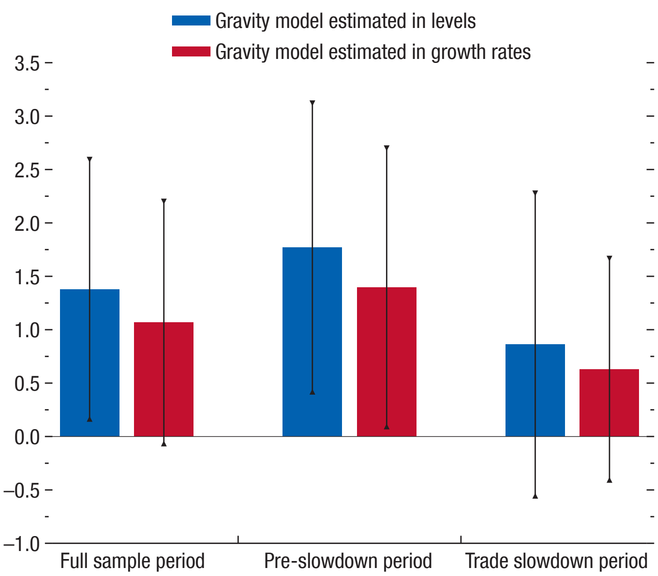
The analysis in this chapter suggests that the slowdown in trade growth since 2012 is to a significant extent, but not entirely, consistent with the overall weakness in economic activity. Weak global growth, particularly weak investment growth, can account for a significant part of the sluggish trade growth, both in absolute terms and relative to GDP. Empirical analysis suggests that, for the world as a whole, up to three-fourths of the decline in trade growth since 2012 relative to 2003–07 can be predicted by weaker economic activity, most notably subdued investment growth. While the empirical estimate may overstate the role of output, given the feedback effects of trade policy and trade on growth, a general equilibrium framework suggests that changes in the composition of demand account for about 60 percent of the slowdown in the growth rate of nominal imports relative to GDP.

However, factors beyond the level and composition of demand are also weighing on trade growth, shaving up to 1¾ percentage points off global real import growth during 2012–15. Among those, trade policies and global value chain participation account for a sizable share of the unpredicted shortfall in annual global trade growth since 2012. The pace of new trade policy initiatives at the global level has slowed notably. At the same time, the uptick in protectionism since the global financial crisis is not innocuous. While the quantitative contribution of trade policies to the slowdown in trade growth has been

[51]Rose (2002) takes a similar approach in analyzing estimated residuals from gravity models.

Figure 2.14. Gravity Model: Global Value Chain Participation and Bilateral Sectoral Trade Growth
(Percentage points)

A high degree of production linkages through global value chains between countries in a particular sector was positively associated with trade growth between them in that sector in the period prior to the global financial crisis. However, there is little evidence that high participation in global value chains has provided a boost to trade growth after 2012.



Source: IMF staff calculations.
Note: Bars depict the average difference in bilateral sectoral trade growth residuals between country-sector pairs in the top quartile in terms of global value chain integration and the rest in 2003–13, 2003–07, and 2012–13. The vertical lines are the 90 percentile confidence intervals. Residuals are obtained from gravity models of trade estimated separately for each sector and year, controlling for all standard gravity variables, as well as importer and exporter fixed effects. See Annex 2.6 for a detailed description of country coverage, data sources, and methodology.

limited so far, protectionist measures could significantly weigh on global trade if they become more widespread. The apparent decline in the growth of production fragmentation across countries is also putting the brakes on trade growth, although it is still difficult to judge whether this is a natural maturation of existing global value chains or the result of policy-induced distortions. The general equilibrium framework also suggests that a slower reduction in trade costs, broadly defined, can account for about one-quarter of the decline in the growth rate of nominal imports relative to GDP.

What does this mean for the outlook for global trade? As the findings of the chapter suggest, trade growth and economic growth are closely linked. Current projections anticipate only a limited pickup in global activity and weak investment growth over the medium term due to both cyclical and structural factors (see Chapter 1 of this WEO), so slow global trade growth will most likely persist. Moreover, even as global growth eventually gathers speed, trade growth is unlikely to achieve the rates seen prior to the global financial crisis when investment growth in many emerging market and developing economies, including China, was unusually high, trade costs were falling due to policy cooperation and technological advances, and global value chains were rapidly developing.[52]

What can be done so that trade can play its role in helping promote productivity and growth in the context of slow and fragile global activity? First, this chapter's findings suggest that much of the trade slowdown appears to be a symptom of the many forces that are holding back growth across countries, possibly including the slower pace of reduction in trade costs and slow trade growth itself as discussed in the section titled "The Slowdown in Trade Growth: Key Patterns" and Box 2.1. Addressing these constraints to growth, and in particular investment, should lie at the heart of the policy response for improving the health of the global economy, which would strengthen trade as a by-product. As discussed in Chapter 1 and Chapter 3 of the April 2016 WEO, a combination of near-term demand support, balance sheet repair to relieve financial constraints where needed, and productivity-enhancing structural reforms, including further progress in trade integration, could help boost global growth and strengthen investment. These policies, by lifting trade growth indirectly, can reinforce each country's economic expansions given trade's role in transmitting economic activity and raising productivity and economic growth.

Second, this chapter's findings also suggest that trade policies, which shape the costs of the international exchange of goods and services, are still relevant. With other factors, notably weak investment, already weighing on trade, resisting all forms of protectionism and reviving the process of trade liberalization to dismantle remaining trade barriers would provide much-needed support for trade growth, including through possibly kicking off a new round of global value chain development. As elaborated in Box 2.2, there is substantial scope to further reduce trade costs through cutting tariffs where they remain elevated, ratifying and fully implementing com-

[52]There are reasons for trade growth optimism as well: many emerging market and developing economies have substantial scope to increase trade flows by integrating into global value chains and reducing still-high trade barriers. For a discussion, see IMF (2015a, 2015d).

mitments made under the Trade Facilitation Agreement, and establishing a way forward in the post-Doha trade agenda. Future trade reforms would need to focus on the areas most relevant to the contemporary global economy, such as regulatory cooperation, reducing barriers to trade in services, and leveraging complementarities between investment and trade (see IMF 2016b).

Such initiatives could help strengthen global economic growth and raise overall living standards over time. As discussed in Box 2.3, an illustrative scenario in which existing tariffs are completely eliminated and the Trade Facilitation Agreement is fully implemented could improve welfare. Various trade models deliver an array of possible outcomes (see Costinot and Rodriguez-Clare 2014), but gains in real incomes from lower trade costs could range from less than 1 percent to more than 6 percent in the long term for the average country.[53] Given the relatively low levels of tariffs for many advanced economies, advancing trade reform in services and other "frontier" areas would likely yield even larger aggregate gains.

But to sustain popular support for trade integration and preserve its economic and welfare benefits, policymakers should be mindful of the adjustment costs that deepening trade integration entails. Although the analysis of these effects is beyond the scope of the chapter, a number of studies document significant and long-lasting adjustment costs for those whose employment prospects were adversely affected by the structural changes associated with trade, even if the gains from trade from lower prices may tend to favor those at the bottom of the income distribution. An increasingly popular narrative that sees the benefits of globalization and trade accrue only to a fortunate few is also gaining traction. Policymakers need to address the concerns of trade-affected workers, including through effective support for re-training, skill building, and occupational and geographic mobility, to mitigate the downsides of further trade integration for the trade agenda to revive.

[53]Note that the calculations presented likely underestimate the real income gains from the Trade Facilitation Agreement as they treat nontariff barriers as tariffs.

Box 2.1. Is the Trade Slowdown Contributing to the Global Productivity Slowdown? New Evidence

This box attempts to quantify the effect of the decline in trade growth on productivity. Using an instrumental variable approach to identify the historical impact of trade on productivity in a sample of 18 Organisation for Economic Co-operation and Development economies,[1] the findings suggest that the trade slowdown could weigh significantly on the already weak productivity growth in advanced economies.

As discussed in this chapter, trade can shape the productivity of an economy in a variety of ways. This box focuses on three distinct channels through which international trade can affect productivity:[2]

- *Imports*—Imports can promote productivity by increasing competitive pressure on domestic firms with the entry of foreign producers in domestic markets. This is often referred to as the "procompetition" channel.
- *Imported inputs*—Imported inputs can improve firm-level productivity by expanding the variety and enhancing the quality of the intermediate goods to which firms have access. This is the called the "input" channel.
- *Exports*—Exporting can increase firm-level productivity via learning from foreign markets both directly, through buyer-seller relationships, and indirectly, through increased competition from foreign producers, externalities, and so forth. Together, these form the "export" channel.

These channels operate both through their effect at the firm level, by pushing companies to adopt more efficient production processes, improve product quality, or undertake specific investments, and at the sectoral level, by bringing about reallocation of resources toward more productive firms within a sector. This box focuses on estimating the effects of trade at the sectoral level.

Empirical Analysis

All three different types of trade grew steadily between the mid-1990s and mid-2000s. In line with aggregate trends, trade in most sectors fell during the global financial crisis and has recovered only slowly since then (Figure 2.1.1). An examination of sectoral data reveals wide dispersion in these trends across countries and industries, providing a source of variation that can be used to identify the impact of each trade channel on growth.

To quantify the effect of each of these channels on productivity at the sector level, Ahn and Duval (forthcoming), estimate an econometric specification using data from the WORLD KLEMS and World Input-Output Database covering 18 sectors across 18 advanced economies from 1995 to 2007:

$$\ln TFP_{i,s,t} = \beta_1 IMP_{i,s,t-2} + \beta_2 IMP^{input}_{i,s,t-2} + +\beta_2 EXP_{i,s,t-2} + FE_{i,s} + FE_{i,t} + \varepsilon_{i,s,t},$$

in which $TFP_{i,s,t}$ denotes total factor productivity (TFP) in country i and sector s in year t, while $IMP_{i,s,t-2}$, $IMP^{input}_{i,s,t-2}$, and $EXP_{i,s,t-2}$ are the corresponding country-sector-level imports (as a share of total domestic sectoral output), imported inputs (as a share of total input used in the sector), and exports (as a share of total domestic sectoral output), respectively, all lagged two years.[3] The specification also includes country-sector ($FE_{i,s}$) and country-year ($FE_{i,t}$) fixed effects to control for any time-invariant variation that is common to all sectors in a country and all country-specific shocks that may equally affect all industries within the country in a particular year.

Identifying the causal effect of trade on growth is challenging due to potentially severe reverse causality and measurement issues. Several studies have addressed these issues through the use of instrumental variables for overall trade (Frankel and Romer 1999; Noguer and Siscart 2005). Because the analysis in this box attempts to identify the causal effect of the three distinct channels through which trade may shape productivity, it requires a separate instrumental variable for each of them. The following instrumental variables are used:

- *China's import penetration in other countries*—In the absence of a proper instrument for imports from all trading partners, the box focuses on estimating the impact of imports from China. The analysis uses a well-established methodology of instrumenting a country's own imports from China in a particular

The authors of this box are JaeBin Ahn and Romain Duval.

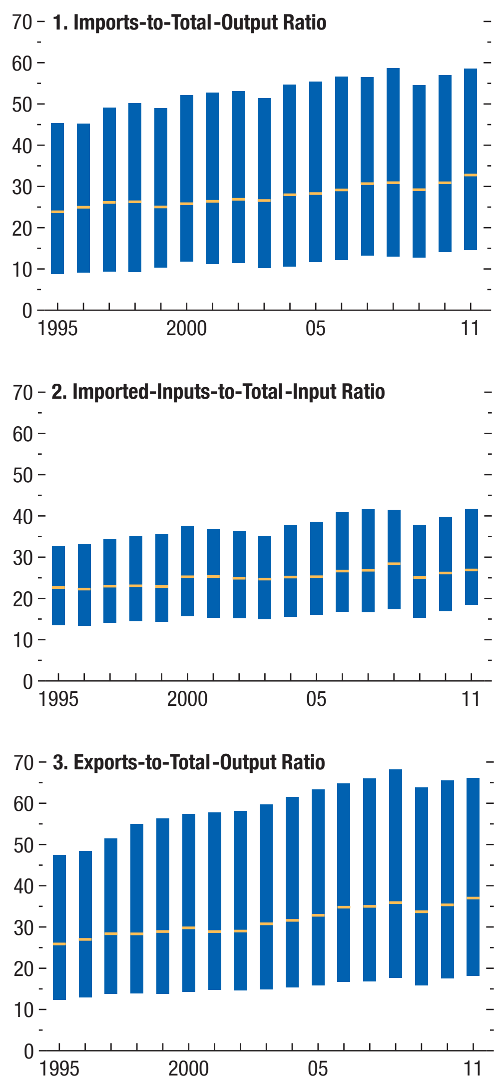
[1]The modern empirical literature on this topic traces to Sachs and Warner (1995) and Frankel and Romer (1999), among others. For a recent study that looks at the growth impact of the recent global trade slowdown, see Constantinescu, Mattoo, and Ruta (2016).

[2]The first two (import) channels are discussed in more detail in Ahn and others (2016), whose summary appears in IMF (2016c). A recent discussion on the export channel can be found in De Loecker (2013).

[3]All the results reported below are robust to alternative productivity measures (for example, labor productivity) or alternative lags (namely, one- or three-year lags).

Box 2.1 *(continued)*

Figure 2.1.1. The Evolution of Trade across Industries in Major Economies
(Percent)



Sources: World Input-Output Database; and IMF staff calculations.
Note: The horizontal line inside each box represents the median value across all country-industry observations; the upper and lower edges of each box show the top and bottom quartiles. They are all expressed in percent. Countries included in the sample are Australia, Austria, Canada, Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Korea, Netherlands, Slovenia, Spain, Sweden, United Kingdom, and United States.

sector with all other countries' imports from China in that particular sector. The identifying assumption is that sector-level import demand shocks are not correlated across sample countries, as confirmed by Autor, Dorn, and Hanson (2013). As such, the analysis estimates the procompetition effect of China's penetration on productivity.

- *Input tariffs*—To the extent that input tariffs, the tariffs applied to imported inputs, are not driven by expected future productivity in the sector considered or by other unobserved factors correlated with it,[4] they can be employed as an instrumental variable for imported inputs. The input tariff in each sector *s* is computed as a weighted average of tariff rates in all sectors, with weights reflecting the share of inputs imported directly and indirectly from each of these sectors used in the production of sector *s*'s output.[5] Its two-year lagged value is used as an instrument for imported inputs.
- *Export tariffs*—For a given country, the export tariff in each sector *s* is computed as a weighted average of output tariff rates in major destination countries, with weights equal to the share of total sector *s* exports to each destination. Its two-year lagged value is a valid instrument for exports insofar as the import tariff applied by the destination country in sector *s* is not influenced by the overall exports of any particular country in that sector.

Findings

International trade boosts productivity through all of the channels discussed above (Table 2.1.1).[6] Moreover, the instrumental variable strategy employed in this box suggests that the magnitude of its

[4]Such simultaneity bias is more likely for output tariffs, which governments may be more inclined to adjust depending on expected future productivity and competitiveness in the sector considered. For this reason, tariffs are not used as instruments for imports above.

[5]To avoid potential endogeneity issues, we pick one vintage of the input-output table for the country-sector-level weights and keep them constant throughout the sample period.

[6]Compared with ordinary least squares (OLS—columns [1]–[4]), the magnitude of the estimated effects is typically stronger when using instrumental variables (columns [5]–[8]). This suggests that measurement bias—which leads OLS to underestimate the impact of trade on productivity—is in practice a more serious concern than simultaneity bias—which is likely instead to inflate OLS estimates—as already flagged by Frankel and Romer (1999).

Box 2.1 *(continued)*

Table 2.1.1. Baseline Estimation Results

	OLS			IV		
Dependent Variable: ln (TFP)$_{i,s,t}$	(1)	(2)	(3)	(4)	(5)	(6)
(Imports from China/Total Output) × 100$_{i,s,t-2}$	0.004			0.021***		
	(0.004)			(0.004)		
(Imports Inputs/Total Input) × 100$_{i,s,t-2}$		0.005**			0.033***	
		(0.002)			(0.009)	
(Exports/Total Output)*100$_{i,s,t-2}$			0.006***			0.032**
			(0.002)			(0.015)
First Stage *F*-stats				154.3	4.3	3.7
First Stage *p*-value				0.00	0.04	0.05
Number of Observations	2,634	2,634	2,976	2,634	2,634	2,976

Source: IMF staff calculations.
Note: The dependent variable is log total factor productivity (TFP) in country *i* and sector *s* in year *t*. Independent variables are corresponding country-sector-level imports from China (as a ratio to total domestic output), total imported inputs (as a ratio to total input), and total exports (as a ratio to total domestic output), all lagged two years. Average value of imports from China relative to domestic output in all other countries, input tariff rates, and export tariff rates, all lagged two years, are used as instrumental variables (IVs) in columns (4) and (7), (5) and (8), and (6) and (9), respectively. Coefficient estimates in bold in columns (7)–(9) denote instrumented variables. Country-sector as well as country-year fixed effects are included in all columns. Robust standard errors are provided in parentheses.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

productivity-enhancing effect can be sizable. For example, a 1 percentage point increase in China's import penetration in a given sector is associated with a 1.5 percent increase in the level of total factor productivity of that sector. A 1 percentage point increase in the ratio of imported inputs to total inputs, or in the ratio of exports to domestic output, leads to about a 0.9 percent increase in productivity in a given sector. Assuming for simplicity that the recent global trade slowdown has led the trade-to-GDP ratio to level off—and hence that there has been no further increase in the share of imported inputs, imports from China, or exports in output—advanced economies are missing out on the productivity boost from international trade.

Box 2.2. The Role of Trade Policies in Reinvigorating Trade

An ambitious yet achievable trade policy agenda would help reinvigorate trade and bolster global economic growth more generally. At a country and global level, trade reforms complement other reforms in goods and services markets, boosting growth by enhancing efficiency, promoting competition, and encouraging innovation (Melitz and Redding 2014). This box discusses the scope for trade policy to remove existing barriers to the cross-border exchange of goods and services and reduce trade costs.

Trade policy needs to address "frontier" areas, such as services trade barriers, as well as remaining traditional barriers, such as tariffs. Firms' investment, sourcing, and export decisions increasingly reflect many different types of policies, especially in global value chains that link companies in many countries in the production of a single end product. While trade policy priorities vary from country to country, there are a number of elements common to each of the main country income groups (Table 2.2.1).

Traditional Barriers

Traditional barriers—tariffs, subsidies, custom procedures, domestic tax policies, and other regulations that de facto discriminate against imports or provoke unwanted tax competition (IMF 2016a)—still pose an obstacle for trade and remain high in many countries. Recent advances by the World Trade Organization (WTO) illustrate how flexible negotiating approaches can lower remaining barriers:

- *Tariffs*—Despite earlier progress through multilateral, regional, and unilateral liberalization, the process of reducing tariffs remains incomplete, particularly in low-income countries and in some emerging market and developing economies. The WTO's Information Technology Agreement (ITA), which eliminated import duties for participating countries on many information technology products, underscores the sizable gains that countries can achieve through tariff reduction, including by developing export industries (Figure 2.2.1, panel 1). The expansion of the ITA to an additional set of 201 products accounting for about 7 percent of world merchandise trade came into force in July 2016.[1] However, in other areas, namely agricultural products in some emerging market and developing economies, tariffs remain relatively high.
- *Subsidies*—WTO trade ministers agreed in December 2015 to eliminate outstanding agricultural export subsidies, which should support the exports of agricultural products of low-income and developing countries. Lower trade-distorting domestic subsidies, particularly in agriculture in advanced economies, would strengthen the global trading environment.
- *Trade facilitation*—In every region of the world, delays in customs represent a larger obstacle to trade than tariffs (Hummels 2007b). Studies estimate that a one-day customs delay decreases imports as much as a 1 percent increase in the distance between the importing and exporting countries (Djankov, Freund, and Pham 2010). For exporters, a 10 percent increase in customs delays can reduce foreign sales by nearly 4 percent (Volpe Martincus, Carballo, and Graziano 2015). The 2013 WTO Trade Facilitation Agreement (TFA) contains provisions to lower trade costs by strengthening customs practices (Figure 2.2.1, panel 2).[2] The WTO estimates that its implementation would increase world trade by $1 trillion and developing economies' growth by 0.9 percent (WTO 2015). It will enter into force when two-thirds of WTO members have concluded domestic approval processes; as of September 26, 2016, 93 of the 108 members needed had approved. Once approved, developing economies will have flexibility in the pace of implementation coupled with expanded technical assistance.

Trade Policy "Frontier" Areas

Addressing behind-the-border barriers can complement and augment other structural reforms. The increasing importance of global value chains and services trade—including as catalysts of foreign direct investment (FDI)—has moved policy cooperation in

The authors of this box are Diego Cerdeiro and Christian Henn.

[1]Tariff eliminations apply to all WTO members' exports, regardless of whether the exporter is a signatory of the ITA. However, the ITA is on a positive-list basis, which implies that, to retain a comprehensive coverage, it would need to be updated regularly as new products appear.

[2]Among its disciplines, the TFA includes prearrival processing and electronic payment for clearance of goods (Article 7), a single window for submission of custom forms (Article 10), and provisions to ensure nondiscrimination and transparency in the application of border controls of food products (Article 5)—the latter is particularly relevant for some developing economies. See Table B.1 in WTO 2015 for an overview of TFA disciplines.

Box 2.2 *(continued)*

Table 2.2.1. Trade Policy Challenges Vary across Countries

Advanced Economies	Advanced economies can address remaining protection in traditional trade areas (for example, agriculture and textiles), further open services markets (for example, transport), make their regulatory systems more coherent, and advance trade policy frontiers. The preference should be for nondiscriminatory approaches that will minimize fragmentation and facilitate raising initiatives to the multilateral level.
Emerging Market and Developing Economies	Many emerging market and developing economies, including Latin America and South Asia, can still benefit greatly from integrating via traditional liberalization, including on a unilateral basis; they should strive to anchor their economies to global value chains, moving further away from failed import-substitution policies and avoiding protectionism through opaque nontariff measures. Trade reform would complement the strengthening of policy and institutional frameworks.
Low-Income Countries	To promote the development and growth, most low-income countries need to prioritize trade facilitation in order to integrate with global value chains, especially by upgrading their hard and soft trade infrastructure and improving economic institutions.[1] They should also address traditional trade barriers and promote competition in those service industries that are critical to local participation in global value chains, such as transport and finance services. Technical assistance can support the development of trade infrastructure, address the fiscal implications of reform, and help to sequence and coordinate the reform process.

Source: IMF 2015c.
[1] Hard infrastructure includes quality of ports, airports, roads, rail, and information and communications networks. Soft infrastructure includes border efficiency (for example, number of documents necessary for import/export, speed of customs clearance) as well as other regulations and institutional frameworks directly impinging on trade.

areas previously outside the sphere of trade policy to the forefront of trade policy discussions. Reforms in these areas carry high potential to bolster productivity and increase medium-term growth:

- *Regulatory cooperation*—While WTO rules already contain meaningful provisions, recent regional agreements have put a stronger emphasis on promoting active regulatory cooperation. This can be challenging because it involves multiple domestic agencies, procedures rooted in domestic legal systems, and differences in domestic policy priorities. As such, provisions in trade agreements can range from transparency provisions to recognizing others' regulatory processes (Mavroidis 2016).
- *Leveraging complementarities between investment and trade*—Sales by FDI affiliates are larger than recorded exports of goods and services (Figure 2.2.2, panel 1), with trade and investment increasingly complementary. FDI is one of the most important channels of technology diffusion, but start-up FDI often faces significant policy-related fixed costs (OECD 2015a). Governance is fragmented: there are more than 3,000 bilateral investment treaties and other agreements without a common template (González 2013). Complementary structural reforms promoting competition and opening government procurement policies would bolster the productivity gains of FDI.
- *Reducing barriers to trade in services*—Services comprise some two-thirds of global GDP and employment, but their share in international trade is smaller: cross-border services represent a quarter of global trade. This rises to almost half when considering value-added trade, which can account for services embodied in traded goods. With policy barriers still very large (Figure 2.2.2, panel 2) and even increasing for e-commerce (OECD 2015b), reforms have tremendous potential to promote trade and growth in the services sector. For example, countries could expand specific commitments under the WTO General Agreement on Trade in Services.

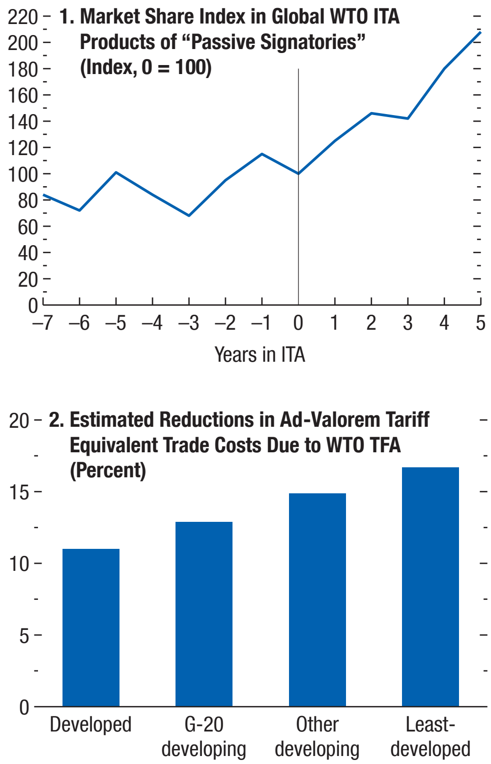
The Way Forward

It will be important to build on the ground covered on frontier issues under regional trade agreements by bringing them to the multilateral level. Megaregional agreements recently signed or under negotiation—for example, the Trade in Services Agreement and the Trans-Pacific Partnership—offer such opportunities because they address a number of frontier issues. These agreements must remain open and harnessed accordingly to reinvigorate trade integration more broadly by forging a post-Doha round agenda at the WTO. This would bring them to a global level and reduce the risk of further proliferation of regional trade agreements

Box 2.2 *(continued)*

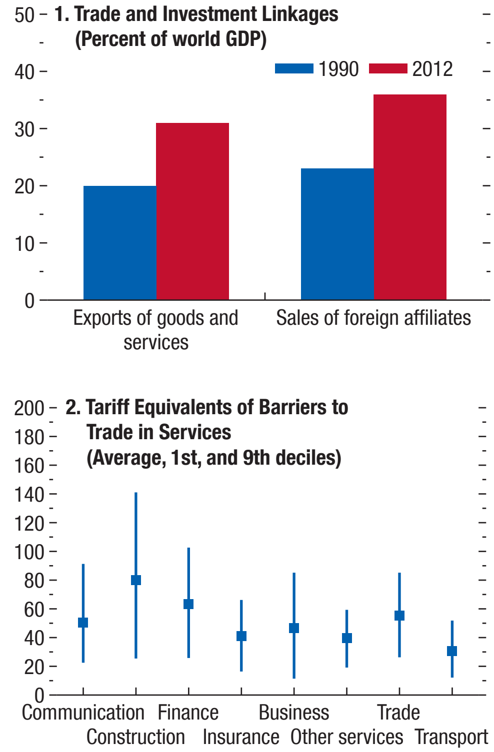
Figure 2.2.1. Potential Gains from Tackling Traditional Trade Barriers

(Percent)



Sources: Henn and Mkrtchyan (2015); and World Trade Organization (WTO) Statistics database.
Note: ITA = Information Technology Agreement; TFA = Trade Facilitation Agreement. Panel 1 shows the evolution (pre- and post-WTO ITA accession) of information technology exports of "passive signatories," that is, those countries that joined the agreement as part of a large policy objective rather than due to an established comparative advantage in the sector.

Figure 2.2.2. Trade Policy Frontier Areas



Sources: United Nations Conference on Trade and Development 2013; and Fontagné, Guillin, and Mitaritonna (2011).

resulting in unintended fragmentation. Meanwhile, at the national level, countries should ensure that the benefits of trade accrue to all. Sufficiently broad social safety nets would likely be most important as trade often only serves as a catalyst of (skill-biased) technological change, although more specific trade adjustment assistance schemes could also have a role to play in certain cases. In this regard, effective support for re-training, skill building, and occupational and geographic mobility can help those who bear the burden of adjusting.

A successful global agenda on trade policy must address both new and long-standing issues while preserving a focus on economic development. Promoting the resilience of the global trading system also calls for countries to resist recent trends toward protectionism and roll back trade-restrictive measures put in place since the global financial crisis.

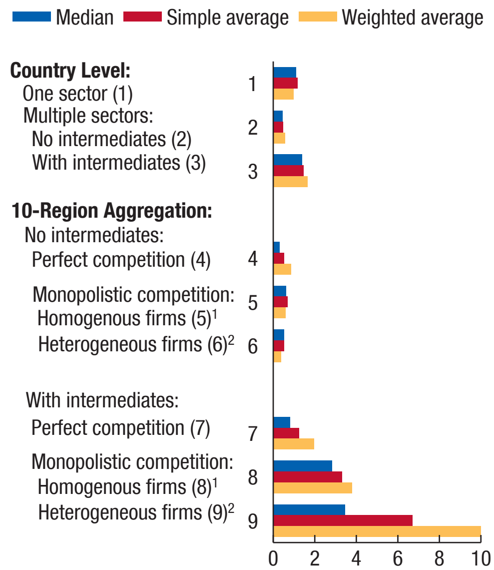
Box 2.3. Potential Gains from Jump-Starting Trade Liberalization

Trade liberalization has slowed over the past decade. This box aims to quantify potential welfare gains from stimulating this liberalization process through an experiment in which all existing tariffs are eliminated and the 2013 World Trade Organization Trade Facilitation Agreement, discussed in Box 2.2, is fully ratified and implemented. Average import-weighted tariffs for the world stand at 8 percent. The World Trade Organization estimates that the implementation of the Trade Facilitation Agreement would reduce trade costs by an ad-valorem tariff equivalent of 14 percent (Figure 2.2.1; Box 2.2). Progress on these two fronts, entailing a total of a 22 percent reduction in trade costs, can bring significant benefits by boosting international trade.

The benefits of tariff reductions, computed as changes in real consumption from initial to counterfactual equilibria, depend crucially on the class of model used for the analysis. Following Costinot and Rodriguez-Clare (2014), this box considers a range of gravity models of trade, which differ in their assumptions about market structure, the existence of firm-level heterogeneity, the number of sectors, and the role of intermediate goods. Models assuming perfect competition can typically be solved to capture the impact of tariff reductions at the country level. Models with monopolistic competition are computationally more challenging, hence countries are aggregated to 10 geographic regions. These alternatives on model specification and level of aggregation yield a total of nine different cases; the first three are solved at the country level and the remaining six at the regional level.[1]

The simple average of the welfare gains from eliminating all existing tariffs and implementing the Trade Facilitation Agreement across countries (or regions) ranges from less than 1 percent to more than 6 percent depending on the model at hand (Figure 2.3.1).[2,3] Weighing countries or regions by their shares in world population in the spirit of utilitarian welfare yields even higher potential gains, while medians suggest that these gains can be more moderate but still sizable, especially considering that they would be permanent. These results highlight that there is potential to improve global well-being through further trade liberalization. However, for these global benefits to be reaped, policymakers would also need to limit the adjustment costs of deeper trade integration, and make the case to an increasingly skeptical public.

Figure 2.3.1. Gains from Eliminating Tariffs and Implementing the World Trade Organization Trade Facilitation Agreement
(Percent)



Source: IMF staff calculations.
[1] Krugman (1980).
[2] Melitz (2003).

The author of this box is Emine Boz.

[1]These cases correspond to columns 5–7 of Table 4.2 and all columns of Table 4.3 in Costinot and Rodriguez-Clare (2014).

[2]These numbers likely underestimate the gains for two reasons. First, modeling the Trade Facilitation Agreement as a tariff reduction assumes a tariff revenue loss when the agreement is implemented, but there would be no such revenue loss in reality. Second, the exercise is conducted with a tariff increase of 22 percent (whose implications are interpreted with a negative sign). Computing the negative of the welfare loss from a higher value of consumption to a lower one would lead to a smaller percentage change than computing the welfare gain from a lower base value of consumption.

[3]All the models considered quantify only the static gains from trade reform and are silent on some potentially important benefits and costs. Such elements as technological spillovers through trade or its distributional implications are absent in all cases studied.

Annex 2.1. Data

Data Sources

The primary data sources for this chapter are the IMF's World Economic Outlook, Information Notice System, and Global Assumptions and Economic Environment databases; the United Nations Commodity Trade Statistics database; and the Eora Multi-Region Input-Output database. For each section of the chapter, several other databases are also used. Annex Table 2.1.1 lists all indicators used in the chapter as well as their sources.

The sample of economies included in the various analytical exercises varies due to data constraints. Annex Table 2.1.2 lists the samples of economies used in each exercise. Economies are grouped based on the analytical exercise in which they are included.

Data Definitions

Trade flows are measured using imports denominated in U.S. dollars throughout the chapter, except in the section "The Role of Output and Its Composition: Insights from an Empirical Investigation," where they are denominated in local currency units. Imports are used in both value and volume terms depending on the exercise undertaken and are specified accordingly. Similarly, the chapter indicates whether imports cover both goods and services or only one of these categories.

Services Trade

For imports of services, the chapter investigates the nominal import growth for different categories using the United Nations Service Trade Statistics database. That database contains 11 different sectors of services imports: (1) transport; (2) travel; (3) communication; (4) construction; (5) insurance; (6) financial; (7) computer and information; (8) royalties and license fees; (9) other business; (10) personal, cultural, and recreational; and (11) governmental. Data coverage varies across countries and sectors.

Annex Figure 2.1.1 aggregates these categories in four main broad categories of import services: (1) travel (sectors 1 and 10), (2) information and communication technologies (sectors 3 and 7), (3) financial (sectors 5 and 6), and (4) other (remaining sectors). The figure displays the average annual nominal growth rates for these categories, as well as for total services, for two different periods (2003–07 and 2012–13) for a balanced sample of 36 economies. This examination reveals that trade in information and communication technologies, travel, and financial services has been more resilient during the recent period while trade in other services has slowed more markedly.

Annex 2.2. Constructing Disaggregated Import Volume and Price Indices

The disaggregated volume data set used in Figure 2.4 and in the subsection on the role of other factors is based on data from the United Nations Commodity Trade Statistics database for about 5,300 products classified according to the Harmonized Commodity Description and Coding Systems (HS) at the six-digit level. Data include information on U.S. dollar values and quantities (for example, units or kilograms) of total goods imports for 52 countries during 2003–15. The disaggregated data are used to construct price and volume indices for products at the HS two-digit level, as well as by end use. The procedure involves three steps: (1) examine growth rates of unit values at the most disaggregate level to eliminate potential outliers, (2) calculate chained Fisher price indices at the HS two-digit level and by end use based on the clean disaggregated unit values, and (3) deflate values of trade at the HS two-digit level or by end use using the constructed Fisher price indices to arrive at trade volumes.

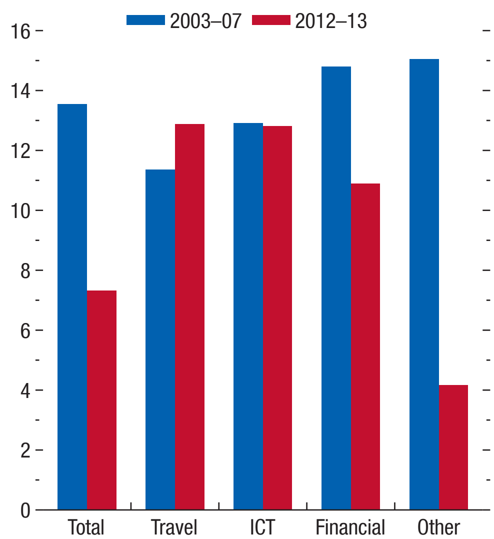
Because value and unit value changes at the six-digit level are noisy, simple procedures to identify outliers are applied to construct these price and volume indices. Boz and Cerutti (forthcoming) document in detail two steps for eliminating outliers for each country individually. First, a cross-section truncation is performed after computing the distribution of annual changes in the log unit value of all six-digit products. Truncating both tails of this distribution eliminates extreme positive and negative values stemming from cases such as typos during recording import values and/or quantities. Second, a time series truncation is applied to the distribution of the standard deviation of unit value changes over time for each product within each HS vintage. This second step is intended to alleviate the unit value bias: unit values capture not only true price changes but also variations in the composition of products, even within narrowly defined HS six-digit categories. Products that suffer from a more severe unit value bias are more likely to have a high standard deviation of unit value changes over

Annex Table 2.1.1. Data Sources

Indicator	Source
Banking Crisis Indicator	Laeven and Valencia (2012)
Bilateral Nominal U.S. Dollar Exchange Rate	IMF, Global Assumptions database
Chicago Board Options Exchange Volatility Index (VIX)	Chicago Board Options Exchange; Haver Analytics
Cost to Import	World Bank, Doing Business Indicators
Discriminatory Trade Measures	Bown 2016; UNCTAD, Trade Analysis Information System
Domestic Value Added Embedded in Exports of Other Countries	OECD–WTO, Trade in Value Added database; Eora MRIO database; IMF staff calculations
Export Prices of Goods and Services	CPB Netherlands Bureau for Economic Policy Analysis; IMF staff calculations using export value divided by export volume
Export Value of Goods and Services	CPB Netherlands Bureau for Economic Policy Analysis; IMF, World Economic Outlook database
Export Volume of Goods and Services	CPB Netherlands Bureau for Economic Policy Analysis; IMF, World Economic Outlook database
Foreign Value Added of Exports	Eora MRIO database; IMF staff calculations; OECD–WTO, Trade in Value Added database
Free Trade Agreements by Year of Signature	DESTA, Free Trade Area Database
Free Trade Agreements Coverage	WTO Regional Trade Agreements Database
Global Value Chain Participation	Eora MRIO database; IMF staff calculations
Industrial Production	CEIC database; Haver Analytics
Import Prices of Goods and Services	CPB Netherlands Bureau for Economic Policy Analysis; IMF staff calculations using import value divided by import volume
Import Prices of Goods at Product Level	United Nations Commodity Trade Statistics (Comtrade) Database; World Bank, World Integrated Trade Solution
Import Value of Goods and Services	CPB Netherlands Bureau for Economic Policy Analysis; IMF, World Economic Outlook database
Import Value of Services by Categories	United Nations Service Trade Statistics Database; IMF staff calculations
Import Volume of Goods and Services	CPB Netherlands Bureau for Economic Policy Analysis; IMF, World Economic Outlook database
Import Volume of Goods at Product Level	Eora MRIO database; United Nations Commodity Trade Statistics (Comtrade) Database; World Bank, World Integrated Trade Solution
Liner Shipping Connectivity Index	UNCTAD, World Maritime Review
Lobbying on Trade Issues in the United States	Ludema, Mayda, and Mishra (2015)
Measures Implemented by Global Trade Alert	Centre for Economic Policy Research, Global Trade Alert Database
Nominal Effective Exchange Rate	IMF, Information Notice System
Nominal GDP	IMF, World Economic Outlook database
Oil Price in U.S. Dollars	IMF, Global Assumptions database
Producer Price Index	Haver Analytics; CEIC database
Real Effective Exchange Rate	IMF, Information Notice System
Real GDP	IMF, World Economic Outlook database
Real Interest Rate	Haver Analytics
Sectoral Gross Production	Eora MRIO database; Haver Analytics; OECD, Structural Analysis Database, Input-Output Tables
Tariffs	UNCTAD, Trade Analysis Information System; WTO Tariff Download Facility; IMF, Structural Reforms database
Nontariff and Temporary Trade Barriers	Bown 2016; Centre for Economic Policy Research, Global Trade Alert Database; UNCTAD, Trade Analysis Information System
Time to Import	World Bank, Doing Business Indicators
Trade Finance Availability	International Chamber of Commerce, Global Trade and Finance Survey; IMF staff calculations
Trade-Weighted Foreign CPI	IMF staff calculations
Trade-Weighted Foreign Demand	IMF, Global Economic Environment database
Trade-Weighted Foreign PPI	IMF staff calculations
U.S. Air Freight Cost	U.S. Bureau of Labor Statistics

Source: IMF staff compilation.
Note: CPI = consumer price index; DESTA = Design of Trade Agreements database; MRIO = Multi-Region Input-Output database; OECD = Organisation for Economic Co-operation and Development; PPI = producer price index; UNCTAD = United Nations Conference on Trade and Development; WTO = World Trade Organization.

Annex Figure 2.1.1. Nominal Import Growth across Categories of Services
(Percent)



Sources: United Nations Service Trade Statistics database; and IMF staff calculations.
Note: ICT = information and communication technologies.

time. Hence, eliminating such products based on the product-specific time series standard deviations can help reduce the bias.[54] The truncation thresholds are set at percentiles 2.5 and 97.5 for the cross-section and at the 80th percentile for the time series, respectively.

Once this procedure is complete, chained Fisher price indices are calculated that are then used to deflate U.S. dollar values.

It is important to note that the aforementioned procedures do not eliminate the products identified as outliers from the volume indices, as they affect only the calculation of price indices. When the unprocessed value index is used in the numerator to compute volume indices as opposed to one that ignores products with missing quantity data or extreme unit value changes, the implicit assumption is that the missing unit values grow at the same rate as the aggregate price index.

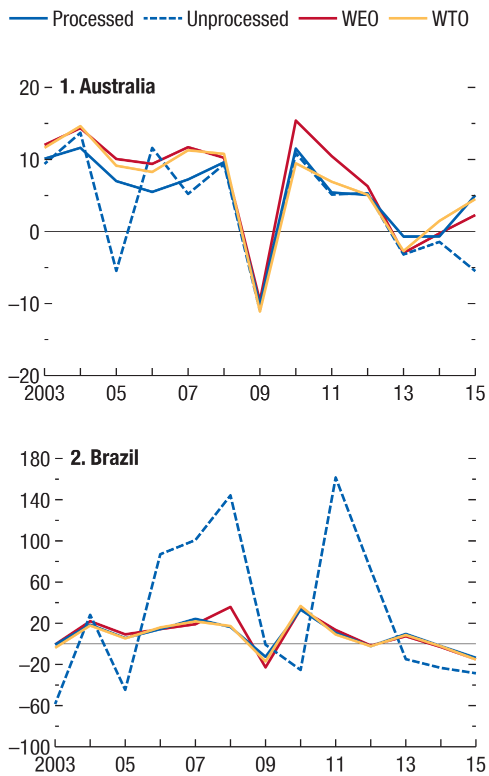
[54]However, for some products this time series standard deviation may be intrinsically high, which may not be a reflection of the severity of the unit value bias—for example, commodities, which experience fluctuations as a result of discoveries of new reserves, disruptions in supply, and so forth.

Annex Table 2.1.2. Sample of Economies Included in the Analytical Exercises

Group[1]	Economies[2]	Exercise[3]			
		I	II	III	IV
A	Argentina, Australia,* Austria,* Belgium,* Brazil, Canada,* Chile, China, Colombia, Czech Republic,* Denmark,* Finland,* France,* Germany,* Hungary, India, Indonesia, Italy,* Japan,* Korea,* Malaysia, Mexico, Norway,* Philippines, Poland, Russia, South Africa, Spain,* Sweden,* Thailand, Turkey, United Kingdom,* United States,* Vietnam	X	X	X	X
B	Algeria, Estonia,* Greece,* Hong Kong SAR,* Ireland,* Israel,* Kazakhstan, Lithuania,* Netherlands,* New Zealand,* Portugal,* Romania, Saudi Arabia, Singapore,* Slovak Republic,* Slovenia,* Switzerland,* Taiwan Province of China,* Ukraine	X		X	X
C	Albania, Angola, Antigua and Barbuda, Armenia, Bahamas, Bahrain, Barbados, Belarus, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brunei Darussalam, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Democratic Republic of the Congo, Republic of Congo, Côte d'Ivoire, Croatia, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Haiti, Honduras, Iceland, Iran, Jordan, Kenya, Lebanon, Lesotho, Luxembourg,* Madagascar, Malawi, Maldives, Mali, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Namibia, Niger, Oman, Pakistan, Papua New Guinea, Peru, Rwanda, Senegal, Serbia, Seychelles, Sierra Leone, Sri Lanka, Suriname, Swaziland, Syria, Togo, Trinidad and Tobago, Uganda, United Arab Emirates, Uruguay, Venezuela, Yemen, Zambia	X			X
D	Afghanistan, Azerbaijan, Bangladesh, Belize, Bhutan, Bulgaria, Cyprus, Fiji, Georgia, Guatemala, Iraq, Jamaica, Kuwait, Kyrgyz Republic, Lao P.D.R., Latvia,* Libya, Macedonia, Malta,* Mauritania, Nepal, Nicaragua, Nigeria, Panama, Paraguay, Samoa, São Tomé and Príncipe, Tajikistan, Tunisia, Uzbekistan, Vanuatu				X
E	Guinea, Mauritius, Myanmar, Tanzania	X			

Source: IMF staff compilation.
[1] Group of countries according to their use in different analytical exercises.
[2] Asterisk (*) denotes advanced economies as classified by the IMF's World Economic Outlook database.
[3] Analytical exercises performed in the chapter: I = Import Demand Model; II = Structural Model; III = Product-Level Regression Framework; IV = Gravity Model.

Annex Figure 2.2.1. Real Import Growth
(Percent)



Sources: IMF, World Economic Outlook (WEO) database; United Nations Comtrade; World Bank World Integrated Trade Solution database; World Trade Organization (WTO) Statistics database; and IMF staff calculations.
Note: "Processed" refers to the index obtained from the truncated data as described in the main text, while the "unprocessed" index is calculated using raw data without any elimination of outliers. Both "processed" and "unprocessed" indices are calculated using chained Fisher price indices.

A comparison of the country-level aggregate import volume indices obtained from the above methodology with those obtained from unprocessed data as well as with those in the IMF's World Economic Outlook database and the World Trade Organization's Statistics database reveals the effectiveness of the proposed methodology (Annex Figure 2.2.1). For Australia, for example, using the cross-section and time series truncations brings the Fisher volume index significantly closer to the two benchmarks relative to the index constructed from unprocessed data. These differences are more striking in the case of emerging market and developing economies, as shown for Brazil.[55]

[55]In addition to these mechanical truncation procedures, all disaggregated indices are thoroughly inspected. In this context, some further adjustments are applied in the case of a few countries in which deviations arose with respect to benchmark indices. For example, large spikes in the unit values of product numbers 710,812 (gold) in 2012 in Switzerland and 880,240 (airplanes) in 2015 in Ireland led to adjustments of those unit value changes to better align them with their historical evolution.

Annex 2.3. Analysis Using an Empirical Model of Import Demand

This annex provides further details on the empirical model of import demand, which is used to quantify the role of economic activity and its composition in the slowdown of trade in the section "The Role of Output and Its Composition: Insights from an Empirical Investigation." The analysis in that section estimates a standard model of import demand that links real imports growth to growth in absorption and growth in relative prices. Such an import demand equation can be derived from virtually any international real business cycle model. The estimated equation is

$$\Delta \ln M_{c,t} = \delta_c + \beta_{D,c} \Delta \ln D_{c,t} + \beta_{P,c} \Delta \ln P_{c,t} + \varepsilon_{c,t}, \quad \text{(A.2.3.1)}$$

in which $M_{c,t}$, $D_{c,t}$ and $P_{c,t}$ denote, respectively, real imports, absorption, and relative import prices of country c in year t. Relative import prices are defined as the ratio of the import price deflator to the GDP deflator. The baseline specification assumes that import growth depends only on the contemporaneous growth rate of the explanatory variables; however, the findings discussed in the chapter are robust to the inclusion of lags of the dependent and explanatory variables' growth rates to allow for richer dynamics. The model is estimated separately for each country and separately for imports of goods and services, as well as for overall imports. The period of analysis is 1985–2015, though data are not available for all countries in all years.

The chapter builds on Bussière and others (2013) and proxies absorption with IAD. Import-intensity-adjusted demand is computed as

$$IAD_{c,t} = C_{c,t}^{\omega_C} G_{c,t}^{\omega_G} I_{c,t}^{\omega_I} X_{c,t}^{\omega_X}, \quad \text{(A.2.3.2)}$$

in which ω_k is the import content of each of the expenditure components for $k \in \{C, G, I, X\}$, normalized to sum to 1. Import content is computed from the Eora Multi-Region Input-Output country-specific input-output tables averaged over 1990–2011. Similar to patterns described by Bussière and others (2013), who rely on the Organisation for Economic Co-operation and Development Trade in Value Added database,

Annex Table 2.3.1. Import Content of Aggregate Demand Components

	Mean	Median	25th Percentile	75th Percentile
	(1)	(2)	(3)	(4)
Consumption	23.3	20.7	13.7	27.7
Govt. Spending	14.9	12.1	8.8	17.4
Investment	29.6	26.1	19.0	35.7
Exports	31.7	25.9	14.6	43.0

Sources: Eora Multi-Region Input-Output database; and IMF staff calculations.

Note: The table reports the mean, median, 25th percentile, and 75th percentile of the import content of the four components of aggregate demand across the 150 countries included in the sample. For each country, the import content refers to the average import content over 1990–2011. See Bussière and others 2013 for the exact definition of import content and its computation from national input-output tables.

there are significant differences in the usage of imports across aggregate demand components (Annex Table 2.3.1). Investment and exports have a much richer import content compared with consumption and government spending.

In addition to the measure proposed by Bussière and others (2013), the chapter estimates two alternative models of import demand. In the first alternative model, absorption is proxied by import-intensity-adjusted demand using only the domestic components of aggregate demand, namely

$$DIAD_{c,t} = C\,c,t\,\omega\,C^{d}\,G\,c,t\,\omega\,G^{d}\,I\,c,t\,\omega\,I^{d},$$

and the following equation is estimated

$$\Delta \ln M_{c,t} = \delta_{\mathrm{c}} + \beta_{DD,\mathrm{c}} \Delta \ln DIAD_{c,t} + \beta_{P,\mathrm{c}} \Delta \ln P\, c,_{t} + \varepsilon_{\mathrm{c,t}}. \qquad \text{(A.2.3.3)}$$

In the second model, absorption is proxied by *DIAD* and exports are predicted by trading partners' *DIAD*, $\widehat{\Delta \ln X_{c,t}}$. To compute the latter, the chapter first estimates equation (A.2.3.3) and recovers the model-predicted import growth for each country, $\widehat{\Delta \ln M_{c,t,DIAD}}$. It constructs a measure of external demand as the trade-weighted average of partners' $\widehat{\Delta \ln M_{c,t,DIAD}}$ and estimates a model of export demand using this measure as a proxy of the demand for a country's exports:

$$\Delta \ln X_{c,t} = \delta_{c}^{X} + \beta_{D,c}^{X} \Sigma_{c,t,p} \widehat{\Delta \ln M_{p,t,DIAD}} + \beta_{P,c}^{X} \Delta \ln P_{c,t}^{X} + \varepsilon_{c,t}^{X}. \qquad \text{(A.2.3.4)}$$

The procedure then recovers countries' predicted export growth $\widehat{\Delta \ln X_{c,t}}$. Finally, a country's import growth is modeled as

$$\Delta \ln M_{c,t} = \delta_{c} + \beta_{DD,c} \Delta \ln DIAD_{c,t} + \beta_{DX,c} \widehat{\Delta \ln X_{c,t}} + \beta_{P,c} \Delta \ln P_{c,t} + \varepsilon_{c,t}. \qquad \text{(A.2.3.5)}$$

Annex Tables 2.3.2–2.3.4 present the results from estimating equations (A.2.3.1), (A.2.3.3), and (A.2.3.5), for real import growth of goods and services, as well as separately for goods and services. The tables also provide the results from estimating equation A.2.3.1 in a panel framework in columns (1), (5), and (9) for comparison with other studies (in other words, where all the countries in the sample are pooled, and the same elasticities of import growth with respect to its determinants are imposed across countries). The remaining columns report the mean and the interquartile range of the estimated coefficients from a country-by-country estimation.

The results show that estimating the import demand model separately for each country is noticeably superior to estimation in a panel framework (see, for example, column [2] versus column [1]). This is due to the substantial variation in the income elasticity of imports across countries. On average, advanced economies' imports have higher income elasticity than do those of emerging market and developing economies, particularly in the case of goods imports (Annex Table 2.3.3). This finding is in line with Slopek (2015), who demonstrates that the shift in relative growth from advanced toward emerging market and developing economies can account for much of the decline in the global trade elasticity in light of the lower income elasticity of trade of the latter. Moreover, regressions using measures of import demand based solely on the domestic components of aggregate demand (columns [3], [7], and [11]) have a significantly worse fit.

To examine whether there is anything unusual in the 2012–15 period, the chapter pools the residuals from estimating equations (A.2.3.1), (A.2.3.3), and (A.2.3.5) for each country in the sample and estimates the following specification:

$$\widehat{\varepsilon_{c,t}} = \theta \mathrm{Const}\left(1 - D_{2012\text{-}15,t}\right) + \tau \mathrm{Const}\left(D_{2012\text{-}15,t}\right) + \varsigma_{c,t}, \qquad \text{(A.2.3.6)}$$

where $D_{2012\text{-}15,t}$ is an indicator that takes the value of 1 for $t \in \{2012, 2013, 2014, 2015\}$. The coefficients θ and τ capture the average value of the residuals of the 1985–2011 and 2012–15 periods, respectively. Regressions are weighted by countries' nominal import shares (in U.S. dollars) to more accurately capture the deviations from predicted growth for the world as a whole (or groups of countries).

Annex Table 2.3.2. Empirical Model of Real Imports of Goods and Services

Sample	Full Sample				Advanced Economies				Emerging Market and Developing Economies			
Estimation	Panel	Country-Specific			Panel	Country-Specific			Panel	Country-Specific		
Measure of Import Demand	IAD	IAD	DIAD	DIAD+E	IAD	IAD	DIAD	DIAD+E	IAD	IAD	DIAD	DIAD+E
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Import Demand	0.99	1.31	1.03	0.87	1.33	1.38	1.08	0.91	0.96	1.25	0.99	0.86
	(0.07)	0.94 1.51	0.66 1.29	0.58 1.19	(0.07)	1.27 1.54	0.92 1.49	0.58 1.06	(0.07)	0.87 1.50	0.59 1.28	0.58 1.20
Predicted Exports				0.45				0.61				0.40
				0.16 0.81				0.36 0.85				0.10 0.78
Relative Prices	–0.24	–0.18	–0.16	–0.15	–0.05	0.04	0.22	–0.03	–0.25	–0.25	–0.26	–0.23
	(0.07)	–0.40 0.04	–0.41 0.07	–0.38 0.00	(0.04)	–0.15 0.16	0.04 0.43	–0.19 0.15	(0.08)	–0.47 –0.05	–0.57 –0.08	–0.42 –0.08
Constant	0.01	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.01	–0.01
	(0.00)	–0.02 0.01	0.00 0.03	–0.03 0.01	(0.00)	–0.01 0.01	0.01 0.04	–0.01 0.01	(0.00)	–0.02 0.01	–0.01 0.03	–0.03 0.01
R^2	0.53	0.70	0.57	0.67	0.75	0.86	0.60	0.72	0.52	0.65	0.54	0.61
		0.58 0.85	0.43 0.72	0.53 0.80		0.74 0.88	0.53 0.73	0.64 0.80		0.52 0.79	0.38 0.72	0.47 0.79

Source: IMF staff calculations.

Note: IAD = import-intensity-adjusted demand; DIAD = import-intensity-adjusted demand using only the domestic components of aggregate demand; DIAD+E = DIAD and exports predicted by trading partners' DIAD. The table presents results from estimating equations (A.2.3.1), (A.2.3.3), and (A.2.3.5). Columns (1), (5), and (9) report point estimates and heteroscedasticity-robust standard errors in parentheses from estimating equation (A.2.3.1) in a panel framework including country fixed effects. The remaining columns report the average point estimates as well as the interquartile range of these estimates from a country-by-country estimation. Absorption is measured as import-intensity-adjusted aggregate demand based on all four components of GDP in columns (1), (2), (5), (6), (9), and (10). In the rest of the columns, absorption is proxied by the import-intensity-adjusted domestic demand. The specifications presented in columns (4), (8), and (12) also control for predicted exports, as estimated according to equation (A.2.3.4).

Annex Table 2.3.3. Empirical Model of Real Imports of Goods

Sample	Full Sample				Advanced Economies				Emerging Market and Developing Economies			
Estimation	Panel	Country-Specific			Panel	Country-Specific			Panel	Country-Specific		
Measure of Import Demand	IAD	IAD	DIAD	DIAD+E	IAD	IAD	DIAD	DIAD+E	IAD	IAD	DIAD	DIAD+E
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Import Demand	0.94	1.32	1.07	0.90	1.52	1.51	1.26	1.00	0.91	1.18	0.93	0.86
	(0.08)	0.95 1.59	0.66 1.37	0.55 1.23	(0.05)	1.38 1.74	1.03 1.58	0.58 1.21	(0.09)	0.77 1.54	0.60 1.32	0.55 1.23
Predicted Exports				0.47				0.66				0.40
				0.12 0.85				0.40 0.94				0.05 0.75
Relative Prices	–0.20	–0.16	–0.06	–0.17	0.01	0.10	0.27	0.01	–0.21	–0.25	–0.24	–0.26
	(0.09)	–0.42 0.13	–0.38 0.20	–0.40 0.03	(0.08)	–0.11 0.25	0.11 0.60	–0.21 0.23	(0.09)	–0.49 0.00	–0.52 0.01	–0.46 0.00
Constant	0.01	0.00	0.02	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.01	–0.01
	(0.00)	–0.02 0.01	0.00 0.03	–0.03 0.02	(0.00)	–0.01 0.01	0.01 0.03	–0.02 0.01	(0.00)	–0.02 0.02	–0.01 0.03	–0.04 0.02
R^2	0.40	0.66	0.54	0.63	0.72	0.79	0.56	0.72	0.38	0.61	0.52	0.59
		0.50 0.78	0.41 0.69	0.50 0.76		0.71 0.87	0.48 0.73	0.61 0.78		0.45 0.71	0.38 0.65	0.46 0.73

Source: IMF staff calculations.
Note: IAD = import-intensity-adjusted demand; DIAD = import-intensity-adjusted demand using only the domestic components of aggregate demand; DIAD+E = DIAD and exports predicted by trading partners' DIAD. The table presents results from estimating equations (A.2.3.1), (A.2.3.3), and (A.2.3.5). Columns (1), (5), and (9) report point estimates and heteroscedasticity-robust standard errors in parentheses from estimating equation (A.2.3.1) in a panel framework including country fixed effects. The remaining columns report the average point estimates as well as the interquartile range of these estimates from a country-by-country estimation. Absorption is measured as import-intensity-adjusted aggregate demand based on all four components of GDP in columns (1), (2), (5), (6), (9), and (10). In the rest of the columns, absorption is proxied by the import-intensity-adjusted domestic demand. The specifications presented in columns (4), (8), and (12) also control for predicted exports, as estimated according to equation (A.2.3.4).

Annex Table 2.3.4. Empirical Model of Real Imports of Services

Sample	Full Sample				Advanced Economies				Emerging Market and Developing Economies			
Estimation	Panel	Country-Specific			Panel	Country-Specific			Panel	Country-Specific		
Measure of Import Demand	IAD	IAD	DIAD	DIAD+E	IAD	IAD	DIAD	DIAD+E	IAD	IAD	DIAD	DIAD+E
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Import Demand	1.39	1.04	0.89	0.83	1.11	1.03	1.02	0.81	1.41	1.06	0.82	0.83
	(0.33)	0.64 1.69	0.50 1.41	0.31 1.44	(0.13)	0.86 1.26	0.71 1.31	0.29 1.22	(0.35)	0.61 1.92	0.38 1.48	0.37 1.61
Predicted Exports				0.30				0.52				0.17
				–0.02 0.84				0.28 0.83				–0.11 0.86
Relative Prices	0.01	–0.14	–0.19	–0.22	–0.32	–0.07	0.08	–0.06	0.02	–0.25	–0.23	–0.25
	(0.21)	–0.56 0.10	–0.61 0.15	–0.58 0.17	(0.11)	–0.37 0.11	–0.33 0.28	–0.42 0.16	(0.22)	–0.60 0.07	–0.65 0.01	–0.69 0.17
Constant	0.00	0.00	0.02	0.00	0.01	0.01	0.02	0.01	0.00	0.00	0.01	–0.01
	(0.01)	–0.01 0.02	–0.01 0.04	–0.05 0.03	(0.00)	0.00 0.03	0.01 0.04	–0.02 0.02	(0.01)	–0.03 0.02	–0.01 0.04	–0.05 0.03
R^2	0.08	0.38	0.29	0.41	0.24	0.47	0.41	0.46	0.08	0.35	0.26	0.39
		0.16 0.55	0.14 0.48	0.19 0.57		0.30 0.59	0.20 0.50	0.33 0.58		0.15 0.55	0.13 0.45	0.18 0.57

Source: IMF staff calculations.

Note: IAD = import-intensity-adjusted demand; DIAD = import-intensity-adjusted demand using only the domestic components of aggregate demand; DIAD+E = DIAD and exports predicted by trading partners' DIAD. The table presents results from estimating equations (A.2.3.1), (A.2.3.3), and (A.2.3.5). Columns (1), (5), and (9) report point estimates and heteroscedasticity-robust standard errors in parentheses from estimating equation (A.2.3.1) in a panel framework including country fixed effects. The remaining columns report the average point estimates as well as the interquartile range of these estimates from a country-by-country estimation. Absorption is measured as import-intensity-adjusted aggregate demand based on all four components of GDP in columns (1), (2), (5), (6), (9), and (10). In the rest of the columns, absorption is proxied by the import-intensity-adjusted domestic demand. The specifications presented in columns (4), (8), and (12) also control for predicted exports, as estimated according to equation (A.2.3.4).

Annex Table 2.3.5. Residuals: Real Goods Import Growth

	Full Sample			Advanced Economies			Emerging Market and Developing Economies		
	IAD	DIAD	DIAD+E	IAD	DIAD	DIAD+E	IAD	DIAD	DIAD+E
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Indicator 1985–2011	0.003	0.000	0.001	0.003	0.000	0.001	0.002	–0.001	0.002
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.005)	(0.007)	(0.006)
Indicator 2012–15	–0.009	–0.023	–0.018	–0.005	–0.014	–0.011	–0.018	–0.040	–0.031
	(0.002)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)
Number of Observations	3,427	3,427	3,427	910	910	910	2,517	2,517	2,517

Source: IMF staff calculations.
Note: IAD = import-intensity-adjusted demand; DIAD = import-intensity-adjusted demand using only the domestic components of aggregate demand; DIAD+E = DIAD and exports predicted by trading partners' DIAD. The table reports point estimates and heteroscedasticity-robust standard errors in parentheses from estimating equation (A.2.3.6). Regressions are weighted by countries' nominal goods import shares.

Annex Tables A.2.3.5 and A.2.3.6 present the regression results for goods and services real import growth, respectively. On average, for goods imports, the residuals are significantly less than zero across all samples and specifications in the 2012–15 period. The extent of "missing" goods import growth varies across advanced and emerging market and developing economies, with emerging market and developing economies having significantly larger (in absolute value) residuals. According to the baseline specification, which proxies import demand with *DIAD* and exports predicted by trading partners' *DIAD* —equation (A.2.3.5), residuals in columns (3), (6), and (9) in Annex Table 2.3.5—the missing goods import growth amounted to about 1 percentage point in advanced economies, 3 percentage points for emerging market and developing economies, and 1¾ percentage points for the world as a whole.

In the case of services, there is no robust evidence of an unexplained slowdown in import growth during the 2012–15 period for the world as a whole. However, in emerging market and developing economies, services import growth seems to have been lower than predicted in the post-2012 period according to models based on the domestic components of aggregate demand. The findings presented in Annex Tables A.2.3.5 and A.2.3.6 are robust to the inclusion of country fixed effects or to clustering the standard errors by country.

To account for the potential role of uncertainty, global financial conditions and financial stress in shaping countries' import demand, Annex Table 2.3.7 presents the results from the estimation of equation (A.2.3.6) augmented to include these variables. The findings of unexplained negative real goods import growth residuals during 2012–15 are robust to this alternative specification.

Annex Table 2.3.6. Residuals: Real Services Import Growth

	Full Sample			Advanced Economies			Emerging Market and Developing Economies		
	IAD	DIAD	DIAD+E	IAD	DIAD	DIAD+E	IAD	DIAD	DIAD+E
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Indicator 1985–2011	0.003	0.002	0.003	–0.001	–0.002	–0.001	0.015	0.019	0.016
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.013)	(0.013)	(0.013)
Indicator 2012–15	0.008	–0.003	–0.003	0.010	0.007	0.006	0.004	–0.024	–0.024
	(0.007)	(0.007)	(0.007)	(0.004)	(0.005)	(0.004)	(0.021)	(0.021)	(0.021)
Number of Observations	3,359	3,359	3,359	909	909	909	2,450	2,450	2,450

Source: IMF staff calculations.
Note: IAD = import-intensity-adjusted demand; DIAD = import-intensity-adjusted demand using only the domestic components of aggregate demand; DIAD+E = DIAD and exports predicted by trading partners' DIAD. The table reports point estimates and heteroscedasticity-robust standard errors in parentheses from estimating equation (A.2.3.6). Regressions are weighted by countries' nominal services import shares.

Annex Table 2.3.7. Residuals: Real Goods Import Growth Controlling for Global Uncertainty, Global Financial Conditions, and Financial Stress

Full Sample	IAD					DIAD+E				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Indicator 1985–2011	0.003	0.005	0.005	0.004	0.007	0.001	0.003	0.004	0.002	0.006
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Indicator 2012–15	–0.009	–0.011	–0.006	–0.009	–0.007	–0.018	–0.020	–0.013	–0.018	–0.015
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
VIX Growth		–0.015			-0.011		-0.026			–0.024
		(0.006)			(0.007)		(0.007)			(0.008)
Change in Global Real Interest Rate			0.008		0.008			0.013		0.013
			(0.003)		(0.003)			(0.003)		(0.003)
Banking Crisis				–0.022	–0.014				–0.020	–0.005
				(0.007)	(0.009)				(0.008)	(0.010)
Number of Observations	3,427	2,987	2,987	3,427	2,987	3,427	2,987	2,987	3,427	2,987

Source: IMF staff calculations.

Note: IAD = import-intensity-adjusted demand; DIAD = import-intensity-adjusted demand using only the domestic components of aggregate demand; DIAD+E = DIAD and exports predicted by trading partners' DIAD. The table reports point estimates and heteroscedasticity-robust standard errors in parentheses from estimating equation (A.2.3.6) augmented to include the growth rate of the VIX (Chicago Board of Volatility Index), change in real global interest rates, and an indicator for the beginning of a banking crisis from Laeven and Valencia (2012). Regressions are weighted by countries' nominal goods import shares.

Annex Table 2.3.8 decomposes the predicted decline in the growth rate of real goods imports between the 2012–15 period and 1985–2007 and 2003–07 across the various components of import demand for the full sample of economies.[56]

As mentioned in the main text, other factors can simultaneously affect economic activity and trade, in particular trade policies. If ignored, these would likely lead to an upward bias in the estimated role of economic activity in explaining the slowdown in trade

[56]Sectors are aggregated along the lines of Eaton and others (2010) with the exception that mining and quarrying, coke, refined petroleum products, and nuclear fuel are stripped out from the residual services sector and used to quantify the commodities sector.

Annex Table 2.3.8. Decomposing the Decline in Real Goods Import Growth: Full Sample

		Import Growth Predicted by IAD Model and Its Components							Import Growth Predicted by DIAD+E Model and Its Components						
	Actual	Overall	C	G	I	X	Relative Prices	Constant	Overall	C	G	I	X	Relative Prices	Constant
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1985–2007	8.1	8.0	1.4	0.7	2.7	4.6	0.3	–1.9	7.8	1.5	0.8	2.9	4.6	0.3	–2.3
2003–07	8.9	8.8	1.4	0.7	3.5	4.8	0.2	–1.7	9.2	1.5	0.7	3.7	5.1	0.3	–2.1
2012–15	2.3	3.2	0.9	0.4	1.4	2.0	0.3	–1.7	4.0	1.0	0.4	1.7	3.0	0.1	–2.1
Average Growth in 2012–15 Minus Average Growth															
1985–2007	–5.7	–4.7	–0.6	–0.4	–1.3	–2.7	–0.1	0.2	–3.8	–0.6	–0.4	–1.3	–1.6	–0.2	0.2
2003–07	–6.6	–5.6	–0.6	–0.3	–2.0	–2.9	0.1	0.0	–5.2	–0.6	–0.3	–2.0	–2.1	–0.2	0.0
Fraction of Import Growth Decline Predicted by Model															
1985–2007		0.82							0.66						
2003–07		0.85							0.79						

Source: IMF staff calculations.

Note: IAD = import-intensity-adjusted demand; DIAD = import-intensity-adjusted demand using only the domestic components of aggregate demand; DIAD+E = DIAD and exports predicted by trading partners' DIAD. The table reports actual and predicted real goods import growth rates. Individual economies' growth rates are aggregated using average import shares over the 1985–2015 period to minimize fluctuations in the contribution of the constant to aggregate import growth. Columns (2)–(8) decompose predicted import growth based on equation (A.2.3.2). Columns (9)–(15) decompose predicted import growth based on equation (A.2.3.5), with column (13) denoting the contribution of export growth predicted based on trading partners' import-intensity-adjusted domestic demand.

Annex Table 2.3.9. Residuals: Real Goods Import Growth, Corrected for Potential Effect of Trade Policies on Aggregate Demand

	Correcting for Role of Trade Policies	
Full Sample	IAD*	(DIAD+E)*
Indicator 1985–2011	0.002	0.001
	(0.002)	(0.002)
Indicator 2012–15	–0.012	–0.021
	(0.002)	(0.004)
Number of Observations	2,840	2,817

Source: IMF staff calculations
Note: IAD = import-intensity-adjusted demand; DIAD = import-intensity-adjusted demand using only the domestic components of aggregate demand; DIAD+E = DIAD and exports predicted by trading partners' DIAD. The table reports point estimates and heteroscedasticity-robust standard errors in parentheses from estimating equation (A.2.3.6). Regressions are weighted by countries' nominal goods import shares.

flows. Part of this bias can be corrected by purging the aggregate demand components of the effect of trade policies prior to constructing the measure for import-intensity-adjusted demand. This is done in a first stage regression of these demand components on the factors of interest:

$$\Delta \ln AD^k_{c,t} = \delta_c + \boldsymbol{\gamma}_{\boldsymbol{c}}{}' \Delta \ln \mathbf{F}_{\boldsymbol{c,t}} + \nu^k_{c,t},$$

where $AD^k_{c,t}$ is a component of aggregate demand, $k \in \{C, G, I, X\}$ and $\mathbf{F}_{\boldsymbol{c,t}}$ is the vector of trade policies, in this case tariffs and participation in free trade agreements. The residuals from this first stage regression, $\nu^k_{c,t}$, which are by construction orthogonal to the trade policy variables, are used to construct the measure of import-intensity-adjusted demand as in equation (A.2.3.2):

$$IAD^*_{c,t} = \left(\nu^C_{c,t}\right)^{\omega_C} \left(\nu^G_{c,t}\right)^{\omega_G} \left(\nu^I_{c,t}\right)^{\omega_I} \left(\nu^X_{c,t}\right)^{\omega_X}.$$

The analysis is repeated as before using this measure, as well as for the alternative measures: (1) $DIAD^*$ and (2) absorption proxied by $DIAD^*$ and exports predicted by trading partners' $DIAD^*$.

Annex Table 2.3.9 presents the results from estimating equation (A.2.3.6) using the residuals obtained from the goods import demand model specified in equations (A.2.3.1), (A.2.3.3), and (A.2.3.5) using these alternatives measures of demand. The "missing" trade growth is slightly larger during 2012–15 when changes in aggregate demand have been purged of the role of trade policies.

Annex Table 2.3.10 decomposes the observed decline in trade growth between the 2012–15 and 2003–07 periods into shares predicted and unpredicted by the import demand model. A slightly smaller share of the slowdown is now attributed to changes in economic activity. For example, comparing 2012–15 with 2003–07, the baseline model can predict 85 percent of the decline in import growth for the average economy, while the model based on the import growth predicted by $DIAD^*$ and exports predicted by trading partners' $DIAD^*$ can predict 79 percent of the observed slowdown. The corresponding numbers using the alternative trade-policies-corrected measure are 79 percent and 70 percent, respectively.

Annex Table 2.3.10. Decomposing the Decline in Real Goods Import Growth Controlling for Trade Policies

		Baseline		Baseline Corrected for Trade Policies	
	Actual	IAD	DIAD+E	IAD*	(DIAD+E)*
Full Sample	(1)	(2)	(3)	(4)	(5)
2003–07	8.9	8.8	9.2	8.8	9.1
2012–15	2.3	3.2	4.0	3.6	4.4
Average Growth in 2012–15 Minus Average Growth					
2003–07	–6.6	–5.6	–5.2	–5.2	–4.6
Fraction of Import Growth Decline Predicted by Model					
2003–07		0.85	0.79	0.79	0.70

Source: IMF staff calculations.
Note: IAD = import-intensity-adjusted demand; DIAD = import-intensity-adjusted demand using only the domestic components of aggregate demand; DIAD+E = DIAD and exports predicted by trading partners' DIAD. The table reports actual and predicted real goods import growth rates. Individual economies' growth rates are aggregated using average import shares over the 1985–2015 period to minimize fluctuations in the contribution of the constant to aggregate import growth. Columns (2) and (4) estimate predicted import growth based on equation (A.2.3.3). Columns (3) and (5) estimate predicted import growth based on equation (A.2.3.5).

Annex 2.4. Analysis Using a General Equilibrium Model

The structural analysis presented in the section "The Role of Demand Composition and Trade Costs: Insights from a Structural Investigation" closely follows the model framework of Eaton and others (2010)—a multisector, multicountry, static general equilibrium model of production and trade, which nests the canonical Ricardian trade model of Eaton and Kortum (2002). A full description and derivation of this model can be found in Eaton and others (2010). This annex describes some of the key changes to the model as well as the data sources used.

Framework

One important modification is the inclusion of a fourth sector composed of commodities in addition to two manufacturing sectors (producing durable and nondurable goods) and the residual sector, which covers primarily services.[57] Production and trade in the commodity sector are modeled as for the manufacturing sectors, and so the functional forms of the equations for the latter can be applied to the former. This means there is an additional set of equilibrium conditions that serve to pin down prices, trade shares, and spending in the commodity sector.[58]

As described in the main text, observed trade dynamics can be attributed to changes in four factors in the model framework: (1) composition of demand, (2) trade costs (or frictions), (3) productivity, and (4) trade deficits. Following the business cycle accounting approach of Chari, Kehoe, and McGrattan (2007), these factors are often referred to as "wedges."

The solution method for the model uses the procedure developed by Dekle, Eaton, and Kortum (2007). The key endogenous variables (wages, spending, prices, trade shares) are expressed as a ratio of their end-of-period to beginning-of-period value (gross changes form) given values for the four wedges. Next, the wedges are solved for in a way that the variation in the key endogenous variables implied by the model's equations matches their variation in the actual data. Counterfactual scenarios—in which certain wedges are turned on and off—rely on the first step of this procedure, in which outcomes are pinned down taking the values of wedges as given. Since the framework is static, the solution procedure is run separately for consecutive year-pairs by feeding in data for two years at a time.

Calibrated parameters include the input-output coefficients, value-added coefficients, and the inverse measure of the dispersion of inefficiencies that governs the strength of comparative advantage in each sector. Following Eaton and others (2010), the inverse measure of the dispersion of inefficiencies is set to 2 and assumed to be the same for all sectors. The literature's estimates for this parameter vary greatly. Setting it to equal 8 as in Eaton and Kortum (2002) yields similar results. The remaining parameters are pinned down using the 2011 Organisation for Economic Co-operation and Development (OECD) Trade in Value database. The only exceptions to this are the value-added coefficients for the "rest of the world" category consisting of countries outside of the sample. Those coefficients are set so as to match the exports-to-production ratio of each sector in the data. The exports-to-production ratios are calculated by aggregating exports and production in 2013 for all countries in the Eora Multi-Region Input-Output database excluding the 34 countries used in the exercise.

Data

The estimation requires sectoral data on absorption, gross production, prices, and bilateral trade—very heavy data input. Numerous data sources were spliced to obtain the necessary time coverage through 2015. The sample consists of 17 advanced economies and 17 emerging market and developing economies listed in Group A of Annex Table 2.1.2. In 2015, six of those countries are excluded (Austria, Belgium, Colombia, Indonesia, Korea, Philippines) due to lack of disaggregated trade data at the time of the analysis. The data sources for the analysis are described in Annex Table 2.1.1.

For sectoral gross production, data through 2009 or 2011 are from the OECD Structural Analysis Database, where available. For countries not included in this database, World KLEMS, OECD Input-Output Tables, and Eora Multi-Region Input-Output database are used. For most advanced economies, national sources provide data through 2014, which are used to extrapolate forward the data from the multinational sources. Remaining gaps in the data are filled using the growth rates of sectoral industrial production and producer price indices. These

[57]Sectors are aggregated along the lines of Eaton and others (2010) with the exception that (1) mining and quarrying, and (2) coke, refined petroleum products, and nuclear fuel are stripped out from the residual services sector and used to quantify the commodities sector.

[58]The modified system of equations is available on request from the authors.

indices tend to be more disaggregated than the four sectors considered in the analysis. The weights for this aggregation are based on the latest available production data. For the bilateral sectoral import and export flows, data for Belgium and the Philippines are rescaled such that total import and exports from the United Nations Commodity Trade Statistics database match those from the IMF World Economic Outlook database to adjust for the inclusion of re-exports in the former.

Annex 2.5. Analysis at the Product Level

This annex provides additional details on the empirical analysis carried out in the section "The Role of Trade Costs and Global Value Chains: Insights from Disaggregated Trade Data." It starts with an overview of the data used to construct the measures for the other factors that could be relevant to explaining the trade slowdown (see also Annex Table 2.1.1), followed by a technical overview of the baseline specification used in that section. It also presents alternative specifications that assess the robustness of the main results.

Data

Trade costs—The chapter uses the methodology set out by Novy (2012). (Tariff-equivalent) trade costs, t_{ij}, are derived from a gravity model of trade as a geometric average of bilateral trade flows between countries i and j, $X_{ij} \neq X_{ji}$, relative to domestic trade flows within each country, $X_{ii} \neq X_{jj}$:

$$t_{ij} = \left(\frac{X_{ii}X_{jj}}{X_{ij}X_{ji}}\right)^{\frac{1}{2(\sigma-1)}} - 1. \qquad \text{(A.2.5.1)}$$

Countries trading more with each other than they trade with themselves is an indication that international trade costs must be falling relative to domestic trade costs. Trade costs are computed at the sectoral level using bilateral sectoral trade data and domestic shipments (that is, intranational trade), which, following the literature, is proxied by gross sectoral output minus total exports. All the data for this exercise is from the Eora Multi-Region Input-Output (MRIO) database.

Tariffs—Data on tariffs are constructed from two sources with detailed information on tariffs for products at the Harmonized System six-digit level: (1) the United Nations Conference on Trade and Development Trade Analysis and Information System database, and (2) the World Trade Organization (WTO) Tariff Download Facility. To extend the historical coverage for average tariffs at the country level, the series on average ad valorem tariffs from United Nations Conference on Trade and Development and WTO is spliced with the country-level series from the IMF Structural Reform database (IMF 2008).

Nontariff barriers—Detailed data on more than 30 different national governments' use of policies, such as antidumping, countervailing duties, and safeguard measures, are obtained from the World Bank Temporary Trade Barriers database for 1990–2015 (see Bown 2016). This data set lists temporary trade barriers at a highly disaggregated level (Harmonized System eight-digit or more detailed), including information on their revocation, which makes it possible to calculate the stock of barriers effective in each year.[59] More comprehensive data on a broader range of nontariff barriers are taken from the Center for Economic and Policy Research Global Trade Alert initiative. This includes not only the trade defense measures, but also other state measures taken since 2009 that are likely to discriminate against foreign commerce—for example, localization requirements, bailouts, and state aid.

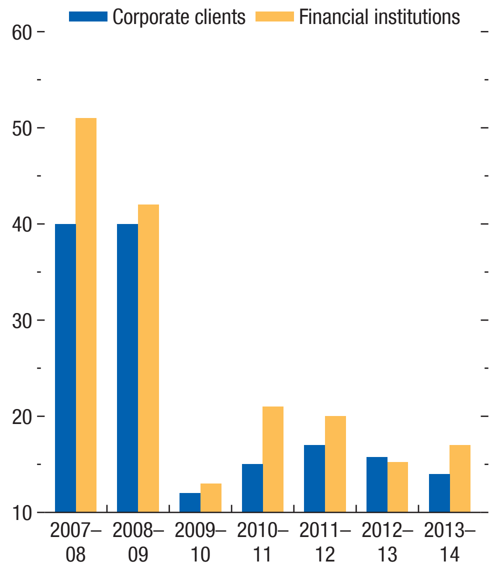
Free trade agreements—Data on flows of agreements by year of signature are obtained from the Design of Trade Agreements database. This data set is complemented by the stock of free trade agreements in force from the WTO Regional Trade Agreements database. The former builds on the latter, supplementing it with data from other multilateral institutions and national sources.

Global value chain participation—Input-output matrices from the Eora MRIO database for 173 countries are used. The measure of vertical specialization employed (developed by Hummels, Ishii, and Yi 2001) is computed as the sum of the import content in a country's exports (also known as foreign value added) and the domestic content of a country's exports that is used by trading partners for their own exports (see Koopman, Wang, and Wei 2014). This total is expressed as a ratio of gross exports.

Trade finance—Changes in trade finance availability also directly influence overall trade costs. Data from the International Chamber of Commerce Global Trade and Finance Survey were used to gauge whether the availability for trade credit has been growing or shrinking since the global financial crisis. The proportion of banks reporting a decrease in trade credit lines to both

[59]These calculations follow those described in the appendix of Bown (2011).

Annex Figure 2.5.1. Trade Finance Availability
(Percent of responding banks reporting a decrease in trade finance credit lines offered)



Sources: International Chamber of Commerce, Global Trade and Finance Survey; and IMF staff calculations.
Note: The chart is based on an unbalanced sample of banks comprising 122 banks in 59 countries in 2009 and 482 banks in 112 countries in 2015.

corporate clients and financial institutions has more than halved since 2008–09 (Annex Figure 2.5.1).

Product-Level Regressions

The analysis in the section on the role of trade costs and global value chains uses an augmented model of import demand that relates the product-level growth rate of imports to product, country, or product-country characteristics that are meant to capture factors proposed in the literature that could help explain the recent trade slowdown. The analysis uses data on import volumes across about 780 products, defined using Standard International Trade Classification revision 2, for 52 economies since 2003 (see the list of economies of Groups A and B in Annex Table 2.1.2). The baseline specification is

$$\Delta \ln M_{p,c,t} = \alpha + \delta_{p,c} + \delta_t + \beta_1' \mathbf{X}_{p,c,t} + \beta_2 \Delta \ln D_{s,c,t} + \beta_3 \Delta \ln P_{c,t} + \varepsilon_{p,c,t}, \quad \text{(A.2.5.2)}$$

in which $\Delta \ln M_{p,c,t}$ is the growth rate of real imports of product p by country c in period t; $\delta_{p,c}$ are product-country fixed effects; and δ_t are time fixed effects.

The equation also controls for the demand (or absorption) in sector s to which a particular product can be mapped, $D_{s,c,t}$, and relative import prices at the country level, $P_{c,t}$. In the absence of a measure of demand at the product level, the chapter maps all products to more aggregated sectors. The chapter uses the Eora Multi-Region Input-Output matrices to compute the intensity with which each of the 10 nonservices sectors is used both directly or indirectly in the four components of an economy's aggregate demand. As with the empirical exercise using import-intensity-adjusted demand, these intensities are used as sector-specific weights for aggregate consumption, investment, government spending, and exports to construct a proxy for the absorption of a particular sector.[60] Relative prices are computed as the ratio of the import price deflator to the GDP deflator, as in the analysis discussed in the section "The Role of Output and Its Composition: Insights from an Empirical Investigation."[61]

The variable, $\mathbf{X}_{p,c,t}$, represents a vector of trade policy measures and other factors, which are included in the regression at either the product-country, sector-country, or country level to understand how product-level import growth varies with them. These include: (1) growth in tariff rates at the product level, (2) a dummy variable that captures whether a particular product category was subject to a temporary trade barrier (trade defense measure) in year t, (3) the growth in the share of global GDP that is covered by the free trade agreements a country is party to, and (4) growth in a measure of backward global value chain participation, expressed as the share of foreign value added in sectoral gross exports. Of these, only participation in free trade agreements varies at the country-year level, while participation in global value chains varies at the sector-country-year level. Tariffs and nontariff barriers are measured at the product level.

In addition (and as a cross-check) to the product-level analysis, a similar augmented import demand model is estimated at the aggregate level. In particular, the analysis pools the estimated residuals from the empirical import demand model estimated in the

[60]All products within each of the 10 nonservices sectors used in the standardized input-output matrices are assumed to have the same absorption.

[61]Ideally, equation (A.2.5.1) should include sector-level prices. While the import deflator for a particular product can be constructed, disaggregated data on domestic prices are not available. Hence, the same relative price change is applied for all products in an economy.

Annex Table 2.5.1. Alternative Specifications for Real Imports in Product-Level Regressions

Dependent Variable (Real)	A. Product and Country				
Sample Period: 2003–13	Import Growth			Level of Imports	Imports-to-Sectoral Demand
	(1)	(2)	(3)	(4)	(5)
Temporary Trade Barriers	–0.031***	–0.037***	–0.036***	–0.033*	–0.031*
	(0.009)	(0.009)	(0.011)	(0.017)	(0.016)
Tariffs	–0.016**	–0.030***	–0.038***	–0.146***	–0.131***
	(0.008)	(0.008)	(0.009)	(0.022)	(0.021)
Free Trade Agreement Coverage	0.106**	0.143***	0.304***	0.134***	0.110***
	(0.054)	(0.053)	(0.060)	(0.013)	(0.012)
Global Value Chain Participation	0.095**	0.474***	0.835***	0.410***	0.322***
	(0.041)	(0.038)	(0.030)	(0.058)	(0.056)
Country x Product Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	No	No	No	No
Control for Demand and Relative Prices	Yes	Yes	No	No	No
R^2	0.293	0.261	0.176	0.978	0.979
Adjusted R^2	0.208	0.173	0.077	0.975	0.977
Number of Observations	258,196	258,196	262,340	292,068	292,068

Source: IMF staff calculations.
Note: Global value chain participation is a measure of backward participation: foreign value added in exports as share of gross exports. In the product-country-level regressions, this variable is calculated at the sectoral level. Standard errors are clustered at the product-country level for regressions A and at the country level in regression B.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

section "The Role of Output and Its Composition: Insights from an Empirical Investigation," according to equation (A.2.3.5) (in other words, real goods import growth that cannot be predicted by fluctuations in import-intensity-adjusted demand and relative prices). The product- and sector-level measures for trade policy and global value chain participation are aggregated up to the country level and used as right-hand-side variables in the following regression equation:

$$\widehat{\varepsilon_{c,t}} = \alpha + \phi_c + \phi_t + \beta' \mathbf{X}_{c,t} + \xi_{c,t}, \qquad \text{(A.2.5.3)}$$

where $\widehat{\varepsilon_{c,t}}$ are the estimated residuals and $\mathbf{X}_{c,t}$ are the same trade policy and global value chain factors at the country level.

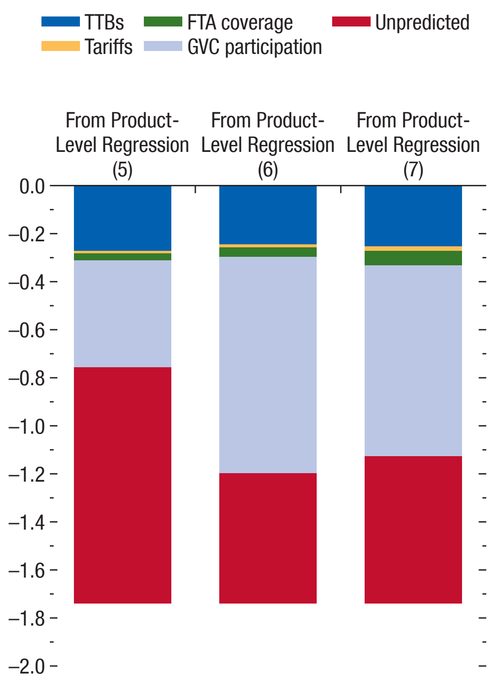
Decomposing the Slowdown into the Role for Other Factors

The final step of the analysis quantifies how much additional decline in import growth one would have expected based on the historical association between trade policies, global value chain participation and import growth, and the evolution of these other factors. The elasticities from the country-level equation (A.2.5.3), β, are combined with differences in the growth rate of the different factors at the product level, $X_{p,c,t}$, between 2012–15 and 2003–07 to compute the relative contribution of each factor. Annex Figure 2.5.2 shows the proportion of the estimated country-specific residuals according to equation (A.2.3.5)—that is, that component of import growth not accounted for by import-intensity-adjusted demand—that can be attributed to these other factors, for both real and nominal import growth.

Robustness

The baseline specification in equation (A.2.5.1) for the product-level regressions was subject to a number of robustness tests. In particular, because the relationship between imports and other factors beyond demand was specified in terms of growth rates, it was important to understand whether similar elasticities were recovered using the levels of the same of variables, as is often done in the literature (see, for example, Box

Annex Figure 2.5.2. Contribution of Trade Policies and Global Value Chains to the Slowdown in Real and Nominal Goods Import Growth
(Percent)



Source: IMF staff calculations.
Note: TTB = temporary trade barrier; FTA = free trade agreement; GVC = global value chain. The figure combines the estimated historical association between real and nominal product-level import growth, and growth in trade costs and global value chain participation, and the differences in the growth rate of these factors between 2003–07 and 2012–15 to compute their contribution to the observed trade slowdown.

2.1). A version using the ratio of real-imports-to-GDP (with the denominator proxied by sectoral demand) on the left-hand side was also estimated.[62] In addition, alternative specifications that omitted the time fixed effects and controls for demand and relative prices were also tested. Omitting time fixed effects can be justified given the synchronicity in the timing of reduction on trade barriers and development of global value chains across countries. In such a setting, including time fixed effects would absorb a large fraction of the variation in trade policies and global value chain measures. To the extent that sectoral demand (and growth) is one of the channels through which trade policies affect import growth, a specification that does not control for sectoral demand could also be useful in gauging what is the correct elasticity of import growth with respect to these other factors.

The exercises show that the findings are generally robust to various modifications of the estimated specifications (Annex Table 2.5.1). However, the exclusion of time fixed effects leads to an increase in the role of tariffs and global value chain participation. This is likely due to the fact that the reduction in trade costs and gradual increase in global value chain participation over time was common to all countries.

The same alternative specifications were also run using nominal imports (growth and level and as a ratio of sectoral demand). The results were once again broadly similar, with a stronger role for import tariffs and global value chains once the common time trends were no longer controlled for (Annex Table 2.5.2).

Annex 2.6. Analysis Using Gravity Model of Trade

This annex provides additional details on the empirical analysis carried out in the section "The Role of Trade Costs and Global Value Chains: Insights from Disaggregated Trade Data" using the gravity model of trade. It provides an overview of the data and describes the methodology used.

Data

The data set used in the gravity model is an extension of the bilateral-sectoral database of trade flows from Chapter 2 of the October 2010 *World Economic Outlook*. The data set is extended by using United Nations Commodity Trade Statistics data on bilateral trade flows at the Standard International Trade Classification revision 2, four-digit level. It includes about 780 uniquely identified products and their bilateral trade flows from 1998–2014. To analyze the connection between trade and global value chains, the 780 sectoral trade flows are mapped into the 10 nonservices sectors used in the Eora Multi-Region Input-Output database and aggregated accordingly. Those resulting bilateral-sectoral trade flows are combined with the IMF Direction of Trade Statistics database and the Head, Mayer, and Ries (2010) database on gravity variables. Countries' participation in free trade agreements is

[62]At the product level, the ratio used was that of product-level imports to sectoral demand.

Annex Table 2.5.2. Alternative Specifications for Nominal Imports in Product-Level Regressions

Dependent Variable (Nominal)	A. Product and Country				
	Import Growth			Level of Imports	Imports-to-Sectoral Demand
Sample Period: 2003–13	(1)	(2)	(3)	(4)	(5)
Temporary Trade Barriers	–0.029***	–0.037***	–0.035***	–0.020	–0.018
	(0.007)	(0.009)	(0.011)	(0.019)	(0.018)
Tariffs	–0.034***	–0.057***	–0.067***	–0.205***	–0.167***
	(0.007)	(0.007)	(0.009)	(0.021)	(0.020)
Free Trade Agreement Coverage	0.205***	0.325***	0.534***	0.218***	0.186***
	(0.055)	(0.056)	(0.063)	(0.017)	(0.016)
Global Value Chain Participation	0.170***	0.719***	1.220***	1.109***	0.916***
	(0.041)	(0.043)	(0.031)	(0.065)	(0.061)
Country x Product Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	No	No	No	No
Control for Demand and Relative Prices	Yes	Yes	No	No	No
R^2	0.407	0.337	0.213	0.975	0.977
Adjusted R^2	0.338	0.260	0.122	0.972	0.975
Number of Observations	270,587	270,587	275,424	303,727	297,374

Source: IMF staff calculations.
Note: Global value chain participation is a measure of backward participation: foreign value added in exports as share of gross exports. In the product-country-level regressions, this variable is calculated at the sectoral level. Standard errors are clustered at the product-country level for regressions A and at the country level in regression B.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

updated using the World Trade Organization Regional Trade Agreements database.

Methodology

The analysis is performed in the three stages described below.

First and Second Stages: Gravity Model Estimation and Residuals Collection

The first stage of the methodology estimates the gravity model for each year t (between 2003 and 2014) and sector s. The gravity model is first estimated in levels:

$$\forall s, t{:}\ln M_{i,e,s,t} = \alpha_{i,s,t} + \mu_{e,s,t} + \vec{\beta}_{s,t}\,\overrightarrow{Gravity}_{i,e,s,t} + \varepsilon_{i,e,s,t}, \tag{A.2.6.1}$$

in which $\ln M_{i,e,s,t}$ is the log of nominal imports between an importer i and an exporter e, $\alpha_{i,s,t}$ denotes importer fixed effects, and $\mu_{e,s,t}$ denotes exporter fixed effects. $\overrightarrow{Gravity}_{i,e,s,t}$ is a vector of standard variables used in gravity models: distance; number of hours difference between exporters and importers; and indicators for contiguity, common official language, common ethnological language, common colonizer, existence of colonial relationship post-1945, trade from colonizer to colony, trade from colony to colonizer, currently in colonial relationship, regional trade agreement in force, common legal system, common religion, common currency, and generalized system of preferences. Finally, $\varepsilon_{i,e,s,t}$ is the error term, which is collected for the third stage of the analysis.

The gravity model is also estimated in terms of annual growth rates for 2004–14:

$$\forall s, t{:}\ln M_{i,e,s,t} - \ln M_{i,e,s,t-1} = \sigma_{i,s,t} + \pi_{e,s,t} + \vec{\omega}_{s,t}\,\overrightarrow{Gravity}_{i,e,s,t} + \varsigma_{i,e,s,t}, \tag{A.2.6.2}$$

in which similarly $\sigma_{i,s,t}$ denotes importer fixed effects, $\pi_{e,s,t}$ denotes exporter fixed effects, $\overrightarrow{Gravity}_{i,e,s,t}$ is the same vector of gravity variables discussed above, and $\varsigma_{i,e,s,t}$ is an independent and identically distributed error term, which is collected for the third stage of the analysis.

Third Stage: Linking Value Chains to the Unexplained Component of Trade Growth

In the third stage, the analysis investigates whether there is an association between the initial value of value chain linkages between two economies in a particular sector and trade growth for that country-pair sector. Using the same notation, the estimated equation is

$$\widehat{\varepsilon_{i,e,s,t}} - \widehat{\varepsilon_{i,e,s,t-1}} = \gamma + \varphi_s GVC_{i,e,s,t-1} + \vartheta_{i,e,s,t}, \quad \text{(A.2.6.3)}$$

or

$$\widehat{\varsigma_{i,e,s,t}} = \gamma + \varphi_s GVC_{i,e,s,t-1} + \vartheta_{i,e,s,t}, \quad \text{(A.2.6.4)}$$

in which γ is a constant, $GVC_{i,e,s,t-1}$ measures the lagged share of *foreign value added exports to gross exports* in a particular economy-pair-sector, and $\vartheta_{i,e,s,t}$ is an independent and identically distributed error term. The estimation allows for sector-specific effects of *GVC*, φ_s.

The results of this test are reported in columns (1), (4), (7), (10), and (13) of Annex Tables 2.6.1 (estimation of gravity in levels) and 2.6.2 (estimation of gravity in growth rates) for different country and sectoral samples. They indicate a robust positive association between sectoral trade growth and value chain link linkages over the 2003–14 period.

The second test investigates whether trade in country-pair-sector combinations with high degree of value chain linkages during the 2003–07 period grew more rapidly than trade in country-pair-sector combinations with lower degree of value chain linkages in different sample periods. In this exercise, the analysis considers a time-invariant measure of global value chain linkages, which is an indicator that takes the value of 1 if the average global value chain participation for a particular country-pair-sector over the 2003–07 period is in the top quartile of the distribution of those value chain linkages (*High GVC participation*). The following regression is then estimated:

$$\widehat{\varepsilon_{i,e,s,t}} - \widehat{\varepsilon_{i,e,s,t-1}} = \delta + \theta_s (\textit{High GVC participation})_{i,e,s,2003\text{-}07} + \xi_{i,e,s,t} \quad \text{(A.2.6.5)}$$

or

$$\widehat{\varsigma_{i,e,s,t}} = \delta + \theta_s (\textit{High GVC participation})_{i,e,s,2003\text{-}07} + \xi_{i,e,s,t}, \quad \text{(A.2.6.6)}$$

in which δ is again a constant and $\xi_{i,e,s,t}$ is the error term. Again, the estimation allows for sector-specific effects of global value chains, θ_s.

The results of this test are reported in the remaining columns of Annex Tables 2.6.1 and 2.6.2. Figure 2.14 displays the results from columns (8) and (9) of those tables, whereas the other columns show the robustness of the findings when using different country and sectoral samples.

Annex Table 2.6.1. Link between Global Value Chain Integration and Yearly Nominal Import Growth Using Gravity Model Estimated in Levels

(Percentage points; year-over-year increase in nominal import growth for country-pair-sectors)

Dependent Variable	Unpredicted Bilateral Import Growth by Year (Gravity Model Estimated on Level of Nominal Imports), 2003–14														
	(Percent, year over year)														
	(1)	(2)	(3)	(4)[2]	(5)[2]	(6)[2]	(7)[3]	(8)[3]	(9)[3]	(10)[4]	(11)[4]	(12)[4]	(13)[5]	(14)[5]	(15)[5]
GVC Participation ($t-1$)	0.021**			0.027***			0.026***			0.028***			0.032***		
	(0.008)			(0.010)			(0.010)			(0.010)			(0.012)		
High GVC Participation Dummy[1] (2003–14)		1.403***			1.256**			1.379*			0.857			1.103**	
		(0.476)			(0.499)			(0.738)			(0.759)			(0.552)	
High GVC Participation Dummy[1] (pre–2012) [I]			1.185**			1.289**			1.770**			1.251			1.693***
			(0.548)			(0.591)			(0.821)			(0.793)			(0.638)
High GVC Participation Dummy[1] × Post–2012 Dummy [II]			0.547			-0.064			-0.909			-0.929			–1.510*
			(0.838)			(0.874)			(1.351)			(1.442)			(0.900)
Constant	–0.603**	–0.474**	–0.474**	–1.046***	–0.709***	–0.709***	–0.910***	–0.539**	–0.539**	–1.017***	–0.524**	–0.524**	–1.243***	–0.761***	–0.761***
	(0.281)	(0.220)	(0.220)	(0.330)	(0.238)	(0.238)	(0.311)	(0.227)	(0.227)	(0.312)	(0.225)	(0.225)	(0.350)	(0.243)	(0.243)
High GVC Participation Total Effect (2012–14) [I + II]			1.732**			1.225*			0.861			0.322			0.183
			(0.730)			(0.741)			(1.189)			(1.300)			(0.792)
F-Test	3.720***	4.100***	3.240***	3.720***	4.080***	3.290***	4.340***	3.850***	3.010***	4.580***	2.630***	2.210***	3.550***	3.520***	2.890***
Analytical Weights	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Pair-Sectors	31,126	31,126	31,126	20,492	20,492	20,492	19,263	19,263	19,263	17,220	17,220	17,220	15,642	15,642	15,642
Number of Observations	364,968	364,968	364,968	252,064	252,064	252,064	229,799	229,799	229,799	204,260	204,260	204,260	202,293	202,293	202,293

Source: IMF staff calculations.

Note: Regressions allow (Eora Multi-Region Input-Output) sector-specific coefficients jointly estimated with standard errors clustered by country-pair-sector. GVC = global value chain. GVC participation is measured as foreign valued added in exports as share of gross exports. Weights are defined as levels of nominal imports.

[1] Dummy equaling 1 for those country-pair-sectors in the top quartile of the distribution of the mean of GVC participation across time (time invariant using period 2003–07 to compute the mean).

[2] Excludes commodity exporters.

[3] Keeps data from importers with national input-output tables; see Lenzen and others (2013).

[4] Uses the same importing-country sample employed in the product level analysis.

[5] Excludes commodity exporters and low-income countries, the commodity sector, and outlier values of GVC participation above 150 percent.

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Annex Table 2.6.2. Link between Global Value Chain Integration and Yearly Nominal Import Growth Using Gravity Model Estimated in Growth Rates
(Percentage points; year-over-year increase in nominal import growth for country-pair-sectors)

Dependent Variable	Unpredicted Bilateral Import Growth by Year (Gravity Model Estimated on Growth Rate of Nominal Imports), 2003–14														
	(Percent, year over year)														
	(1)	(2)	(3)	(4)[2]	(5)[2]	(6)[2]	(7)[3]	(8)[3]	(9)[3]	(10)[4]	(11)[4]	(12)[4]	(13)[5]	(14)[5]	(15)[5]
GVC Participation ($t-1$)	0.023***			0.023***			0.031***			0.032***			0.032***		
	(0.008)			(0.010)			(0.009)			(0.010)			(0.011)		
High GVC Participation Dummy[1] (2003–14)		1.647***			1.202**			1.067			2.131***			0.975*	
		(0.464)			(0.502)			(0.689)			(0.621)			(0.522)	
High GVC Participation Dummy[1] (pre–2012) [I]			1.559***			1.405**			1.397*			2.087***			1.530**
			(0.578)			(0.594)			(0.792)			(0.765)			(0.632)
High GVC Participation Dummy[1] × Post–2012 Dummy [II]			0.229			–0.517			–0.767			0.113			–1.408
			(0.886)			(0.851)			(1.364)			(1.474)			(0.887)
Constant	–0.598*	–0.464**	–0.464**	–0.925**	–0.651**	–0.651**	–1.017***	–0.451*	–0.451*	–1.075***	–0.547**	–0.547**	–1.335***	–0.837***	–0.837***
	(0.308)	(0.230)	(0.230)	(0.372)	(0.273)	(0.273)	(0.341)	(0.254)	(0.254)	(0.344)	(0.256)	(0.256)	(0.349)	(0.241)	(0.241)
High GVC Participation Total Effect (2012–14) [I + II]			1.788**			0.888			0.630			2.200*			0.122
			(0.712)			(0.730)			(1.154)			(1.165)			(0.741)
F-Test	4.810***	4.870***	4.310***	4.450***	3.680***	3.550***	5.210***	2.790***	2.590***	5.370***	2.770***	2.570***	3.890***	3.420***	3.680***
Analytical Weights	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Pair-Sectors	48,329	48,341	48,341	29,580	29,589	29,589	28,171	28,176	28,171	24,418	24,420	24,420	20,451	20,458	20,458
Number of Observations	446,968	448,302	448,302	297,500	298,202	298,202	266,479	266,992	266,479	231,657	232,040	232,040	228,559	228,954	228,954

Source: IMF staff calculations.
Note: Regressions allow (Eora Multi-Region Input-Output) sector-specific coefficients jointly estimated with standard errors clustered by country-pair-sector. GVC = global value chain. GVC participation is measured as foreign valued added in exports as share of gross exports. Weights are defined as levels of nominal imports.
[1] Dummy equaling 1 for those country-pair-sectors in the top quartile of the distribution of the mean of GVC participation across time (time invariant using period 2003–07 to compute the mean).
[2] Excludes commodity exporters.
[3] Keeps data from importers with national input-output tables; see Lenzen and others (2013).
[4] Uses the same importing-country sample employed in the product level analysis.
[5] Excludes commodity exporters and low-income countries, the commodity sector, and outlier values of GVC participation above 150 percent.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

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