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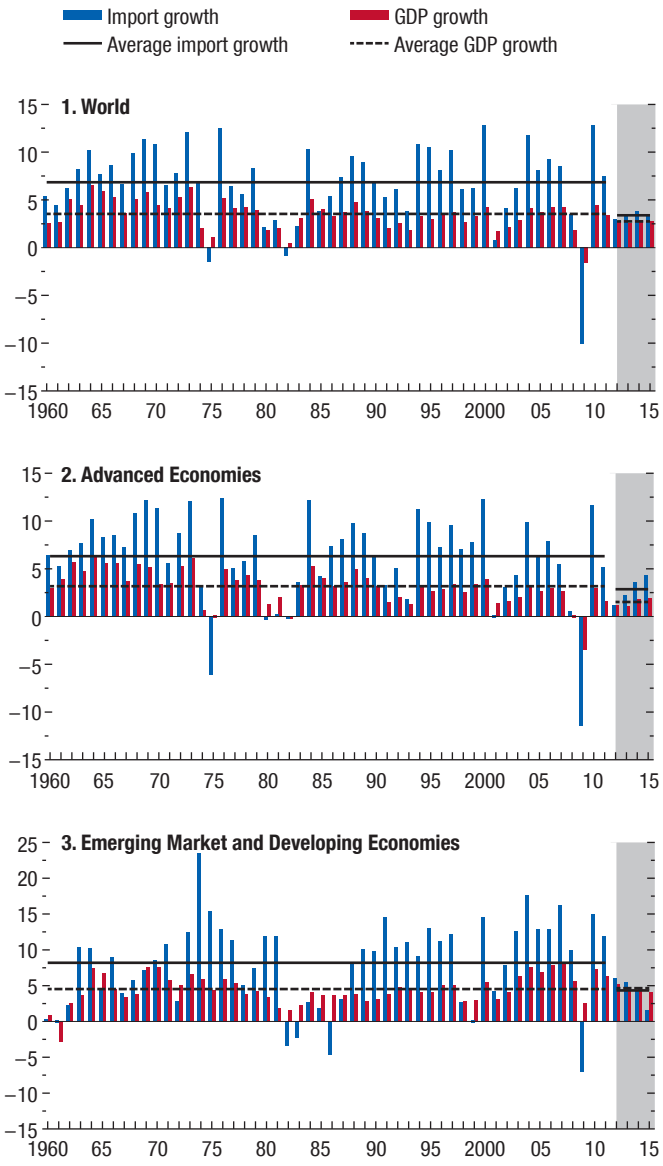
[1]See Hoekman (2015) and papers therein for an analysis of the global trade slowdown. Relative to the studies in Hoekman (2015), the chapter's approach allows for a more comprehensive horse race among the various hypotheses for a large number of economies and using a range of analytical approaches.

[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 are 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) and (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).

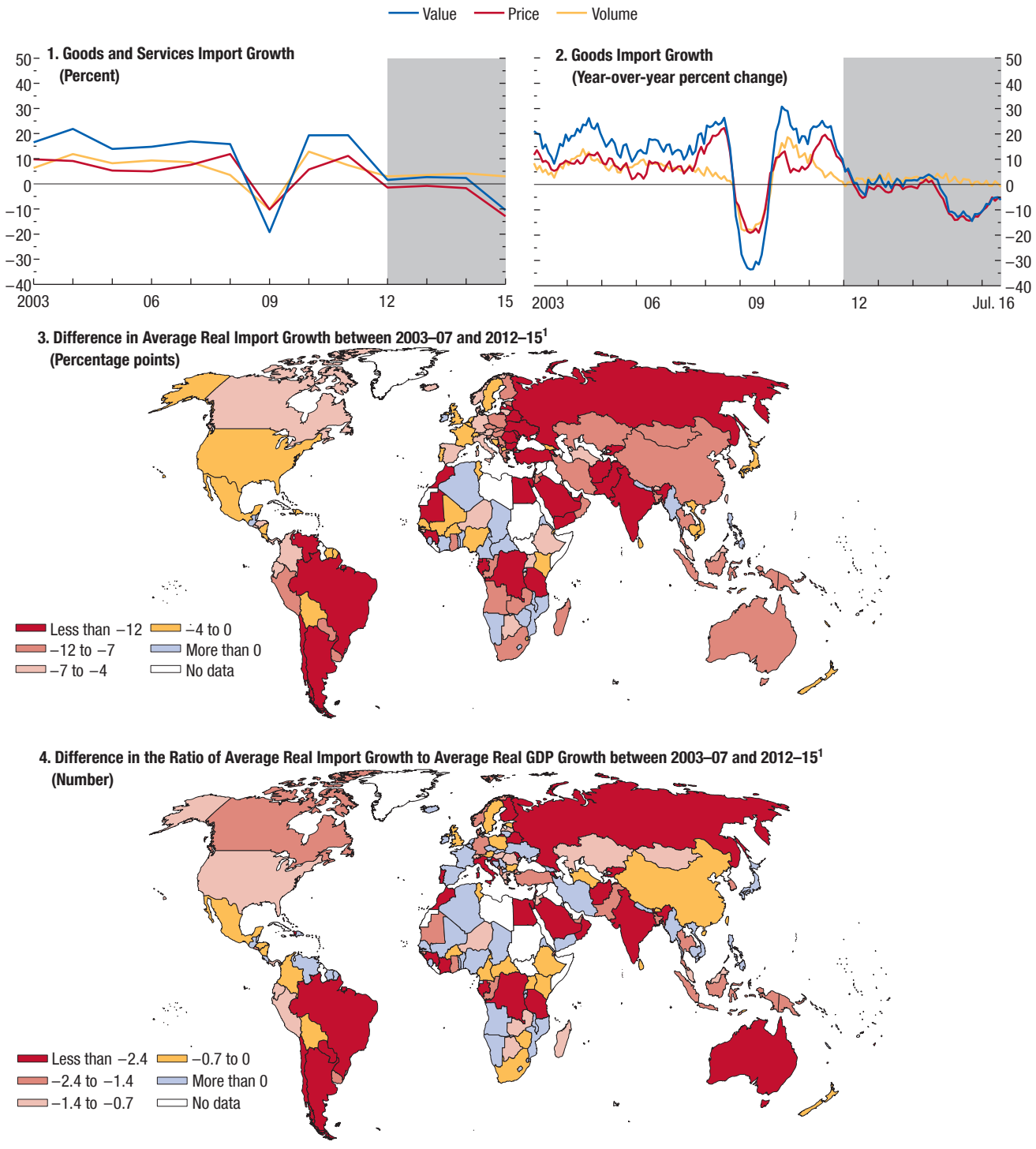
[14]See Chapter 3 of this WEO for a discussion of the effect of import prices on global inflation.

[15]In fact, according to the CPB *World Trade Monitor*, as of June 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.



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 explain 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.

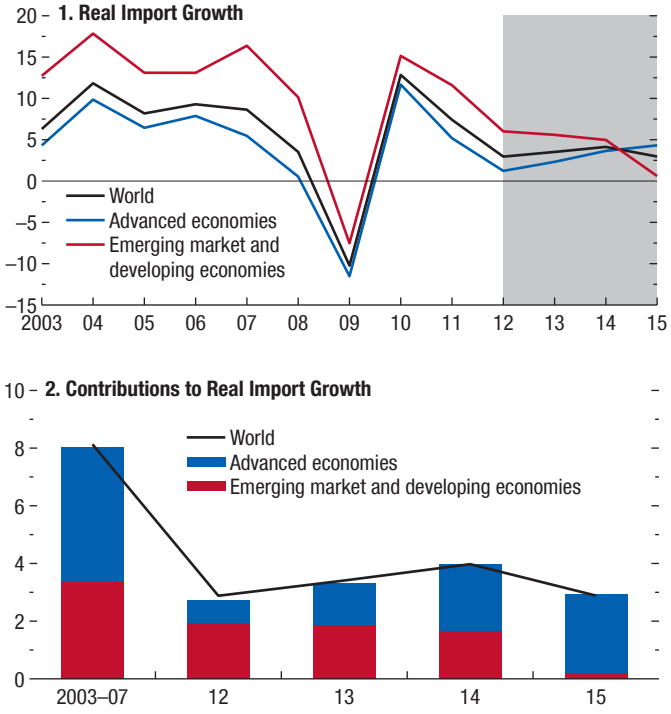
[18]A closer examination of nominal services trade across sectors reveals that trade in information and communication technologies, travel, and financial services has been significantly more resilient than trade in other services. (See Annex 2.1.)

[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)

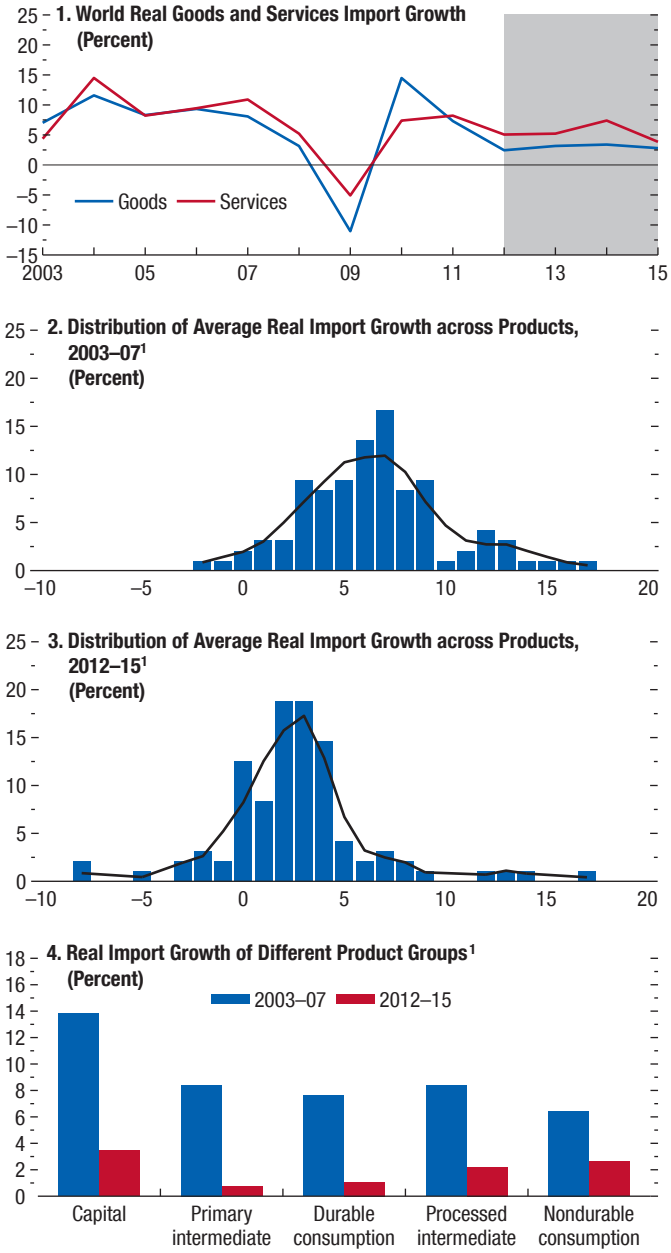
Not all economies experienced the slowdown in trade at the same time. In advanced economies, import growth fell sharply in 2012. In emerging market and developing economies, the decline in import growth became more severe in 2014 and 2015.



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.

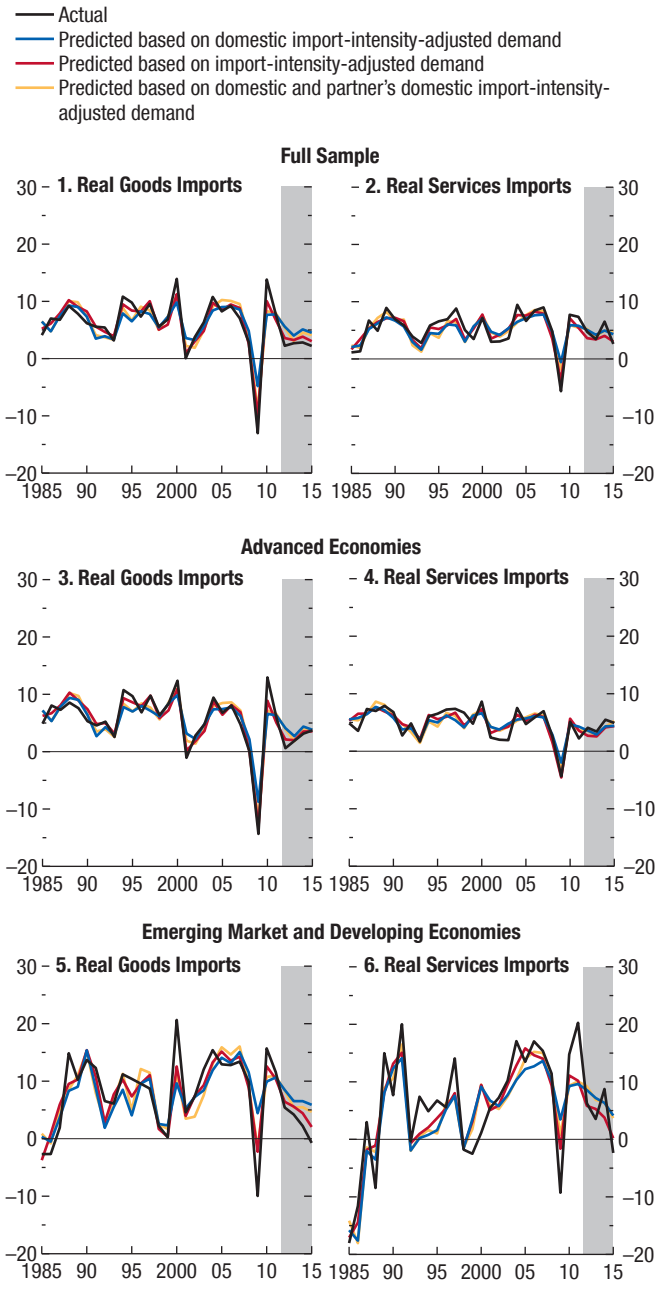
[22]Import-intensity-adjusted demand is computed as $IAD_t = C_t^{\omega_C} G_t^{\omega_G} I_t^{\omega_I} X_t^{\omega_X}$, in which ω_k is the import content of each of the expenditure components for $k \in \{C, G, I, X\}$, normalized to sum to 1. Import content is computed from the Eora Multi-Region Input-Output country-specific input-output 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.

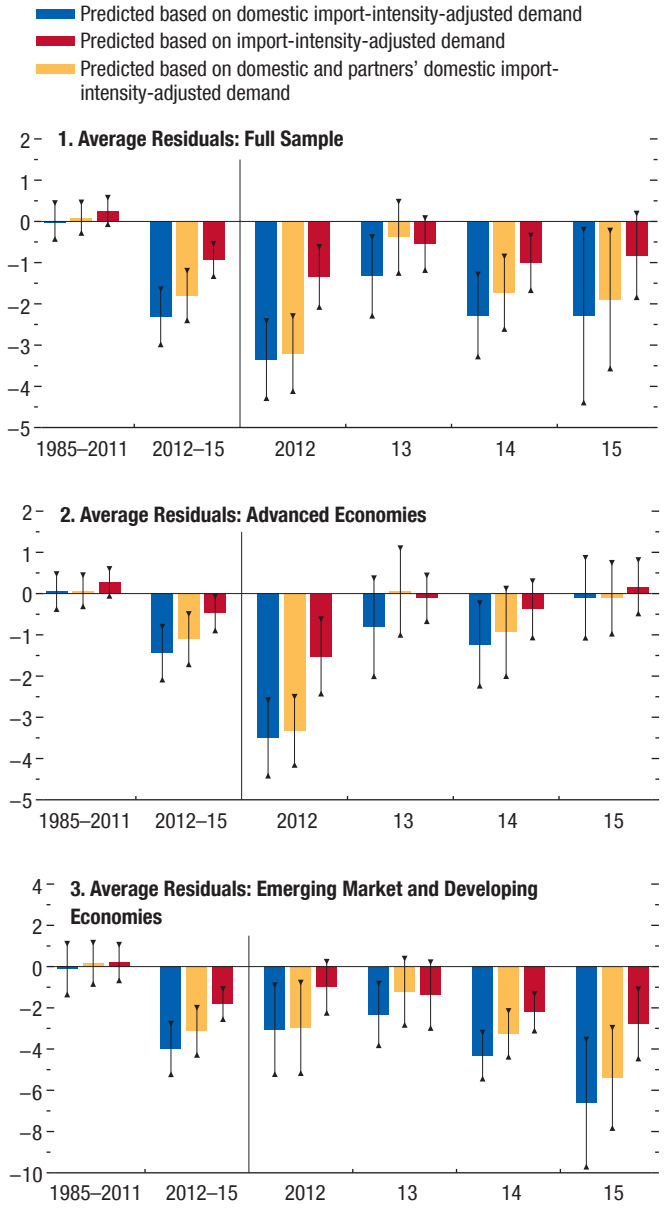
Regarding the second result, the extent to which the decline of exports underlies the slowdown of import growth in individual economies reflects two factors: (1) the tight linkages between a country's imports and exports as production processes become increasingly fragmented across borders and (2) the

[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.

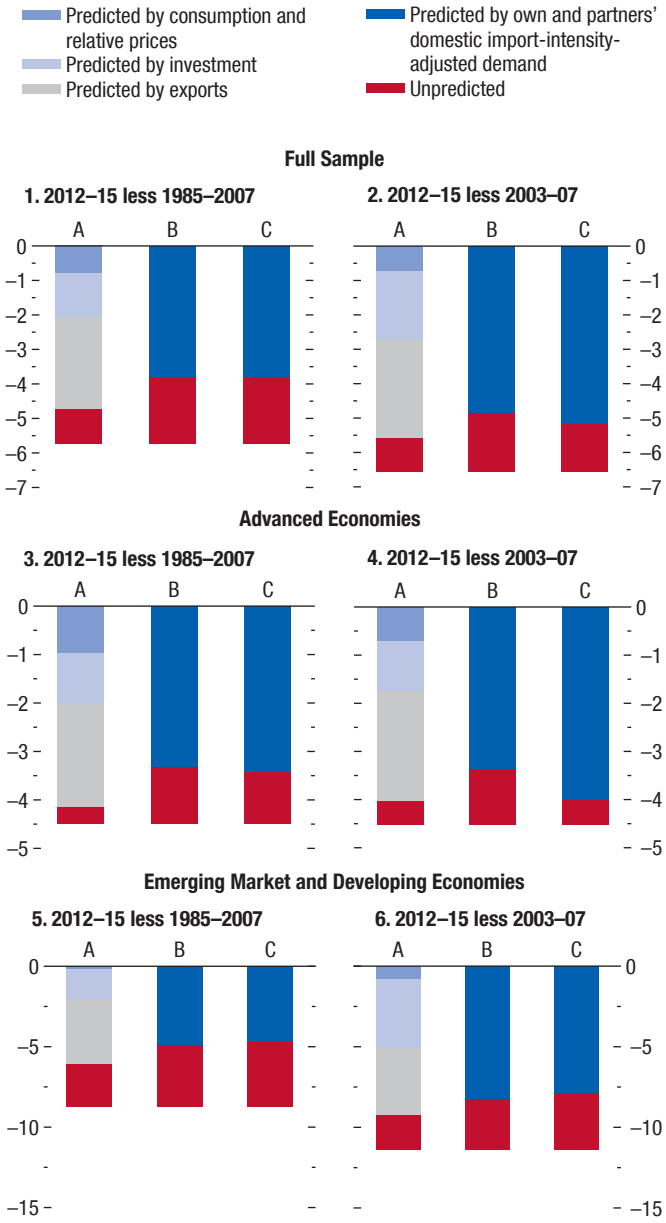


Source: IMF staff calculations.
Note: Bars display the average residuals, weighted by import shares, from an import demand model, estimated country-by-country, linking real import growth to growth in import-intensity-adjusted demand and relative import prices. Black markers denote the 90 percent confidence 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 24.

[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.

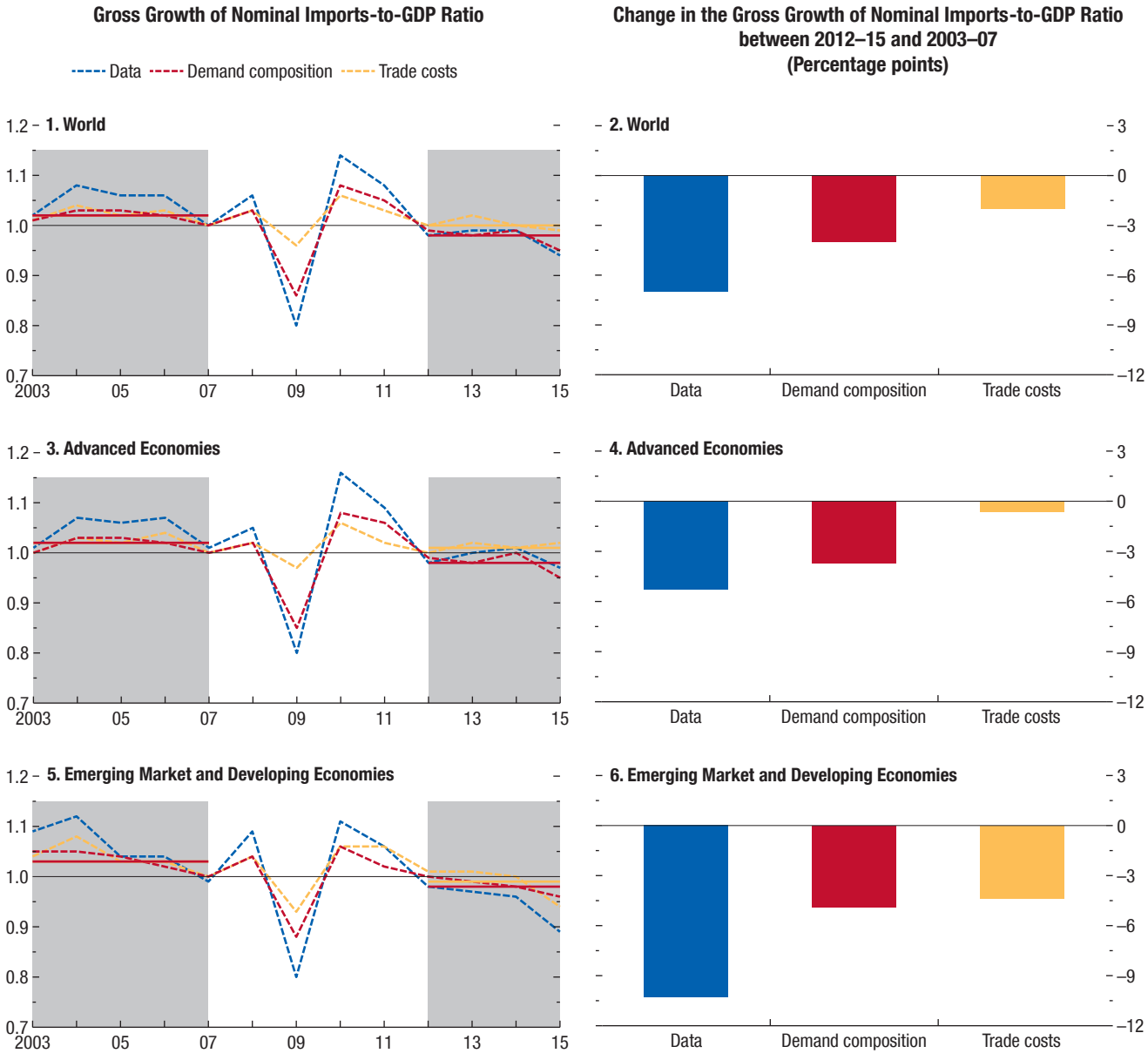
[33]In this Ricardian model of trade, trade in commodities occurs as a result of differences in the efficiency of production. This can be mapped to the real world—for example, oil importers have reservoirs deep underground and extraction is more inefficient than for oil exporters.

[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 both due to 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 one 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; (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.

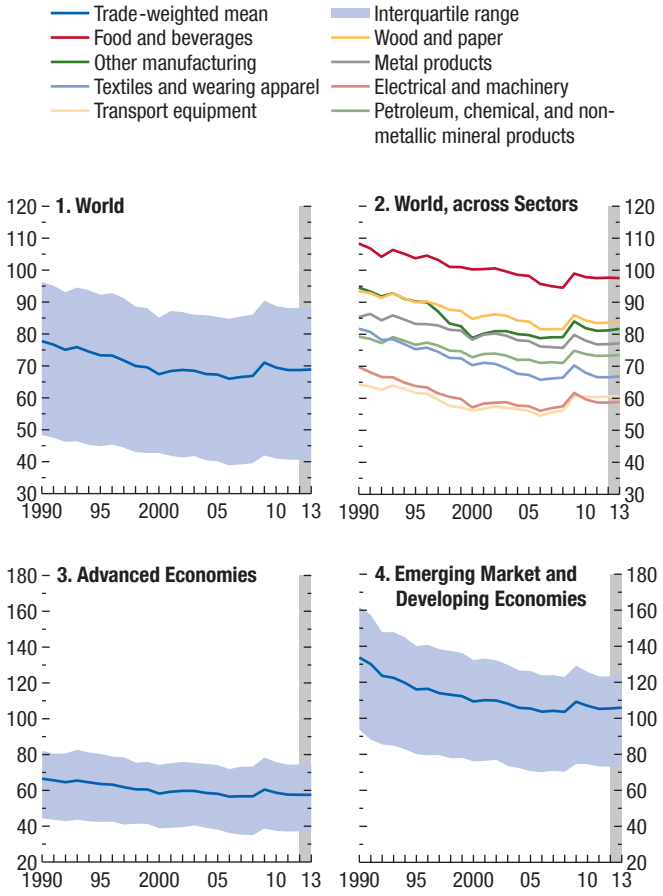
[38]The 10 largest importers include Canada, China, France, Germany, Italy, Japan, Korea, Mexico, the United Kingdom, and the United States.

[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. These trends may be part of the reason for the halt in the decline of overall trade costs (Figure 2.10, panel 6).[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—

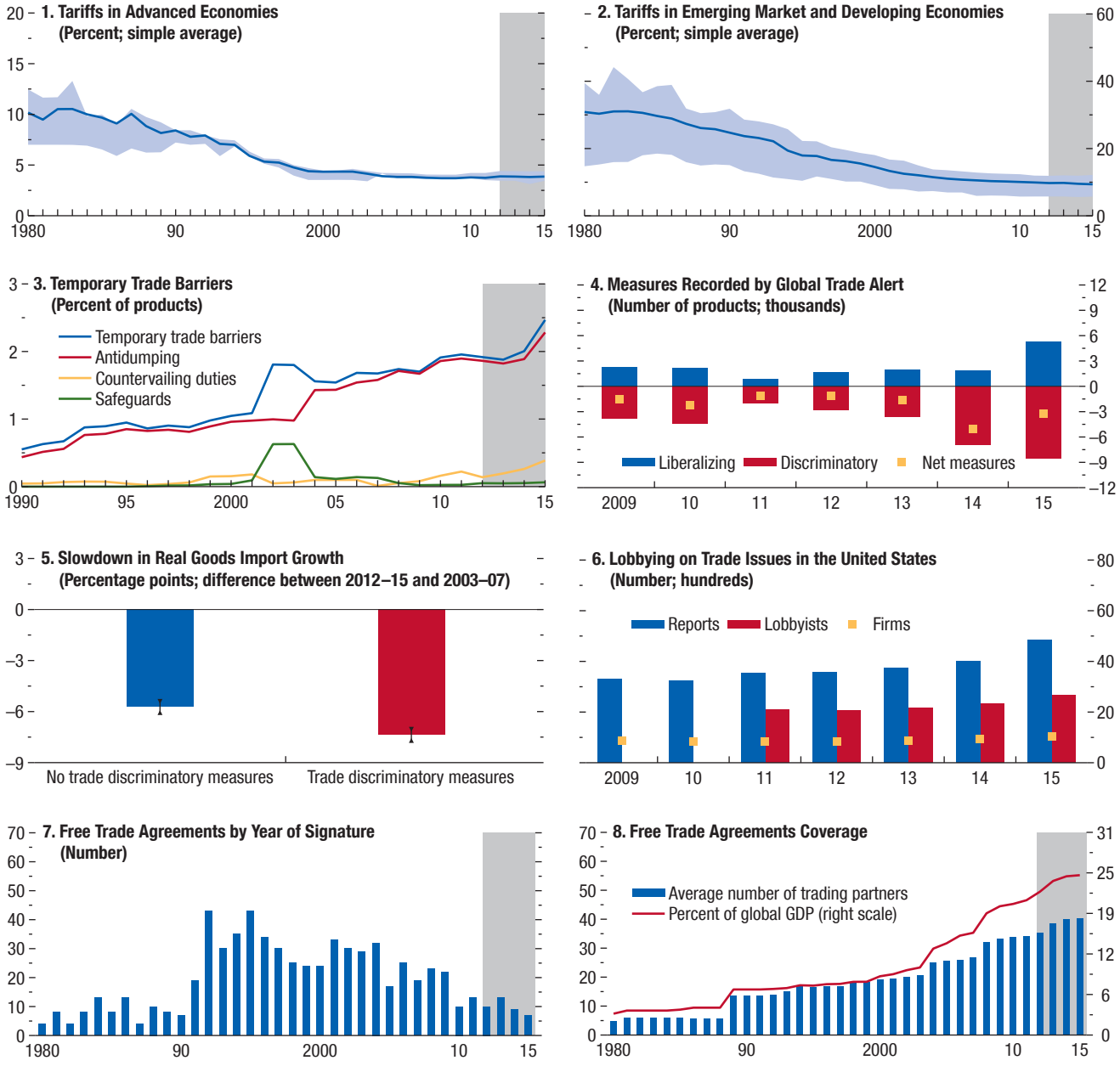
[41]We thank Chad Bown, Simon Evenett, and Johannes Fritz for generously sharing their databases on nontariff barriers. The Global Trade Alert database has the most comprehensive coverage of all types of trade-discriminatory and trade-liberalizing measures, although it only begins in 2008 (Evenett and 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—but not tariffs—and the time involved in this process have significantly fallen in emerging market and developing economies since 2006. These costs have remained flat in advanced economies at their already low levels (Figure 2.11, panels 1 and 2). 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 first 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.

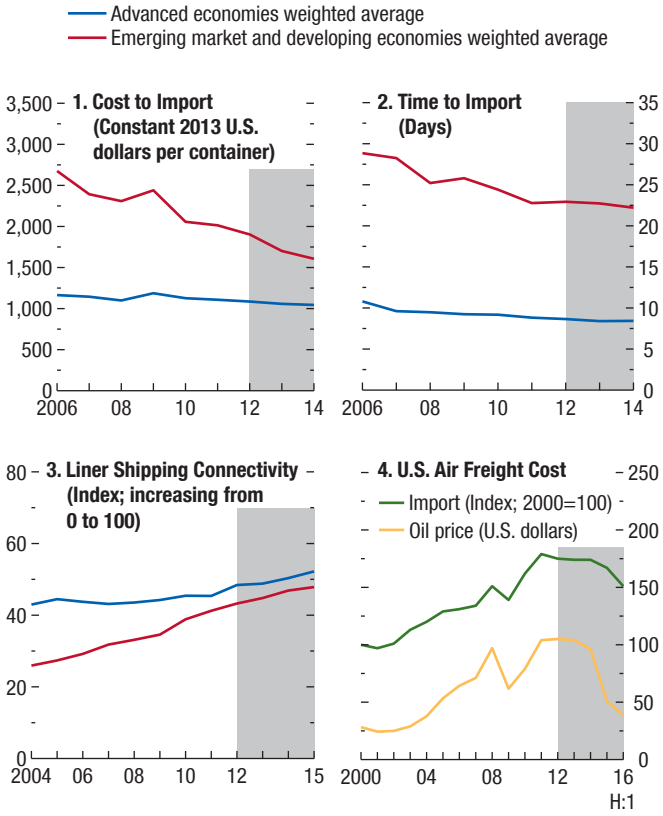
[45]See, for example, Constantinescu, Mattoo, and Ruta (2015); Crozet, Emlinger, and Jean (2015); and Gangnes, Ma, and Van Assche (2015).

[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.

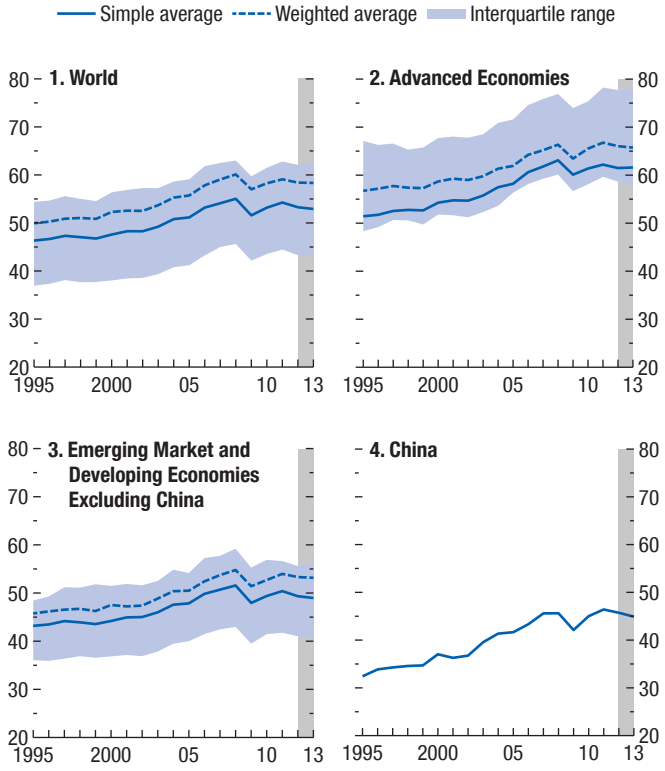


Sources: United Nations Conference on Trade and Development (UNCTAD); U.S. Bureau of Labor Statistics; World Bank, *Doing Business Indicators*; and IMF staff calculations.
Note: The cost and time indicators measure the cost (excluding tariffs) and time associated with three sets of procedures—documentary 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	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

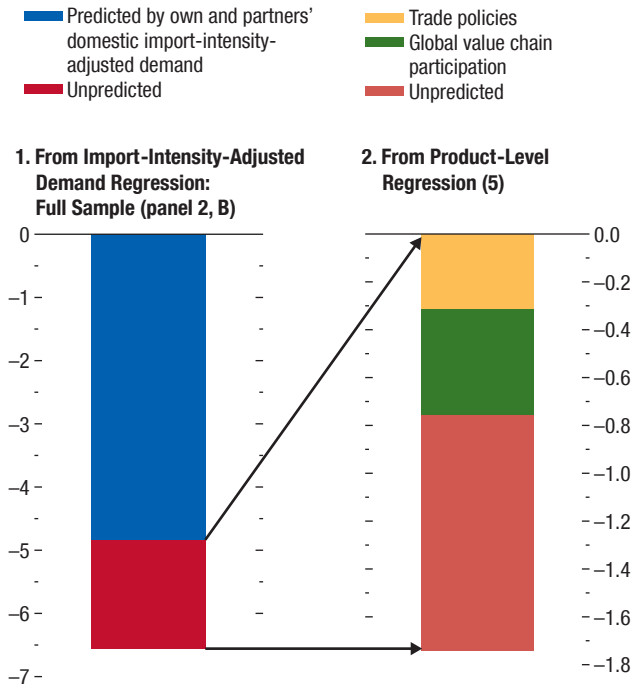
Source: IMF staff calculations.

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

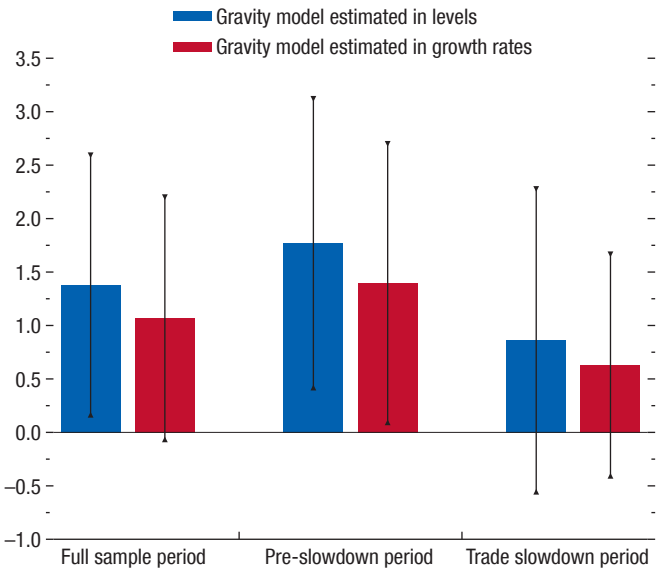
The analysis in this chapter suggests that the slowdown in trade growth since 2012 is to a significant extent, but not entirely, consistent with the overall weakness in economic activity. Weak global growth, particularly weak investment growth, can account for a significant part of the sluggish trade 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) and IMF (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.

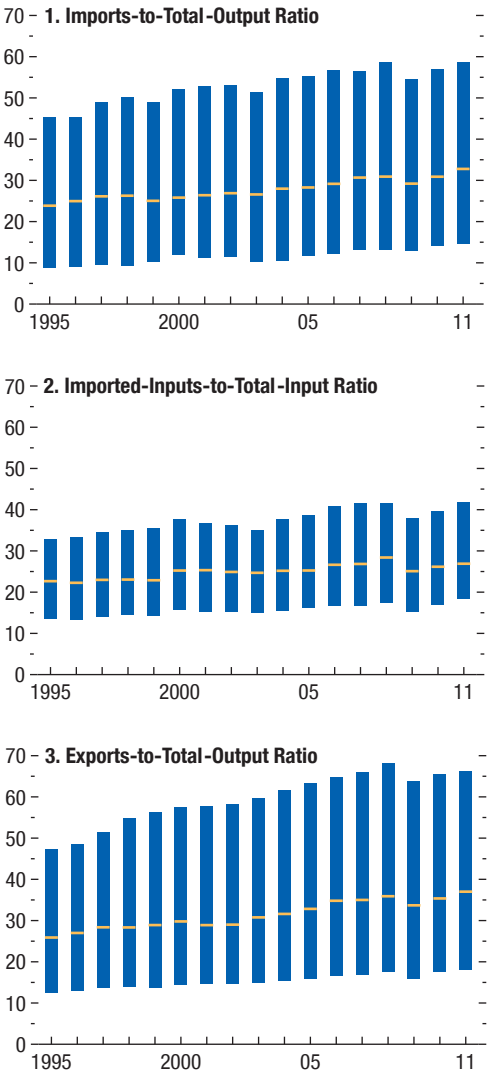
[1]The modern empirical literature on this topic traces to Sachs and Warner (1995) and Frankel and Romer (1999), among others. For a recent study that looks at the growth impact of the recent global trade slowdown, see Constantinescu, Mattoo, and Ruta (2016).

[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 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)	(7)	(8)
(Imports from China/Total Ouput) $\times 100_{i,s,t-2}$	0.004			0.002	0.021***			0.015*
	(0.004)			(0.003)	(0.004)			(0.009)
(Imports Inputs/Total Input) $\times 100_{i,s,t-2}$		0.005**		0.002		0.033***		0.008
		(0.002)		(0.003)		(0.009)		(0.015)
(Exports/Total Output)*$100_{i,s,t-2}$			0.006***	0.006***			0.032**	0.009
			(0.002)	(0.002)			(0.015)	(0.010)
First Stage *F*-stats					154.3	4.3	3.7	22.5
First Stage *p*-value					0.00	0.04	0.05	0.00
Number of Observations	2,634	2,634	2,976	2,634	2,634	2,634	2,976	2,634

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), (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 mid-September 2016, 92 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)—have 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.

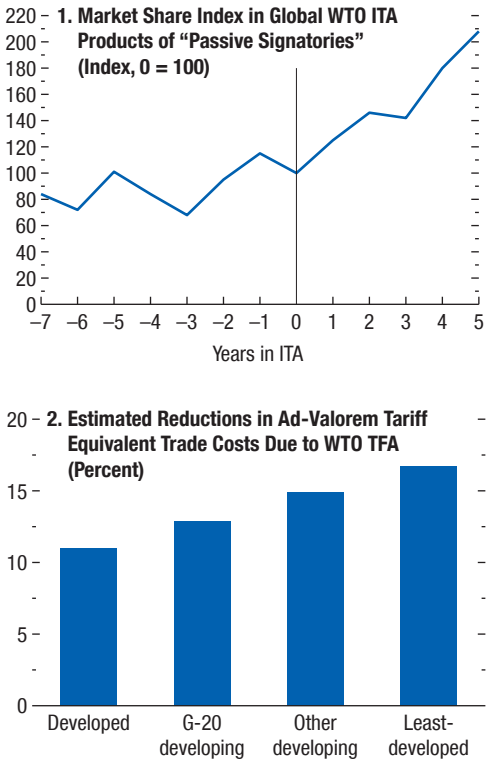
The Way Forward

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)*

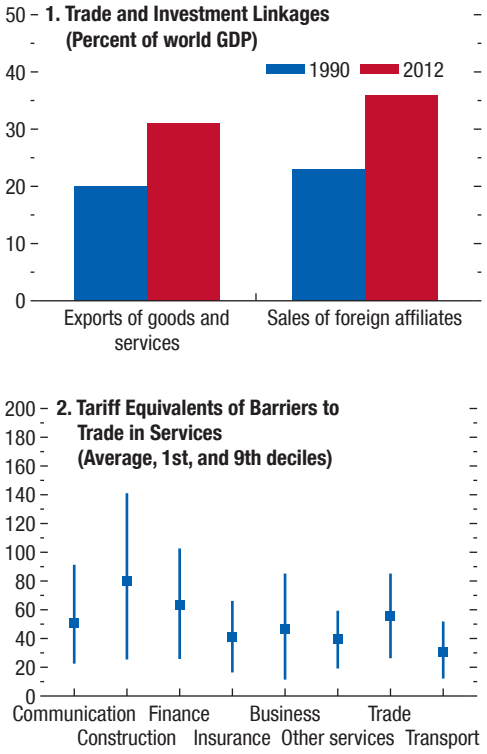
Figure 2.2.1. Potential Gains from Tackling Traditional Trade Barriers

(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 towards protectionism and roll back trade-restrictive measures put in place since the global financial crisis.

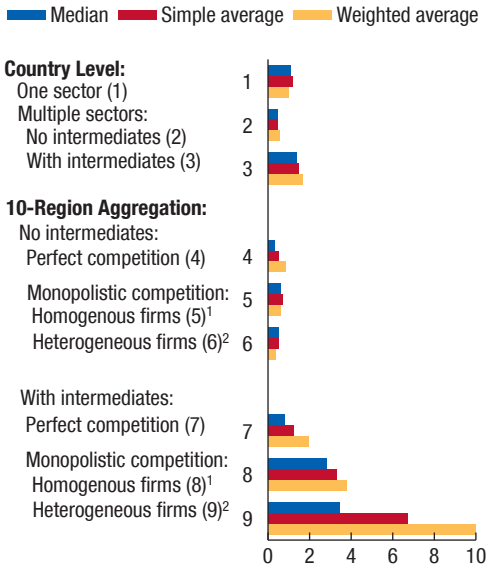
Box 2.3. Potential Gains from Jump-Starting Trade Liberalization

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]

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).

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.

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 dataset 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.

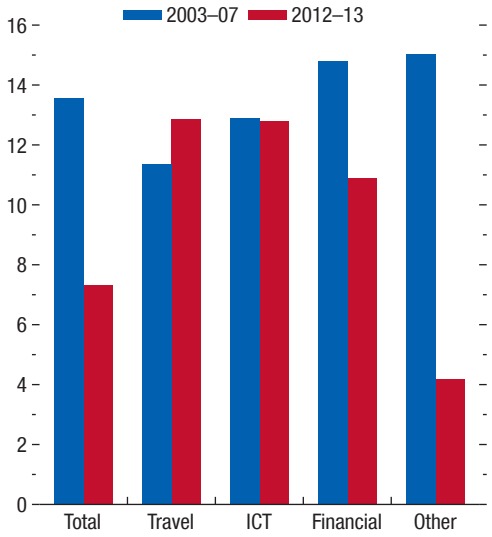
Because value and unit value changes at the six-digit level are noisy, simple procedures to identify outliers are applied to construct these price and volume indices. Boz and Cerutti (forthcoming) document in detail two steps for eliminating outliers for each country individually. First, a cross-section 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; and 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.

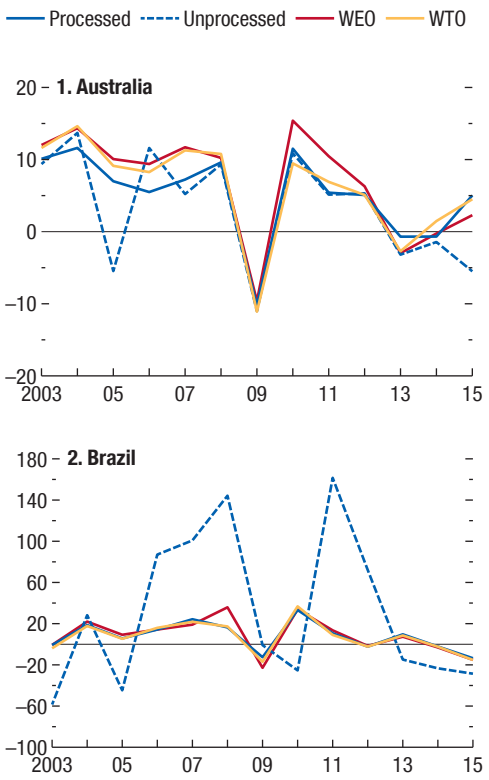
[54]However, for some products this time series standard deviation may be intrinsically high, which may not be a reflection of the severity of the unit value bias—for example, commodities, which experience fluctuations as a result of discoveries of new reserves, disruptions in supply, and so forth.

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; and 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:

$$\Delta \ln M_{c,t} = \delta_c + \beta_{DD,c} \Delta \ln DIAD_{c,t} + \beta_{P,c} \Delta \ln P_{c,t} + \varepsilon_{c,t}. \quad \text{(A.2.3.3)}$$

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:

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

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

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

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 towards 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:

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

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 τcapture 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
	4,398	0.58 0.85	0.43 0.72	0.53 0.80	1,115	0.74 0.88	0.53 0.73	0.64 0.80	3,283	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	
	3,520	0.50	0.78	0.41	0.69	0.50	0.76	934	0.71	0.87	0.48	0.73	0.61	0.78		2,586	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
	3,483	0.16 0.55	0.14 0.48	0.19 0.57	934	0.30 0.59	0.20 0.50	0.33 0.58	2,549	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:

$$\Delta \ln AD^{k}_{c,t} = \delta_c + \boldsymbol{\gamma_c}' \Delta \ln \mathbf{F_{c,t}} + \nu^{k}_{c,t},$$

where $AD^{k}_{c,t}$ is a component of aggregate demand, $k \in \{C, G, I, X\}$ and $\mathbf{F_{c,t}}$ 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 multi-sector, multi-country, 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 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 dataset 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.

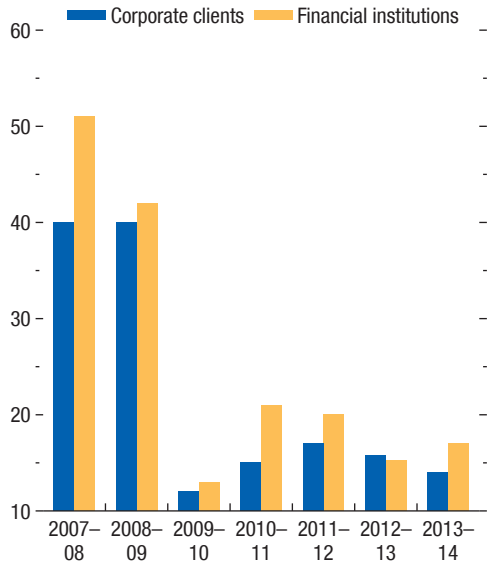
Free trade agreements—Data on flows of agreements by year of signature are obtained from the Design of Trade Agreements database. This dataset is complemented by the stock of free trade agreements in force from the WTO Regional Trade Agreements database. The former builds on the latter, supplementing 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:

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

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, $X_{p,c,t}$, 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:

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

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

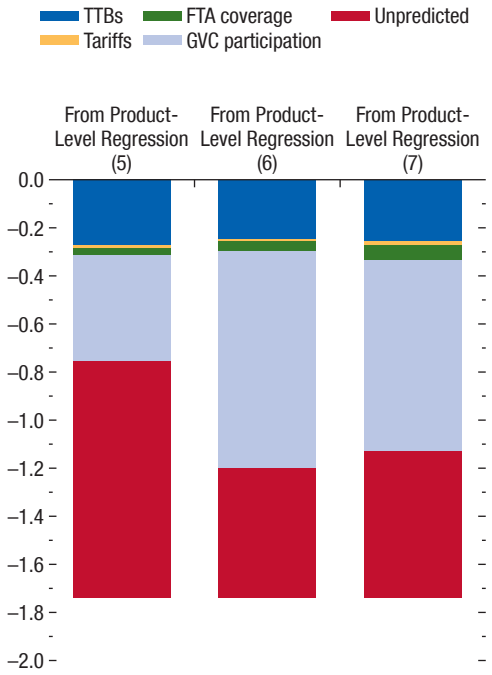
Decomposing the Slowdown into the Role for Other Factors

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 dataset 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 dataset 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

	A. Product and Country				
Dependent Variable (Nominal)	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:

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

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:

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

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 (*HighGVCparticipation*). 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 equalling 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 equalling 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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CHAPTER 3

GLOBAL DISINFLATION IN AN ERA OF CONSTRAINED MONETARY POLICY

Inflation has declined markedly in many economies over the past few years. This chapter finds that disinflation is broad based across countries, measures, and sectors—albeit larger for tradable goods than for services. The main drivers of recent disinflation are persistent economic slack and softening commodity prices. Most of the available measures of medium-term inflation expectations have not declined substantially so far. However, the sensitivity of expectations to inflation surprises—an indicator of the degree of anchoring of inflation expectations—has increased in countries where policy rates have approached their effective lower bounds. While the magnitude of this change in sensitivity is modest, it does suggest that the perceived ability of monetary policy to combat persistent disinflation may be diminishing in these economies.

Inflation rates in many economies have steadily declined toward historically low levels in recent years (Figure 3.1). By 2015, inflation rates in more than 85 percent of a broad sample of more than 120 economies were below long-term expectations, and about 20 percent were in deflation—that is, facing a fall in the aggregate price level for goods and services (Figure 3.2). While the recent decline in inflation coincided with a sharp drop in oil and other commodity prices, core inflation—which excludes the more volatile categories of food and energy prices—has remained below central bank targets for several consecutive years in most of the major advanced economies.

Disinflation can have multiple explanations and is not necessarily a cause for concern. For instance, a temporary decline in inflation due to a supply-driven decline in energy prices can be beneficial to the overall economy. Even when low demand is behind a temporary disinflation, its negative implications may not necessarily go beyond those of depressed demand itself. However, if persistently low inflation leads firms and households to revise down their beliefs about the future path of inflation, it can have negative implications. In particular, if medium-term inflation expectations drift down significantly, a deflationary cycle may emerge in which weak demand and deflation reinforce each other. Eventually, the economy may end up in a deflation trap—a state of persistent deflation that prevents the real interest rate to decrease to the level consistent with full employment. Moreover, even if deflation is avoided, a persistent downward shift in inflation to very low levels would not be desirable: lower nominal interest rates would leave little room to ease monetary policy if needed, the economy would still not be far from slipping into deflation and, given stickiness in wages, a weakening in demand would be more likely to cause large job losses.

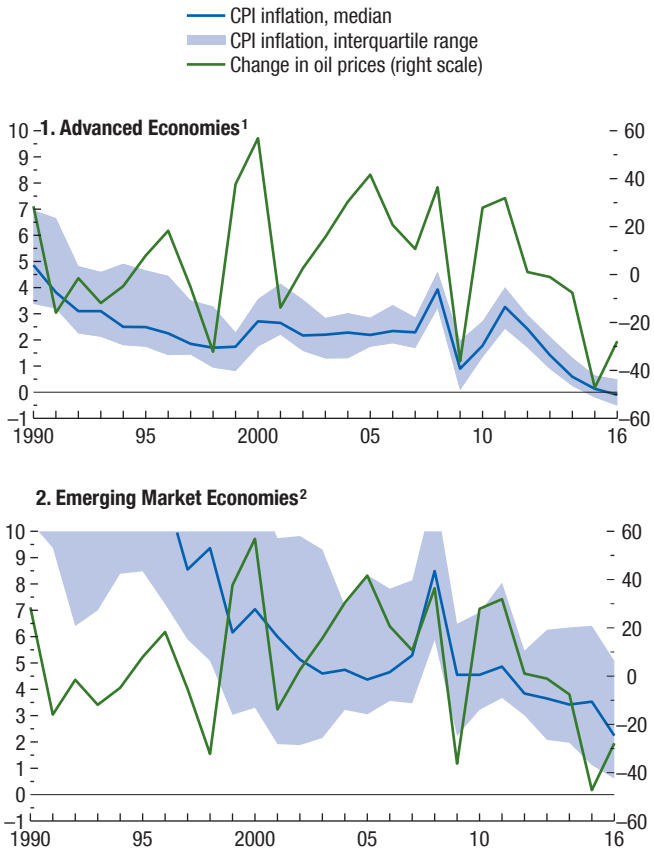
The risk of disinflation potentially leading to a deflation trap or to persistently weak inflation is closely related to whether monetary policy is perceived to be effective in ensuring that inflation converges to its objective once temporary effects fade. At the current juncture, the ability of central banks to keep inflation expectations anchored could be challenged by several factors. First, the scope of monetary policy to further stimulate demand is perceived to be increasingly constrained in many advanced economies where policy rates are not far from their effective lower bounds. Second, in many countries, the weakness in inflation to some extent reflects price developments abroad—in particular substantial slack in tradable goods–producing sectors in several large economies.[1] Although domestic monetary policy can do little to combat deflation pressure from abroad, its credibility may end up undermined if weakness in import prices combines with weak demand at home to keep inflation

The authors of this chapter are Samya Beidas-Strom, Sangyup Choi, Davide Furceri (lead author), Bertrand Gruss, Sinem Kılıç Çelik, Zsoka Koczan, Ksenia Koloskova, and Weicheng Lian, with contributions from Jaebin Ahn, Elif Arbatli, Luis Catão, Juan Angel Garcia Morales, Keiko Honjo, Benjamin Hunt, Douglas Laxton, Niklas Westelius, and Fan Zhang, with support from Hao Jiang and Olivia Ma. Refet Gürkaynak was the external consultant for the chapter. Comments from Jesper Linde and Signe Krogstrup are gratefully acknowledged.

[1]Investment in tradable goods sectors in some large economies, notably China, grew strongly in the aftermath of the global financial crisis, in part because of a sizable macroeconomic policy stimulus. The increase in investment was underpinned by a path of projected global and domestic demand that subsequently fell short of expectations, leaving several manufacturing sectors with substantial overcapacity (see IMF 2016b).

Figure 3.1. Oil Prices and Consumer Price Inflation
(Percent)

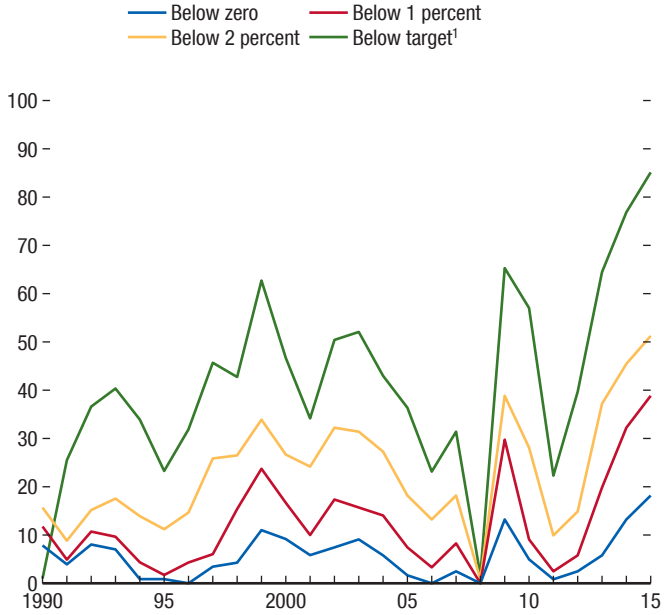
Inflation has steadily declined toward historically low levels in recent years, both in advanced and emerging market economies.



Sources: Haver Analytics; and IMF staff calculations.
Note: CPI = consumer price index.
[1] Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.
[2] Argentina, Brazil, Bulgaria, Chile, China, Colombia, Dominican Republic, Ecuador, Egypt, Hungary, India, Indonesia, Jordan, Kazakhstan, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, Venezuela.

Figure 3.2. Share of Countries with Low Inflation
(Percent)

A large number of countries is currently facing low inflation or even deflation.



Sources: Consensus Economics; and IMF staff calculations.
Note: The figure is based on an unbalanced sample of 120 countries.
[1] Target refers to long-term inflation expectations from Consensus Economics (10-year inflation expectations) or inflation forecasts from the World Economic Outlook database (5-year inflation expectations).

rates persistently below target. After a long period of stability, certain measures of medium-term inflation expectations have indeed fallen in some advanced economies—especially after the decline in oil prices in 2014 (Figure 3.3).[2] Against this backdrop, there is a growing concern that further disinflationary shocks could keep inflation persistently low and eventually lead to deflation trap conditions.

To assess these risks and contribute to the policy debate, this chapter investigates the following questions:

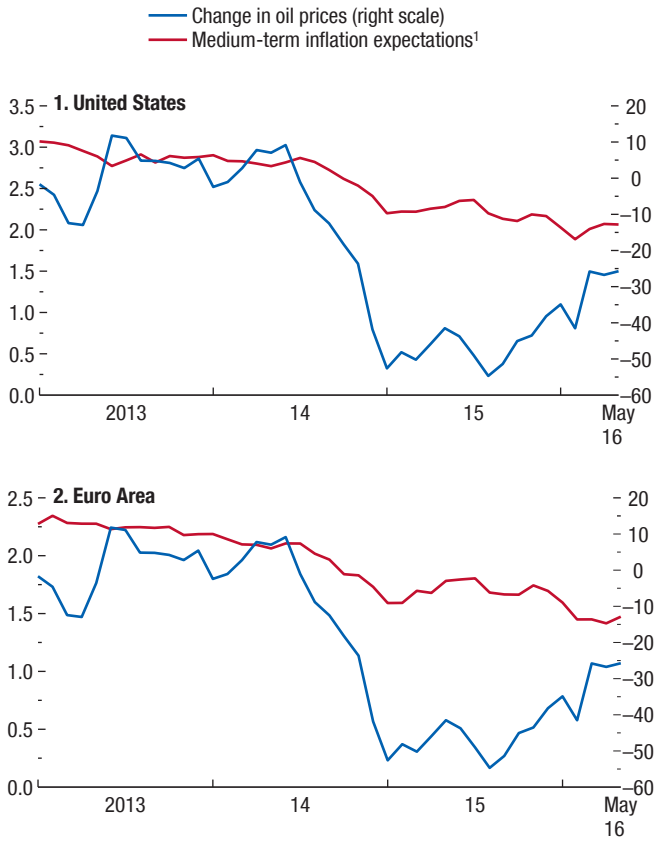
- How widespread is the recent decline in inflation across countries? Does the extent of the decline vary by type of measure—headline, core, wages—and by sectors?
- Can the weakening in commodity prices and economic slack explain recent inflation dynamics? What is the role of other factors, including cross-border spillovers from industrial slack in large economies?[3]

[2]As measured by inflation compensation embedded in long-maturity nominal bonds or swaps.

[3]Industrial slack in light and heavy industries (including commodities)—generated either by weak demand or an excess of supply stemming from previous overinvestment—results in lower producer prices and, in the case of traded goods, lower export prices. Several studies point to marked overcapacity in a range of industrial sectors (National Association of Manufacturers 2016; Organisation for Economic Co-operation and Development 2015). Estimates presented in Box 3.1 suggest that industrial slack in the first quarter of 2016

Figure 3.3. Medium-Term Inflation Expectations and Oil Prices
(Percent)

Medium-term inflation expectations have significantly declined, especially since the sharp drop in oil prices in 2014.



Sources: Bloomberg, L.P.; and IMF staff calculations.
[1] Medium-term inflation expectations are based on five-year/five-year inflation swaps.

- Have inflation expectations become more sensitive to inflation outturns in recent years, especially in countries where monetary policy is perceived as being constrained? How large is the risk that a decline in inflation will lead to lower inflation expectations? How do monetary policy frameworks affect the degree of anchoring of inflation expectations?

The chapter starts by discussing the potential costs of persistently low inflation and deflation. Next, it examines the evolution of inflation across countries and the factors driving it during the past decade. It then offers new evidence on the sensitivity of inflation expectations to changes in inflation and the role of monetary policy frameworks in affecting this sensitivity.

The key findings of the chapter suggest that persistently below-target inflation poses downside risks and calls for a number of policy responses. Specifically,

- Disinflation is a broad-based phenomenon. Inflation has declined across many countries and regions, in both headline and core measures, but more markedly in tradable goods sectors than in services.
- Economic slack and changes in commodity prices are the main drivers of lower inflation since the Great Recession. In addition, industrial slack in large exporters (such as Japan, the United States, and especially China) may also have contributed to lower inflation by putting downward pressure on global prices of tradable goods (Box 3.1).[4] However, the recent decline in inflation goes beyond what these factors can explain—suggesting that inflation expectations may have dropped more than implied by available measures or that economic slack is greater than estimated in some countries.
- The response of inflation expectations to inflation surprises has been decreasing over the past couple of decades in both advanced and emerging market economies as a result of improvements in monetary policy frameworks. The sensitivity remains larger among the latter, suggesting further scope for improvements in emerging market economies.
- However, in countries where monetary policy is constrained, inflation expectations have recently become more responsive to oil price changes or unexpected movements in inflation itself.

Many advanced economies with low inflation and persistent economic slack run the risk of chronically undershooting their inflation targets, which would erode the credibility of monetary policy. To avoid this risk, policymakers in these economies need to boost demand and firm up expectations. With limited policy space, a comprehensive and coordinated approach that exploits the complementarities among all available tools to boost demand and that amplifies the effects of individual policy actions through positive cross-border

stood at about 5.5 percent in China, 5 percent in Japan, and 3 percent in the United States.

[4]Industrial production in China, Japan, and the United States accounts for a significant share of total world industrial production (about 45 percent), which is even larger than the share of these economies in global GDP (about 38 percent).

spillovers would be the most effective (Gaspar, Obstfeld, and Sahay forthcoming). This approach should be centered on continued monetary policy accommodation to help keep medium-term inflation expectations anchored—including a transparent commitment to more aggressive accommodation where there are signs that expectations are becoming unanchored.[5] But monetary stimulus should be complemented with a combination of a more growth-friendly composition of fiscal policy, an expansionary fiscal stance in countries with credible medium-term fiscal frameworks and available fiscal space, and structural reforms that stimulate consumption and investment through higher expected incomes and profits. Income policies could be used in countries where wages are stagnant and deflation expectations appear entrenched (IMF 2016a). Distortionary policies that perpetuate overcapacity should be avoided as they not only worsen resource allocation—and weaken asset quality in the banking system where financed by credit—but also exert disinflationary pressures on other economies.

Although low inflation is a less pervasive phenomenon among emerging market economies, improving monetary policy frameworks is also a policy priority in many of these countries. Additional efforts to strengthen the credibility, independence, and effectiveness of central banks would improve the degree of anchoring of inflation expectations, enhancing the ability to fight deflationary forces in some cases and above-target inflation in others.

A Primer on the Costs of Disinflation, Persistently Low Inflation, and Deflation

Like high inflation, persistently low inflation, disinflation, and deflation can potentially have a severe impact on an economy. Whether they entail costs, and how large these costs are, depends on their underlying sources, their extent and duration, and, most importantly, the degree of anchoring of inflation expectations.

Unexpected Disinflation

An unexpected decline in the inflation rate can harm demand in an economy with high debt by increasing the real debt burden of borrowers and the real interest rate they face—a phenomenon called "debt deflation"—and increase difficulties in achieving deleveraging (see the October 2016 *Fiscal Monitor*). The increase in the real burden of servicing debt would be more severe under outright deflation. While creditors' wealth rises with debt deflation, they are unlikely to increase their spending enough to offset the macroeconomic consequences of debtors' losses, meaning that debt deflation has a net negative effect on the economy (Fisher 1933). The reduction in collateral values—including house prices—that tends to accompany deflation can result in lower or negative equity, magnifying the problem through costly defaults. Debt deflation not only affects mortgage holders, firms, and banks, but also governments that hold long-maturity debt.[6]

Persistent Disinflation and the Deflation Trap

Persistently low inflation increases the possibility that an adverse shock will reduce the aggregate price level and tip the economy into a deflation trap. But falling into this trap is far from automatic. Inflation expectations would need to drop significantly for this to happen.

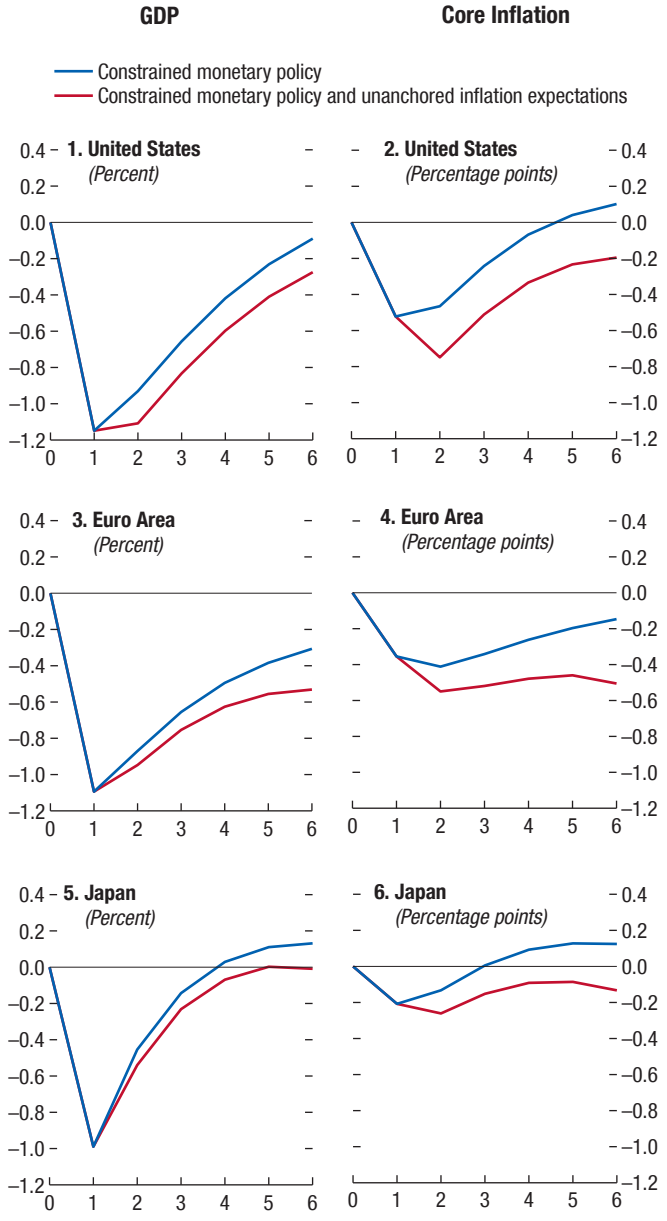
In periods of low inflation, even small disinflationary shocks can lead to a fall in the level of prices of goods and services. If economic agents expect prices to continue to fall, they can become less willing to spend—particularly on durable goods whose purchases can be postponed—since the ex-ante real interest rate increases and holding cash generates a positive real yield. Consumption and investment would be deferred farther into the future, leading to a contraction in aggregate demand that would in turn exacerbate deflation pressures. A deflation cycle would then emerge, with weak demand and deflation reinforcing each other, and the economy could end up in a deflation

[5]Several empirical studies have documented that certain unconventional monetary policies adopted in the aftermath of the Great Recession had significant impacts on inflation expectations or asset prices that convey information about these. In particular, a number of recent papers have found significant effects on break-even inflation rates (Guidolin and Neely 2010; Krishnamurthy and Vissing-Jorgensen 2011), survey-based inflation expectations (Hofmann and Zhu 2013), and firms' inflation expectations (Cloyne and others 2016), as well as on interest rates and asset prices (Krishnamurthy and Vissing-Jorgensen 2011; Swanson 2016; Wright 2012; Yu 2016).

[6]The effect on governments is especially important in the current environment because as debt rises, fiscal space is reduced. Persistently weak growth in the GDP deflator, and hence in nominal GDP, worsens the interest-rate-growth differential and contributes to a higher debt burden. Deflation also entails other fiscal costs. For example, since tax provisions are progressive in nominal income and are not indexed to prices, while some components of public spending—such as wages and social transfers—are indexed, deflation could increase government deficits. See End and others (2015) for further details.

Figure 3.4. Effect of Disinflationary Shocks in Advanced Economies under Constrained Monetary Policy and Unanchored Inflation Expectations
(Years after the shock on x-axis)

Demand-driven deflationary shocks can have particularly large and persistent negative effects if monetary policy is constrained and inflation expectations become unanchored.



Source: IMF staff estimates.
Note: The figure reports the deviation of output and core inflation from their baseline path after a temporary decline in domestic demand. It is assumed that conventional monetary policy in all countries is constrained at the effective lower bound on nominal interest rates. The alternative scenario (red line) also assumes that inflation expectations are affected by inflation shocks in line with the empirical evidence presented in the chapter. See Annex 3.2 for further details.

trap. In this context, the behavior of prices and output could become unstable if monetary policy is constrained by the effective lower bound on interest rates (see, for instance, Benhabib, Schmitt-Grohe, and Uribe 2002; Cochrane 2016).[7] These difficulties are aggravated if fiscal policy cannot be readily and efficiently deployed to stimulate demand.

The capacity of monetary authorities to maintain medium-term inflation expectations anchored at the target (that is, persuade agents that inflation will eventually converge to the target once the effect of temporary factors fades out) is critical to mitigate such concerns. Indeed, model simulations in Annex 3.2 illustrate that even with constrained monetary policy, an economy would escape the deflation trap induced by a negative demand shock as long as medium-term inflation expectations were well anchored. But if expectations drifted down, it could take a very long time for the economy to emerge from deflation (Figure 3.4).[8]

Persistently Low Inflation

An environment of subdued but positive inflation could carry significant economic costs even if a deflation trap is avoided. A prolonged period of below-target inflation may lead to a belief that the central bank is willing to accept low inflation for longer, effectively reducing inflation expectations for the medium term to positive but below-target levels.

The main cost of this low-inflation environment is reduced effectiveness of monetary policy. Low inflation constrains the ability of monetary policy to respond to depressed demand. In a severe downturn, real interest

[7]Estimates of the probability of a situation of constrained monetary policy with unstable output and price dynamics vary substantially depending on the shocks considered. Previous studies find this probability to be nonnegligible and as high as 5–10 percent when inflation is around 2 percent and financial shocks similar to those in 2007–08 are considered (Blanco 2015; Chung and others 2012; Coibion, Gorodnichenko, and Wieland 2012; Williams 2014). While the probability associated with an episode of monetary policy at the effective lower bound lasting several years—as in the current juncture—is more difficult to estimate with existing models, it is likely to be larger than previous estimates and associated with greater economic costs.

[8]Many theoretical studies have examined the behavior of the economy in a long-lasting liquidity trap in a context in which prices are slow to move—or sticky—and have proposed distinct solutions to escape from it (Buiter and Panigirzoglous 1999; Cochrane 2016; Eggertsson and Woodford 2003; Svensson 2001; Werning 2012). The solutions range from a combination of devaluation, prolonged monetary policy accommodation, and price level targeting to more aggressive approaches, including negative interest rates or "helicopter money."

rates (the nominal rate minus the expected inflation rate) must decrease significantly to restore full employment and bring output back to its potential. With normal levels of inflation, a central bank can accomplish that by reducing the nominal policy interest rate, but when the economy is experiencing low inflation and nominal interest rates, the central bank would have little room to reduce real interest rates, even if it resorted to unconventional tools.[9]

A low-inflation environment may also lead to higher unemployment in the face of adverse demand shocks. When the demand for goods and services declines, firms seek to reduce costs. In this context, inflation facilitates adjustment because it pushes down real wages—even in the presence of downward nominal wage rigidity. Real wages would be less flexible under lower average inflation. In the context of low inflation, cost reduction by firms is more likely to take the form of job cuts (Akerlof, Dickens, and Perry 1996; Bernanke 2002; Calvo, Coricelli, and Ottonello 2012), because it is typically difficult to lower costs by reducing nominal wages.[10]

In Sum: Slow Growth?

While the above economic costs are difficult to quantify, the Great Depression and the more recent Japanese deflation experience (IMF 2003, Box 3.2) suggest that prolonged weak inflation and, especially, persistent deflation may dampen medium-term growth prospects.

Inflation Dynamics: Patterns and Recent Drivers

How Widespread Is the Decline in Inflation?

The evidence points to a broad-based decline in inflation across countries and regions as well as among different measures of inflation, but more markedly in manufacturing than in services. The breadth of the decline in inflation across countries and the fact that it is stronger in the tradable goods sectors underscore the global nature of disinflationary forces.

Headline Inflation

Inflation was surprisingly stable during the Great Recession (2008–10). Indeed, while previous recessions were usually associated with marked disinflation, inflation proved broadly resilient among advanced economies even as unemployment rates climbed to multidecade highs.[11]

However, since 2011, inflation rates began to decline across many advanced and emerging market economies. Headline inflation—the change in the prices of a broad range of goods and services, including food and energy—recently reached historical lows in many countries (Figure 3.5; Box 3.3).[12] Moreover, many advanced economies—notably in the euro area—experienced outright deflation in 2015, and price declines became more widespread in the first quarter of 2016. In many emerging market economies, headline inflation also declined sharply following the drop in oil prices, despite large currency depreciations in some of these economies—even though in some of these economies inflation actually has recently increased, as evidenced by a relatively wider interquartile range in the past year (Figure 3.5, panels 2, 4, and 6).[13] Some emerging market economies with close links to the euro area or with exchange rates pegged to the euro also experienced some deflation. The evidence of a broad-based decline in headline inflation is supported by principal component analysis (Figure 3.6).

[9]Even if unconventional monetary policies such as quantitative easing are adopted, their effects on long-term interest rates and output are uncertain (Williams 2014).

[10]Bernanke and Bewley (1999) suggest that an important reason for the reluctance of firms to cut nominal wages is their belief that such cuts would harm workers' morale.

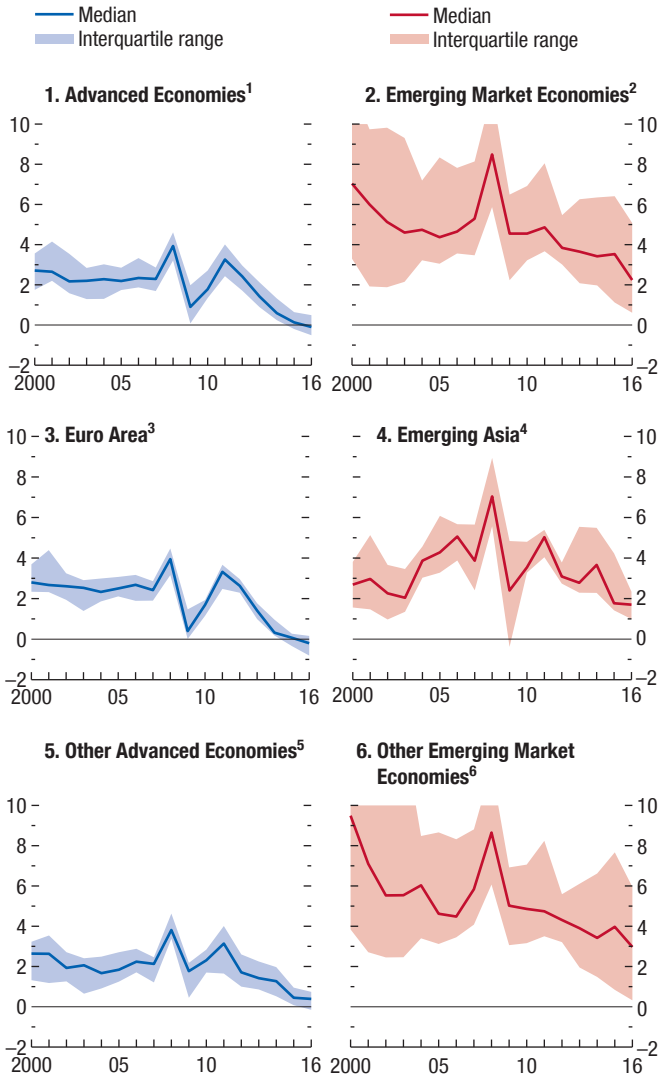
[11]Headline inflation did decline during the crisis, but rebounded quickly. A number of hypotheses were put forward to explain the resilience of inflation, or the missing disinflation—"*the dog that did not bark.*" These include improved credibility of central banks, which helped stabilize inflation outcomes by anchoring inflation expectations (Bernanke 2010); a more muted relationship between cyclical unemployment and inflation—implying a flatter Phillips curve (Chapter 3 of the April 2013 *World Economic Outlook*); and increased wage rigidity that prevented nominal wages from falling as much as during previous recessions. In addition, low inflation contributed to holding up real wages (Daly, Hobijn, and Lucking 2012), and the increase in commodity prices in 2011 may have partly offset the disinflationary impact of increased cyclical unemployment (Coibion and Gorodnichenko 2015).

[12]Box 3.3 explores the role of food price inflation and shows that in some economies, particularly emerging market and developing economies, the global deflation pressure from tradables was mitigated by low pass-through of food prices to domestic headline inflation.

[13]In emerging market economies, headline inflation has been on a downward trend—in part due to improved monetary policy frameworks. Globalization may have helped reduce inflation in emerging market economies (IMF 2006) by limiting the ability of central banks to temporarily stimulate the economy (Rogoff 2003) and increasing the cost of imprudent macroeconomic policies through the adverse response of international capital flows (Tytell and Wei 2004).

Figure 3.5. Consumer Price Inflation
(Percent)

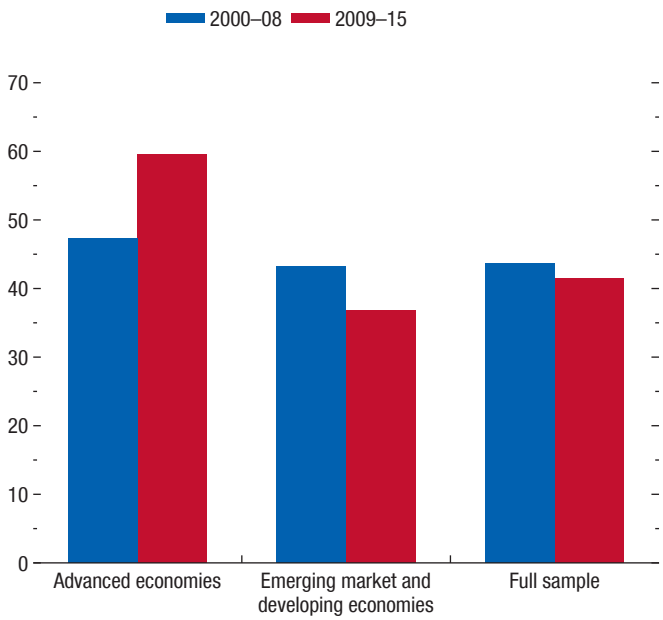
Inflation declined substantially during the global financial crisis in many countries but quickly rebounded afterwards. Since 2011, however, there has been a broad-based slowdown in inflation across advanced and emerging market economies.



Sources: Haver Analytics; and IMF staff calculations.
Note: Labels in footnotes 1–6 below use International Organization for Standardization (ISO) country codes.
[1] AUS, AUT, BEL, CAN, CHE, CZE, DEU, DNK, ESP, EST, FIN, FRA, GRC, HKG, ISL, ITA, IRL, ISR, JPN, KOR, LVA, LTU, LUX, NLD, NOR, NZL, PRT, SGP, SVK, SVN, SWE, GBR, USA.
[2] ARG, BGR, BRA, CHN, CHL, COL, DOM, ECU, EGY, HUN, IND, IDN, JOR, KAZ, MAR, MEX, MYS, PER, PHL, POL, ROU, RUS, THA, TUR, VEN, ZAF.
[3] AUT, BEL, DEU, ESP, EST, FIN, FRA, GRE, IRL, ITA, LTU, LUX, LVA, NLD, PRT, SVK, SVN.
[4] CHN, IDN, IND, MYS, PHL, THA.
[5] AUS, CAN, CHE, CZE, DNK, GBR, ISL, ISR, JPN, KOR, NOR, NZL, SGP, SWE, USA.
[6] ARG, BGR, BRA, CHL, COL, DOM, ECU, EGY, HUN, JOR, KAZ, MAR, MEX, PER, POL, ROU, RUS, TUR, VEN, ZAF.

Figure 3.6. Share of Consumer Price Inflation Variation Explained by First Common Factor
(Percent)

The share of consumer price inflation variation across advanced economies that can be attributed to global factors increased during 2009–15.



Source: IMF staff calculations.
Note: The figure reports the share of variation in headline consumer price inflation explained by the first common factor based on a principal component analysis. The sample comprises 120 economies, including 31 advanced economies.

The results of this analysis show that the contribution of the first common factor—a proxy for the "global" component—to the variation in headline inflation was broadly similar before and after the Great Recession for an entire sample of about 120 countries. However, the contribution increased substantially (from 47 percent to 60 percent) in advanced economies during 2009–15, likely reflecting the importance of large movements in commodity prices for headline inflation in largely net commodity importers and the synchronized increase in economic slack since the Great Recession (Annex 3.3).[14]

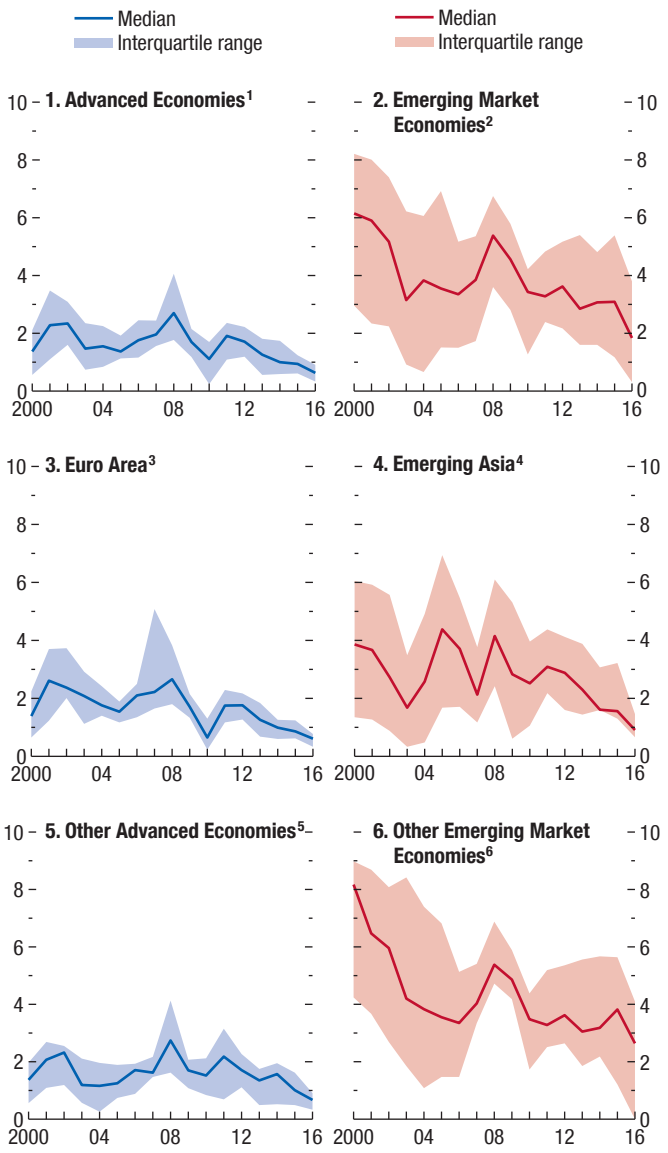
Core Inflation, Wages, and Sectoral Developments

Core inflation—the change in the prices of goods and services excluding food and energy—has also

[14]Additional analyses using Bayesian modeling average and weighted least squares confirm that commodity prices stand out among several variables as being strongly linked with the first common factor.

Figure 3.7. Core Consumer Price Inflation
(Percent)

The decline in core inflation over the past few years was broad based across regions.



Sources: Haver Analytics; and IMF staff calculations.
Note: Labels in footnotes 1–6 below use International Organization for Standardization (ISO) country codes.
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[2] ARG, BGR, BRA, CHN, CHL, COL, DOM, ECU, EGY, HUN, IND, IDN, JOR, KAZ, MAR, MEX, MYS, PER, PHL, POL, ROU, RUS, THA, TUR, VEN, ZAF.
[3] AUT, BEL, DEU, ESP, EST, FIN, FRA, GRE, IRL, ITA, LTU, LUX, LVA, NLD, PRT, SVK, SVN.
[4] CHN, IDN, IND, MYS, PHL, THA.
[5] AUS, CAN, CHE, CZE, DNK, GBR, ISL, ISR, JPN, KOR, NOR, NZL, SGP, SWE, USA.
[6] ARG, BGR, BRA, CHL, COL, DOM, ECU, EGY, HUN, JOR, KAZ, MAR, MEX, PER, POL, ROU, RUS, TUR, VEN, ZAF.

declined widely across countries and regions (Figure 3.7). This measure, which captures the underlying trend in inflation better than headline inflation, has recently been higher than headline inflation given the sharp decline in energy prices. However, core inflation has declined in all advanced economies to rates below central banks' targets and, since 2016, it has also done so in several emerging market economies.

Wage growth has been increasing recently but remains subdued in many advanced economies despite some improvements in labor markets (Figure 3.8). One reason for the muted behavior, suggested by Daly and Hobijn (2015) for the United States, may be that many firms were unable to reduce wages enough to avoid job cuts during the 2008–09 recession, but as they resumed hiring thereafter, employers were able to keep a lid on wage gains to effectively work off "pent-up wage cuts." The cyclical slack in labor market participation rates may also have kept wages in check during the postrecession recovery.

Sectoral developments in producer prices in advanced economies show that, although inflation has recently softened in all sectors, the decline has been larger in manufacturing producer prices—a typical proxy for the price of tradable goods (Figure 3.9).[15] This may reflect a larger effect of lower commodity prices and lower import prices in manufacturing—given the larger commodity and imported input content in this sector (Box 3.4)—but, for some large advanced and emerging market economies, it is also associated with an increase in excess manufacturing capacity (Box 3.1).

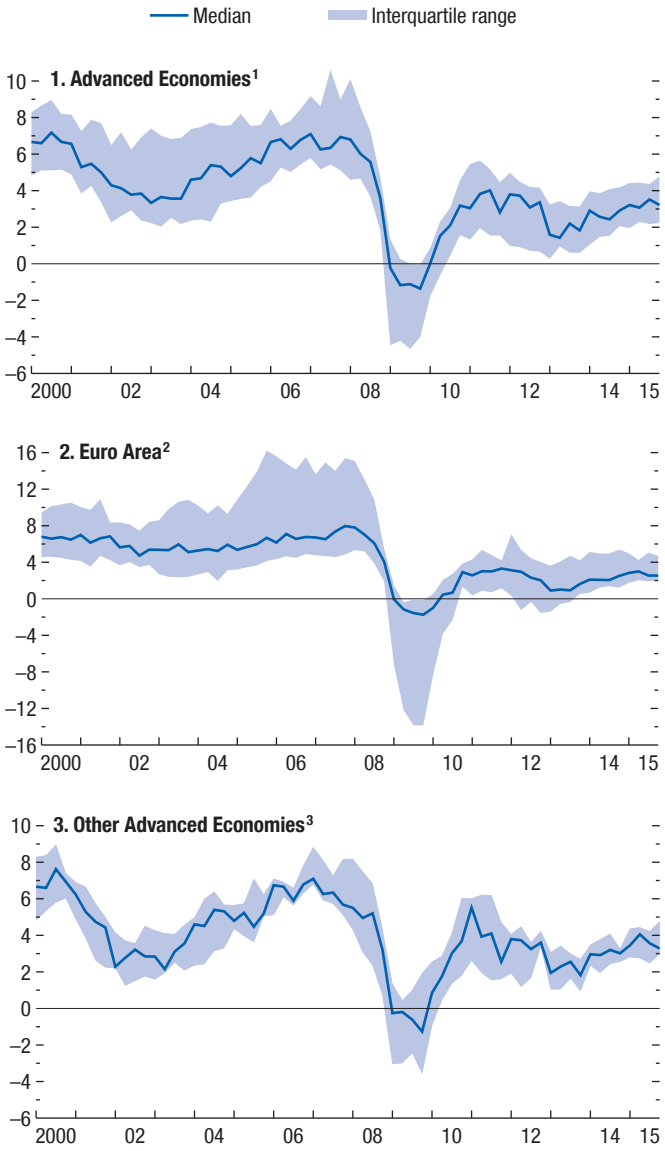
While distinguishing tradable from nontradable components in consumer price indices is challenging, the comparison of inflation across expenditure categories provides supportive evidence that the recent decline in inflation in advanced economies has been substantially stronger in tradable goods (Figure 3.10). On average, the decline in goods inflation has been steeper than in the case of services. Indeed, there has been a widespread decline in the average price level of nonfood goods across advanced economies over the past two years. Instead, food price

[15]Producer price inflation for manufactured goods has, on average, been lower than total producer price inflation during 1990–2016, while business services inflation has been higher (IMF 2006). Together, manufacturing, business services, and utilities services account for about 70 percent of a typical advanced economy in the sample. The other sectors are agriculture, mining, construction, and social and personal services (including government).

Figure 3.8. Wage Inflation in Advanced Economies

(Year-over-year percent change of nominal wages)

Despite improvements in labor markets, wage growth remains subdued in many advanced economies.

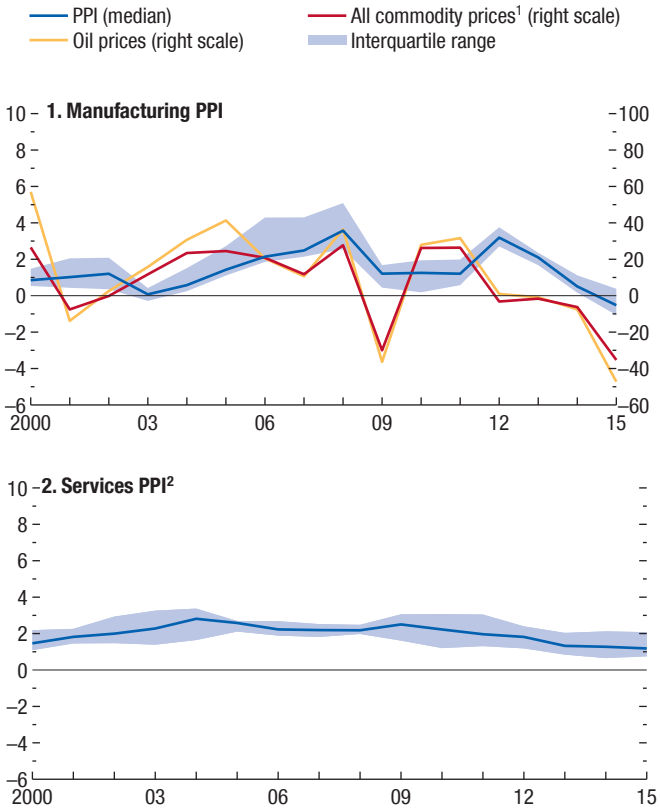


Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.
[1] Australia, Austria, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Netherlands, Slovenia, Spain, Sweden, United Kingdom, United States.
[2] Austria, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Lithuania, Netherlands, Slovenia, Spain.
[3] Australia, Canada, Czech Republic, Denmark, Israel, Japan, Sweden, United Kingdom, United States.

Figure 3.9. Sectoral Producer Prices in Advanced Economies

(Percent change)

While producer price inflation in advanced economies has slowed across sectors, the slowdown has been particularly sharp for manufacturing industries.



Sources: Haver Analytics; Organisation for Economic Co-operation and Development, Structural Analysis Database; and IMF staff calculations.
Note: The sample includes Australia, Austria, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, Luxembourg, Norway, the United Kingdom, and the United States. PPI = producer price index.
[1] Price index using weights based on 2002–04 average world export earnings.
[2] Services comprise wholesale and retail trade; hotels and restaurants; transportation, storage, and communications; and finance, insurance, real estate, and business services.

inflation has slowed but remains generally positive despite the decline in international food prices over the same period—suggesting a rather low pass-through from international to domestic food prices (Box 3.3).

Explaining the Recent Decline in Inflation

To what extent can declines in oil and other commodity prices and economic slack explain recent inflation patterns? How important is the cross-border transmission of deflation pressure from industrial

slack in large economies? How large is the portion of disinflation that cannot be attributed to these factors? To answer these questions, an econometric analysis is performed to assess the contribution of various factors to recent inflation developments.

The empirical framework follows the approach of IMF (2013) and Blanchard, Cerutti, and Summers (2015), building on the hybrid New Keynesian Phillips Curve of Fuhrer (1995) and Galí and Gertler (1999). Specifically, the following version of the Phillips curve is estimated:[16]

$$\pi_t = \gamma_t \pi^e_{t+h} + (1-\gamma_t)\tilde{\pi}_{t-1} + \theta_t u^c_t + \mu_t \pi^m_t + \varepsilon_t, \quad (3.1)$$

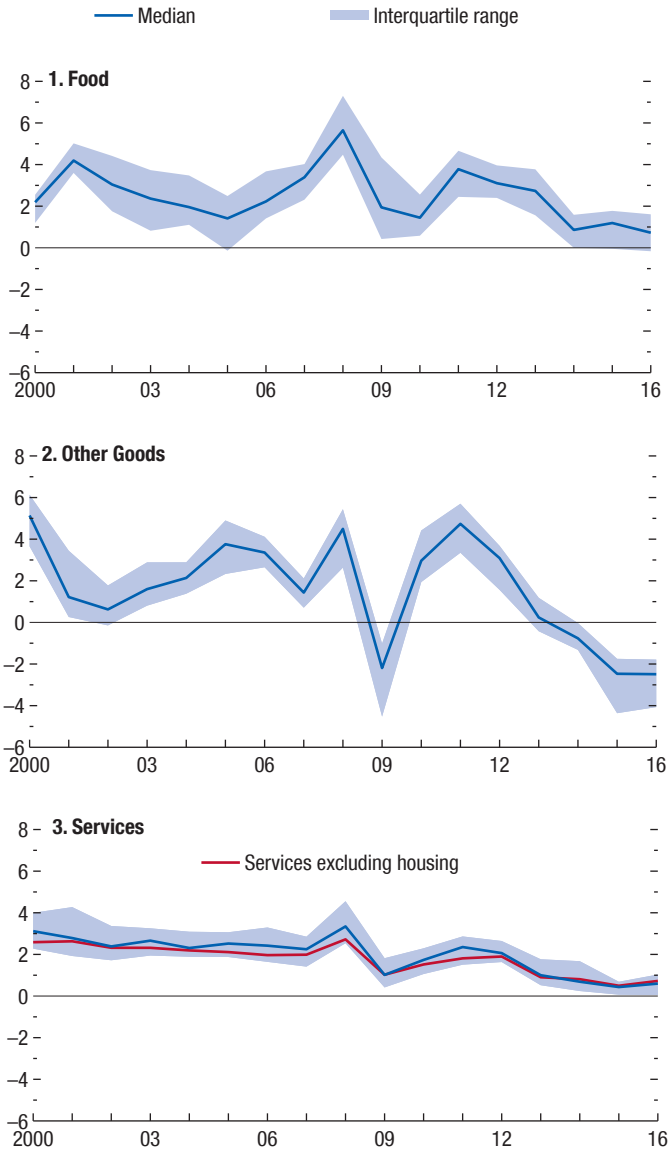
in which π_t is headline consumer price inflation; π^e_{t+h} is inflation expectations h years in the future (with 10-year-ahead expectations used in the baseline specification); $\tilde{\pi}_{t-1}$ is the moving average of inflation over the previous four quarters, to allow for inflation persistence; u^c_t is cyclical unemployment—that is, the deviation of the unemployment rate from its level consistent with stable inflation (the nonaccelerating inflation rate of unemployment, or NAIRU); π^m_t is inflation in the relative price of imports—defined as the import-price deflator relative to the GDP deflator—to account for the impact of import prices, including commodity prices, on domestic consumer prices; and ε_t captures the impact of other factors, such as fluctuations in inflation driven by temporary supply shocks, or measurement error in other variables in the specification—particularly in unobservable variables, such as inflation expectations and cyclical unemployment.[17] The coefficient γ captures the degree to which inflation is driven by long-term inflation expectations as opposed to lagged inflation; θ denotes the strength of the relationship between cyclical unemployment and

[16]There is a vast literature on the ability of alternative Phillips curve specifications to fit the data, particularly for advanced economies (see, for instance, Ball and Mazumder 2011; Fuhrer 1995; Stock and Watson 2007). The specification used here aims for sufficient versatility to accommodate a large sample of heterogeneous economies over a long period.

[17]Some studies use core inflation, producer price inflation, or GDP deflator inflation when estimating a Phillips curve. However, because for many countries measures of expectations are available only for consumer price inflation, which also tends to be the focus of central bank targets, equation (3.1) is estimated for consumer price inflation. The expectation term in the equation should ideally capture the expectations of firms that set prices for consumer goods and services. Since firms' inflation forecasts are not available, the analysis uses long-term inflation projections—at a 10-year horizon—from professional forecasters reported by Consensus Economics (Annex 3.4 discusses the choice of forecast horizon and the robustness of results to using different measures).

Figure 3.10. Sectoral Consumer Prices in Advanced Economies
(Percent change)

Consumer price inflation declined more for goods than for services, with deflation for nonfood goods in most advanced economies.



Sources: Haver Analytics; and IMF staff calculations.
Note: "Food" comprises food and beverages. "Other goods" comprises fuels, purchases of vehicles, and all categories under the following expenditure groups: clothing and footwear; electricity, gas, and other fuels; and furnishings, household equipment, and routine maintenance. All other consumer price categories are in "Services." Country sample includes Austria, Belgium, Canada, Czech Republic, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

inflation—the slope of the Phillips curve; and μ is the effect of relative import prices on inflation.

The estimation allows for time variation in all the parameters to capture possible changes in the structure of each economy.[18] The model is estimated for each advanced and emerging market economy for which data are available, yielding estimates for a set of 44 countries from the first quarter of 1990 to the first quarter of 2016. The estimates are then used to assess the contribution of labor market slack and import prices to recent inflation dynamics in each country.[19]

Before turning to examine which factors have contributed to the recent decline in inflation, it is useful to assess whether the parameters of the Phillips curve have changed over time. The results suggest that the parameters are broadly stable and, in particular, there is no strong evidence that the slope of the Phillips curve has declined since the mid-1990s (Figure 3.11).[20] A notable exception, particularly for advanced economies, is the degree to which inflation is driven by long-term inflation expectations as opposed to past inflation. The estimated coefficient on expected inflation (γ) steadily increased up to the Great Recession but has been declining since then and now stands at levels comparable to those in the early 1990s (about 0.6).[21] The consequent increase in the coefficient on lagged inflation (1 - γ) implies that inflation has become more backward looking. This implies that the effect of cyclical unemployment and import prices on inflation has become more persistent in the recent period.

Despite some heterogeneity across countries, the results of the country-by-country decompositions show that unemployment slack and weaker import prices are, on average, the most important factors in explaining deviations of inflation from inflation targets in advanced economies since the Great Recession (Figure 3.12). Instead, changes in long-term inflation expectations (as measured by 10-year-ahead expectations by professional forecasters) have played a limited role—although repeating the exercise with expectations at shorter horizons suggests a larger contribution from inflation expectations (see Annex 3.4).

Although parameters are allowed to vary over time—therefore capturing possible nonlinearities (Swamy and Mehta 1975)—the model residuals ("others" in Figure 3.12) have increasingly contributed to the decline in inflation over the past few years. This could reflect a host of factors, including measurement errors in some of the explanatory variables. In particular, expectations of actual price setters may have dropped more than those of professional forecasters (Coibion and Gorodnichenko 2015). Also, underestimation of the extent of unemployment slack could be reflected in larger residuals.[22]

As an aside, the results also suggest that the reason inflation in advanced economies did not fall more between 2008 and 2012 is that the positive effect on inflation of import prices, notably oil prices, partly offset the disinflationary effect stemming from high labor market slack.[23] Accordingly, as import prices started to fall in 2012, inflation began to weaken and undershoot targets.

The decomposition for emerging market economies shows significant heterogeneity. In countries where inflation has recently fallen below long-term inflation expectations, labor market slack, import prices, and, to a lesser extent, currency appreciations explain, on average, the bulk of the recent decline (Figure 3.13, panel 1). In contrast, currency depreciations—notably in commodity exporters—contributed to the increase in inflation in those emerging market economies with inflation currently above long-term expectations. The model residuals over the recent years are particularly large in these economies (Figure 3.13, panel 2), possibly reflecting greater measurement error on inflation expectations as well as changes in administered prices in some cases.[24] Similar to the case of advanced economies, the roles played by these factors vary across countries (Figure 3.13, panels 3 and 4).

[18]For example, improvements in the conduct of monetary policy and structural factors—such as globalization changes in rigidities in product and labor markets—may have affected the sensitivity of inflation to fluctuations in domestic production (April 2006 *World Economic Outlook*, Chapter 3, and references therein; Rogoff 2003).

[19]The decomposition of inflation dynamics is conducted in a manner similar to that in Yellen (2015). See Annex 3.4 for details.

[20]This finding is in line with that of the April 2013 *World Economic Outlook*, Chapter 3, and Blanchard, Cerutti, and Summers (2015), which document that the flattening of the Phillips curve from the 1960s to the 2000s was largely completed by the mid-1990s.

[21]The finding that the parameter increased during the 1990s is consistent with earlier research, including IMF (2013). That study also finds that the link between current and past inflation started to strengthen since the Great Recession.

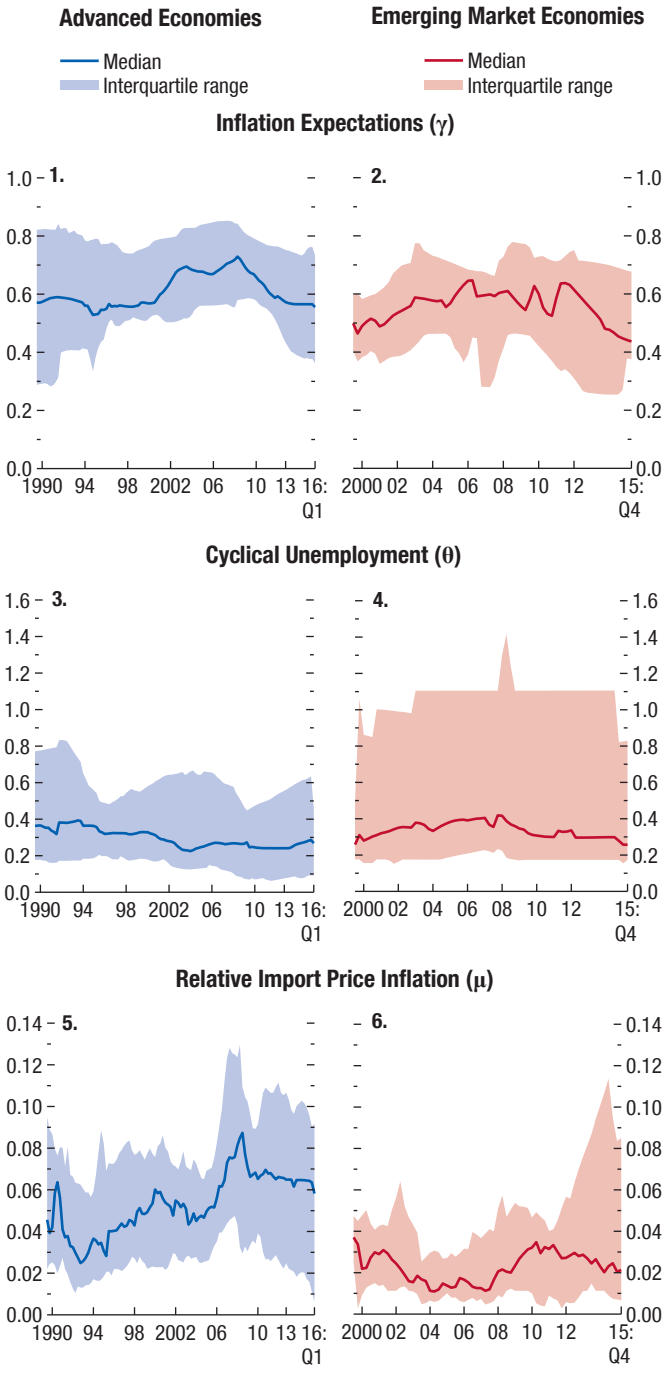
[22]The exercise reported in Annex 3.4 shows that the results are typically robust to using alternative measures of cyclical unemployment but somewhat sensitive to different inflation expectations horizons.

[23]Coibion and Gorodnichenko (2015) and Yellen (2015) find similar results for the United States.

[24]Indeed, robustness exercises in Annex 3.4 show that the residuals vary considerably across different measures of inflation expectations and are much smaller when using inflation expectations at shorter horizons.

Figure 3.11. Estimated Phillips Curve Parameters

Estimation results suggest that the degree of anchoring of inflation to long-term expectations increased in the 1990s and early 2000s but declined more recently toward the level attained in the early 1990s. Other parameters, including the slope of the Phillips curve, have been broadly stable.

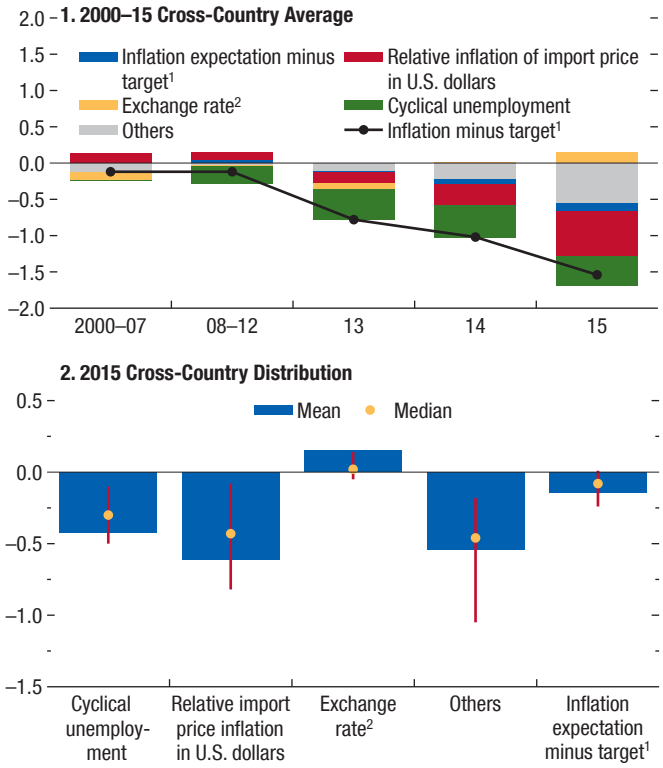


Sources: Consensus Economics; Haver Analytics; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: The sample is defined in Annex Table 3.1.1. Venezuela is excluded because of missing data.

Figure 3.12. Contribution to Inflation Deviations from Targets: Advanced Economies

(Percent)

Cyclical unemployment and weaker import prices can account for the bulk of the deviation of inflation from targets in advanced economies since the global financial crisis, but other unexplained factors have been playing an increasingly larger role more recently.



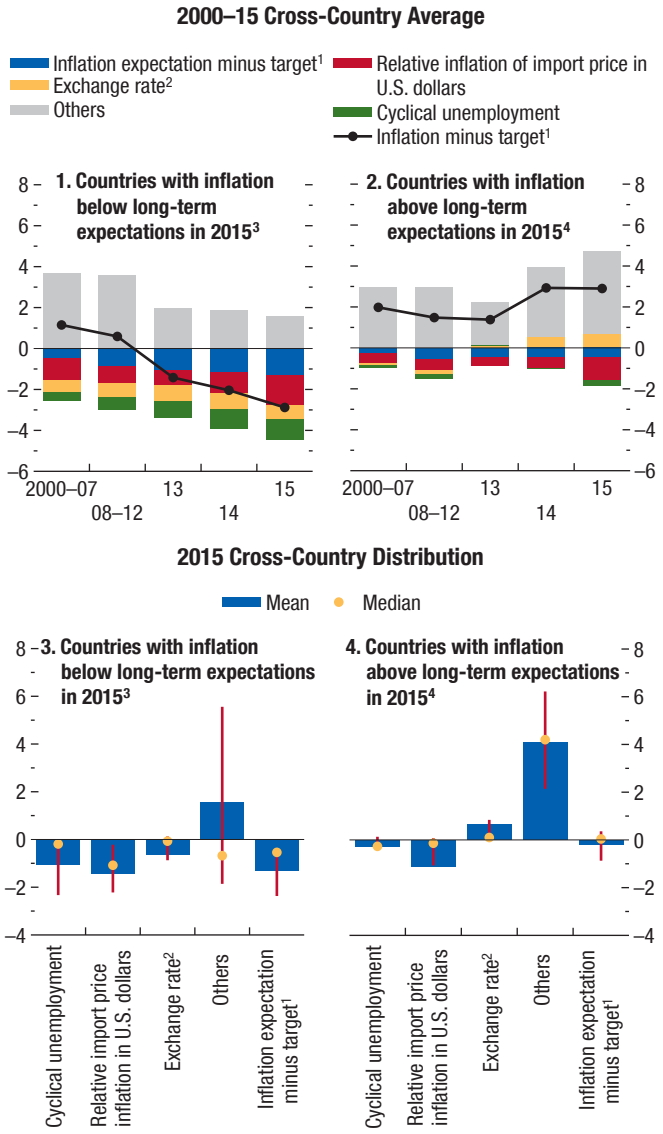
Sources: Consensus Economics; Haver Analytics; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: Vertical lines in panel 2 denote interquartile ranges. The sample is defined in Annex Table 3.1.1. Estonia, Latvia, Lithuania, the Slovak Republic, and Slovenia are excluded as outliers.
[1] Target refers to the average of long-term inflation expectations in 2000–07, which are from Consensus Economics (10-year inflation expectations) or *World Economic Outlook* inflation forecasts (5-year inflation expectations).
[2] Exchange rate is defined as currency value per U.S. dollar.

Given the important role played by import prices, the rising slack in tradables sectors in large economies and systemic trading partners (such as China, Japan, and the United States; Box 3.1) raises an interesting question: are spillovers from industrial slack in large economies an important factor in the decline in import prices and inflation?[25] Further

[25]A single country can take the price of its imports as given, but the world as a whole does not have import prices. Changes in import prices depend on the degree of excess supply or excess demand in globally integrated markets for tradable goods and services.

Figure 3.13. Contribution to Inflation Deviations from Targets: Emerging Market Economies

Economic slack and weak import prices also account for a large share of the observed disinflation in emerging market economies with inflation below long-term inflation expectations over the recent past. In contrast, exchange rate depreciations and other unexplained factors played a key role in emerging market economies in which inflation has been above long-term expectations.



Sources: Consensus Economics; Haver Analytics; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: Vertical lines in panels 3 and 4 denote interquartile ranges. The sample is defined in Annex Table 3.1.1. Venezuela is excluded because of missing data. Ukraine is excluded as an outlier.
[1] Target refers to the average of long-term inflation expectations in 2000–07, which are from Consensus Economics (10-year inflation expectations) or *World Economic Outlook* inflation forecasts (5-year inflation expectations).
[2] Exchange rate is defined as currency value per U.S. dollar.
[3] Bulgaria, China, Hungary, Malaysia, Mexico, Philippines, Poland, Romania, Thailand.
[4] Argentina, Brazil, Chile, Columbia, India, Indonesia, Peru, Russia, Turkey.

analysis provides suggestive evidence that this may be the case. In many advanced and emerging market economies, the contribution of import prices to inflation over time is correlated with manufacturing slack in China, Japan, and the United States. The average correlation with manufacturing slack in all three countries is important, but is particularly strong in the case of China (Figure 3.14, panel 1; Annex Figure 3.4.3).[26,27]

Causal relationships cannot be inferred from this simple exercise, as many factors could drive manufacturing slack in each of these large economies (including weak demand elsewhere) or be associated with it (for instance, lower international oil prices) and could therefore bias the results. Indeed, the conditional correlation between manufacturing slack and the contribution of import prices to inflation is significantly lower when other global variables—such as oil prices and global demand conditions—are also taken into account (Figure 3.14, panel 2; Annex Figures 3.4.3 and 3.4.4). Nonetheless, the correlation with manufacturing slack in China remains significant and economically meaningful: the recent widening in manufacturing slack of about 5 percentage points would be associated, on average, with a decline in inflation in advanced and emerging market economies of about 0.2 percentage point—down from 0.5 percentage point when the estimation does not control for global conditions.[28]

In sum, while an accounting of the drivers of global manufacturing slack is beyond the scope of

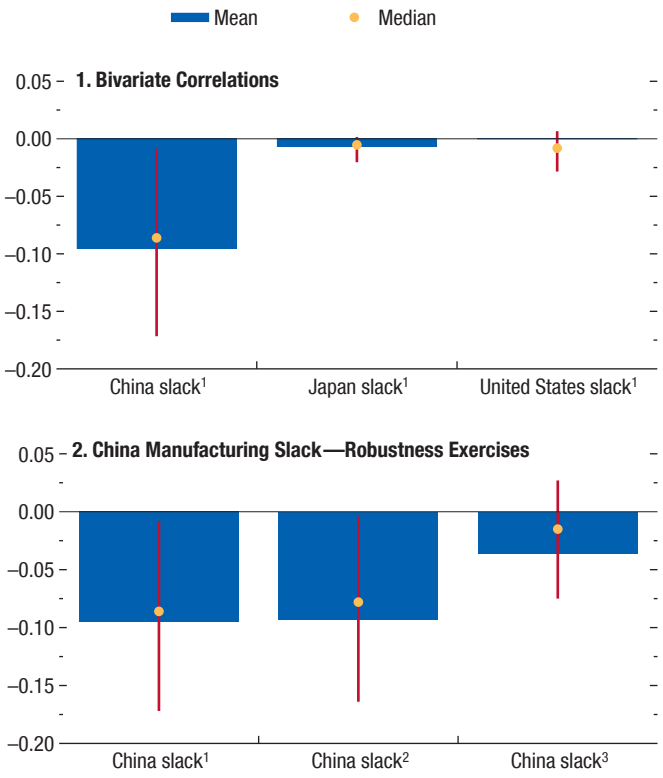
[26]The impact of industrial slack cannot be directly tested in the empirical framework because reliable estimates for it are available only from the mid-2000s (as discussed in Box 3.1). To avoid shortening the Phillips curve estimation period, the analysis instead regresses, country by country, the contribution of import prices on measures of industrial slack in China, Japan, and the United States. See Annex 3.4 for details on the estimation framework as well as robustness checks.

[27]The association between import price contribution and China's manufacturing slack appears to be stronger for advanced economies than emerging market economies (see Annex Figure 3.4.3).

[28]The correlation of the contribution of import prices to inflation and manufacturing slack in China is negative for 84 percent of the sample, and additional results from panel regressions confirm the statistical significance of this result (see Annex 3.4). Further analysis finds that this correlation is higher in countries with stronger trade links with China, providing additional evidence of direct spillover effects through tradable goods. However, slack in China could exert disinflationary pressure on the price of domestic tradable goods in other countries—when these prices are set in global markets—beyond what is captured through import prices. Indeed, the correlation of model residuals with manufacturing slack in China is statistically significant.

Figure 3.14. Correlation of Manufacturing Slack in China, Japan, and the United States with Import Price Contribution to Inflation in Other Economies
(Percentage points)

Subdued inflation across a large number of countries is associated with manufacturing slack in Japan, the United States, and especially China.



Sources: Consensus Economics; Haver Analytics; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: Vertical lines denote interquartile ranges. The figure shows the means, medians, and interquartile ranges of coefficients of manufacturing slack from country-specific regressions. See Annex 3.4 for the regression specifications.
[1] No controls.
[2] Controlling for manufacturing slack in the other two economies, change in oil prices, and global output gap.
[3] Controlling for global output gap and change in oil prices in current and previous four quarters.

this chapter, these findings suggest that manufacturing slack in large economies may add deflation pressure in other economies.

How Well Anchored Are Inflation Expectations?

The previous results suggest that economic slack and the sharp drop in the global price of tradable goods explain a large fraction of the undershooting of inflation targets observed in many countries over the past few years. The contribution of long-term inflation expectations to recent inflation dynamics has been much smaller—although the results are somewhat sensitive to the inflation expectations horizon. But if inflation expectations drift down substantially even as a result of temporary shocks, this would lead to a protracted period of disinflation—especially in the context of constrained monetary policy.[29]

Therefore, a key question in the current juncture is how well anchored inflation expectations are. In particular, is there evidence that recent inflation developments are affecting inflation expectations? To explore that question, the analysis investigates the sensitivity of inflation expectations to changes in actual inflation, examines the role of monetary policy frameworks in influencing this sensitivity, and assesses whether this sensitivity has increased in countries with policy rates at, or close to, their lower bound.

Measuring Inflation Expectations

The link between inflation and economic activity stems in part from the pricing decisions of firms and their beliefs about future macroeconomic outcomes.[30] Because firms' inflation expectations are not generally known, they are approximated by: (1) surveys of inflation expectations of professional forecasters or households and (2) market-based measures of inflation expectations, such as estimates of inflation compensation embedded in the returns of financial instruments.

Survey-based and market-based measures of inflation expectations measure somewhat different concepts and have different statistical properties. Surveys collect one measure of central tendency—the mean, median, or mode—of the believed distribution of individual professional forecasters or households, and different individuals may report a different measure of their believed distribution. It is customary to use the median of this distribution of individual responses as a summary statistic of survey-based expectations to reduce the distortionary effect of outliers. The dispersion of expectations in the survey is a measure of heterogeneity of beliefs rather than

[29]See Annex 3.2 for simulations on the effect of temporarily subdued import prices—stemming from a decline in oil prices and industrial slack in a key large economy—under constrained monetary policy and unanchored inflation expectations.
[30]Another link is related to household purchases of consumer durables and residential investment. Expectations of price declines can delay purchases.

a measure of uncertainty—although these tend to move together (Gürkaynak and Wolfers 2007). Survey-based measures of professional forecasters' inflation expectations (such as those from *Consensus Economics*) are available at different horizons for a large set of countries while surveys on the expectations of households (such as the University of Michigan survey for the United States) are available only for a few advanced economies.

Market-based measures of inflation expectations can be extracted from inflation compensation embedded in long-maturity inflation-linked and nominal bonds or from inflation-linked swaps.[31] The break-even inflation rate measured by the yield spread between conventional bonds and comparable inflation-linked bonds provides an estimate of the level of expected inflation at which a (risk-neutral) investor would be indifferent between holding either type of bond. It is widely used as a timely measure of investors' inflation expectations, although it is effectively based on the pricing of the marginal investor and includes a liquidity premium and an inflation risk premium.[32]

It is thus not surprising to observe differences in the behavior of survey- and market-based measures over time, including during the most recent period of disinflation. Inflation expectations from professional forecasters for horizons of up to three years vary over time, but expectations for horizons of five years or more are remarkably stable. Households' expectations are also highly stable over longer horizons. In contrast, historical market-based measures of inflation expectations exhibit more variation over time.

Turning to the most recent period, medium-term market-based expectations (five years or more) in the United States and the euro area have fallen by about 0.9 percentage point and 0.8 percentage point, respectively, since 2011—and by about 0.6 percentage point and 0.5 percentage point, respectively, since the sharp drop in oil prices in 2014—and are now significantly below their historical averages and survey-based measures (Figure 3.15, panels 1 and 2). Survey-based inflation expectations have instead declined by much less—about 0.15 percentage point on average during the same period.[33] But, although survey-based medium-term expectations have remained near central banks' targets since the Great Recession, the deviations of inflation expectations from targets in key advanced economies after the crisis have become large even at relatively long horizons such as three years—while under well-anchored inflation expectations these deviations should be zero (Figure 3.15, panels 3 and 4).[34]

Empirical Analysis

The sensitivity of inflation expectations is estimated empirically in a framework that relates changes in inflation expectations to inflation surprises. In particular, the following equation is estimated:

$$\Delta\pi^{e}_{t+h} = \beta^{h}_{t}\pi^{news}_{t} + \epsilon_{t+h}, \tag{3.2}$$

in which $\Delta\pi^{e}_{t+h}$ denotes the first difference in expectations of inflation h years in the future, and π^{news}_{t}

[31]Inflation-linked bonds are now issued in more than 20 countries. In addition to the United Kingdom, the United States, and four large euro area countries, these countries include Brazil, South Africa, South Korea, and Turkey. For a historical overview of international inflation-linked bond markets, see Garcia and van Rixtel (2007) and references therein. Inflation-linked swaps are derivatives through which one party pays a fixed rate of inflation in exchange for actual inflation over the length of the contract. The rate of inflation quoted as the fixed leg of the swap can be used to provide an alternative measure of inflation compensation. Inflation-linked swaps are less prone to incorporate a liquidity premium than inflation-linked and nominal bonds because the swaps do not require an upfront payment and are settled by the net exchanges of flows at the end of the contract.

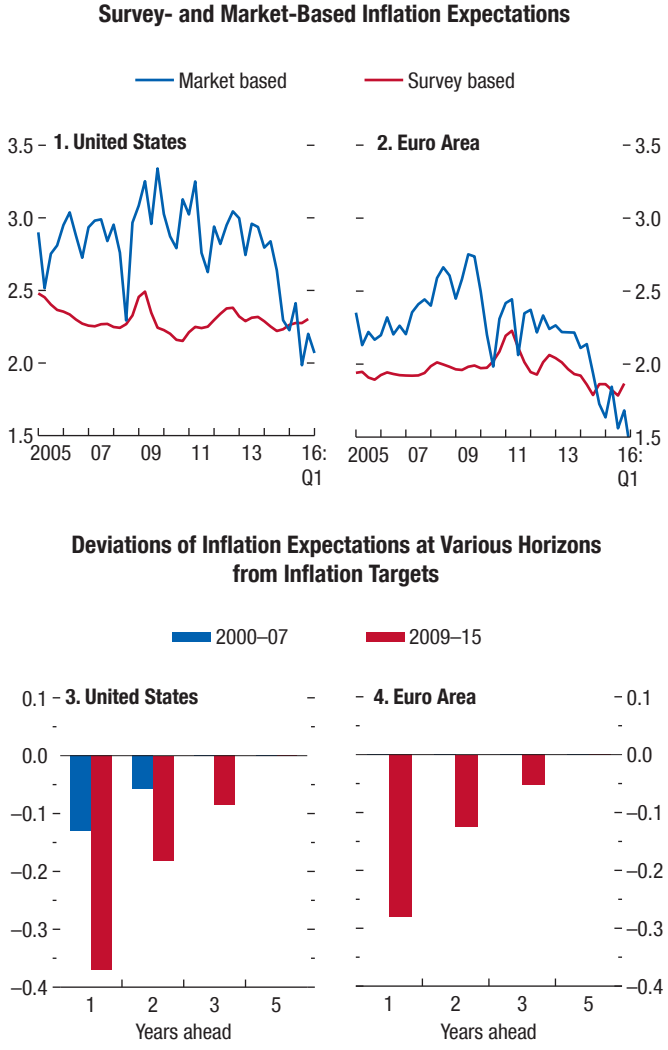
[32]The liquidity premium may arise from factors unrelated to inflation expectations, such as trading frictions or insufficient market activity and could be gauged by looking at relative trade volumes or asset-swap spreads (see, for example, Celasun, Mihet, and Ratnovski 2012; Gürkaynak, Sack, and Wright 2010). The inflation risk premium captures markets' pricing of risk surrounding inflation expectations and is much more difficult to estimate than the liquidity premium. Estimates of the inflation risk premium are typically taken from term-structure models. But, even for a single country, estimates vary significantly over time, across maturities, and across specifications, which makes the interpretation of changes in inflation compensation far from straightforward. For term-structure models applied to the United States, see, for example, Abrahams and others (2012); Christensen, Lopez, and Rudebusch (2010); and D'Amico, Kim, and Wei (2014). For the euro area, see, for example, Garcia and Werner (2014).

[33]Although the expectations of professional forecasters and households have barely declined since the precrisis period, the skew of the distributions has changed. Evidence for the United States suggests that for both of those measures, the share of respondents expecting 1–2 percent inflation has increased, while most of the declines reflect a reduction in expectations for above-target inflation. Inflation expectations based on professional forecasts show a marked reduction in the upper tail, whereas those based on household forecasts point to a reduction in uncertainty.

[34]Empirical evidence for the United States and the euro area suggests that three-year-ahead inflation expectations were not statistically different from inflation targets during the precrisis period but were statistically significantly lower in 2009–15. The analysis controls for the magnitude of inflation shocks in the two periods.

Figure 3.15. Survey- and Market-Based Inflation Expectations
(Percent)

Medium-term market-based inflation expectations have decreased substantially in the United States and the euro area recently. Survey-based inflation expectations fell by much less, but they have deviated significantly from inflation targets even at a three-year horizon.



Sources: Bloomberg L.P.; and IMF staff calculations.
Note: Survey-based inflation expectations in panels 1 and 2 correspond to 5-years-ahead inflation forecasts from Consensus Economics; market-based expectations are based on 5 year/5 year inflation swaps. Panels 3 and 4 show the estimated constant in a regression of deviations of survey-based inflation expectation at different horizons from the inflation target (proxied by 10-year ahead inflation expectation) on deviations from target of actual annualized quarterly inflation. Estimated coefficients are set to zero if they are not significant at the 5 percent confidence level. Euro area forecasts correspond to the GDP-weighted average of the forecasts for France, Germany, Italy, the Netherlands, and Spain.

is a measure of inflation shocks.[35] The coefficient β^h captures the degree of anchoring in h-years-ahead inflation expectations—a term usually referred to as "shock anchoring" (Ball and Mazumder 2011)—and it is allowed to vary over time in some specifications. If monetary policy is credible, the value of this parameter at a sufficiently long horizon should be close to zero. That is, inflation shocks should not lead to changes in medium-term expectations if agents believe that the central bank is able to counteract any short-term developments to bring inflation back to the target over the medium term. Given uncertainty about the relevant horizon for firms' pricing decision and in light of the previous results, the exercise is performed using survey- and market-based inflation expectations at various horizons.

The model is estimated for each advanced and emerging market economy for which data are available, which produces estimates for 44 countries from the first quarter of 1990 to the first quarter of 2016. The specification allows for the parameter β^h to vary over time to capture changes in the sensitivity of inflation expectations due, for instance, to changes in monetary policy frameworks. The analysis is performed for survey-based inflation expectations using data available at quarterly frequency and for market-based inflation expectations using data available at daily frequency.

Results—Survey-Based Inflation Expectations

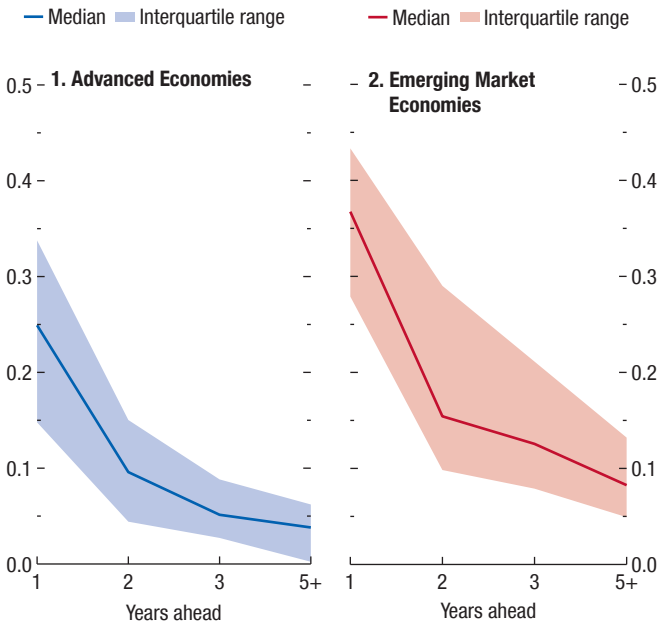
The analysis starts by using a static framework—that is, β^h is assumed constant over time—to explore how the sensitivity of survey-based inflation expectations varies across countries and how this is related to characteristics of monetary policy frameworks.[36] The

[35]Inflation shocks are defined as the quarterly difference between actual inflation and short-term expectations for the analysis based on survey forecast–based measures of inflation expectations and as the daily change in oil price futures for the analysis using market-based expectations. The quarterly forecast error is used as a baseline measure of inflation shocks for the analysis based on survey-based measures of inflation expectations because it is less subject to reverse causality than other measures, such as changes in inflation or deviations of inflation from target. The results using these two alternative measures are, however, not statistically significantly different. Measures of inflation surprises are not available at daily frequency, so changes in oil price futures are used as proxies for inflation shocks for the analysis based on market-based expectations. While the scope of this measure is clearly narrower, inflation expectations have been shown to be strongly related to oil price developments (see Coibion and Gorodnichenko 2015).

[36]This part of the analysis is carried out using a static framework since data for several characteristics of monetary policy frameworks, such as transparency and independence, are available only for a

Figure 3.16. Sensitivity of Inflation Expectations to Inflation Surprises
(Years on x-axis)

Inflation expectations are less sensitive to inflation surprises in advanced economies than in emerging market economies.



Sources: Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: The figure shows the response of inflation expectations at various horizons to a 1 percentage point unexpected increase in inflation based on coefficients from country-specific static regressions. The sensitivity for 5+ years corresponds to the average of estimations using 5- and 10-year-ahead inflation expectations.

estimates show that the sensitivity of inflation expectations is significantly lower in advanced economies than in emerging market economies (Figure 3.16). This is particularly true for inflation expectations at short-term horizons—for example, a 1 percentage point increase in inflation results in a 0.25 percentage point increase in inflation expectations one year ahead for advanced economies, whereas this increase is 0.37 percentage point for emerging market economies. The difference in sensitivity is present, albeit to a lesser degree, even at longer horizons—a 1 percentage point increase in inflation leads to an increase of 0.05 percentage point in three-year-ahead inflation expectations in advanced economies, and of 0.13 percentage point in emerging market economies.

The average lower sensitivity of inflation expectations to inflation shocks in advanced economies points to the credibility of monetary policy frameworks as a possible determinant of the cross-country heterogeneity. An exploration of the differences in estimated sensitivities shows that they are related to measures of central bank independence and transparency—two key areas of central bank governance that have improved dramatically over the past few decades and are positively associated with monetary policy performance (Crowe and Meade 2007).

Medium-term inflation expectations—that is, inflation expectations at three years and at five or more years—are typically better anchored in countries where the central bank is more independent. On average, a 1 unit increase in an index based on the turnover of the central bank's governor—a de facto measure of central bank independence, with higher values associated with a lower degree of independence—is associated with an increase of about 0.3 unit in the sensitivity of inflation expectations (Figure 3.17, panels 1 and 2).[37] This suggests that if a country moves from the 25th percentile to the 75th percentile in terms of turnover—which is similar to the average gap in this independence indicator between the United States and Indonesia in the past 20 years—the sensitivity will increase by 0.03, a nontrivial change considering that the median sensitivity across countries is 0.08.

Analogously, the sensitivity of medium-term inflation expectations to inflation surprises is lower the more transparent the central bank is about its objectives and policy decisions. The results show that, on average, a 1 unit increase in an index of central bank transparency is associated with a 0.16 unit decrease in the sensitivity of three-year-ahead inflation expectations (Figure 3.17, panels 3 and 4).[38] The magnitude

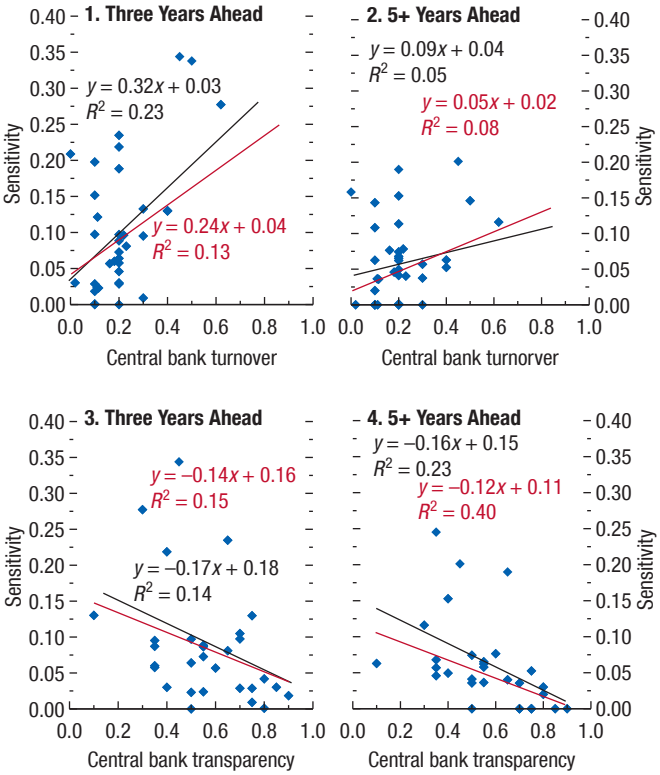
few points in time. The sensitivity of inflation expectations for the survey-based forecast is normalized to measure how much inflation expectations are updated in response to a 1 percentage point change in inflation. See Annex 3.5 for details on the estimation and the computation of inflation shocks.

[37]The central bank governor's term in office shortens relative to that of the executive as turnover increases, making the governor more vulnerable to political interference from the government and reducing the degree of independence of the central bank. Cukierman, Webb, and Neyapti (1992) find that the link between central bank independence and inflation outcomes is stronger when using the de facto measure based on governor turnover than in the case of de jure metrics based on legal measures. Therefore, the analysis uses the governor turnover index from Crowe and Meade (2007), which extended Cukierman, Webb, and Neyapti's (1992) index up to 2004 and includes a large number of emerging market and developing economies.

[38]The central bank transparency index is taken from Crowe and Meade (2007) and corresponds to 1998.

Figure 3.17. Sensitivity of Inflation Expectations to Inflation Surprises and Monetary Policy Frameworks

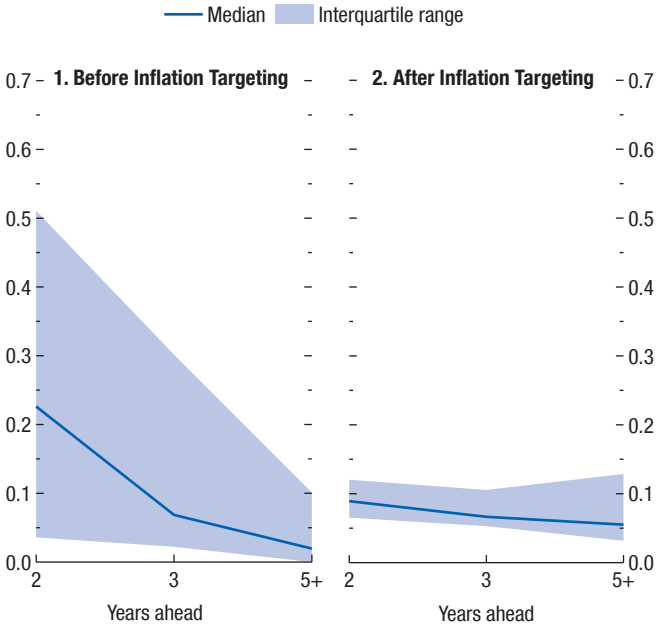
Medium- and long-term inflation expectations are less sensitive to inflation surprises in countries with more independent and transparent central banks.



Sources: Consensus Economics; Crowe and Meade (2007) data set; Haver Analytics; and IMF staff calculations.
Note: The sensitivity is measured as the response of inflation expectations at various horizons to a 1 percentage point unexpected increase in inflation based on coefficients from country-specific static regressions. The sensitivity for 5+ years corresponds to the average of estimations using 5- and 10-year-ahead inflation expectations. Black lines denote the fitted lines for the entire sample. Red lines denote the fitted lines excluding outliers.

Figure 3.18. Sensitivity of Inflation Expectations to Inflation Surprises before and after Adoption of Inflation Targeting

Inflation targeting is associated with lower sensitivity of medium- and long-term inflation expectations to inflation surprises.



Sources: Consensus Economics; Haver Analytics; *World Economic Outlook* (2011, Chapter 3); and IMF staff calculations.
Note: The figure shows the response of inflation expectations at various horizons to a 1 percentage point unexpected increase in inflation based on coefficients from country-specific static regressions. The sensitivity for 5+ years corresponds to the average of estimations using 5- and 10-year-ahead inflation expectations.

of the estimated coefficient suggests that if a country moves from the 25th percentile to the 75th percentile in terms of transparency—which is similar to the average gap in the transparency indicator between Peru and Canada over the past 20 years—the sensitivity would decline by 0.05.

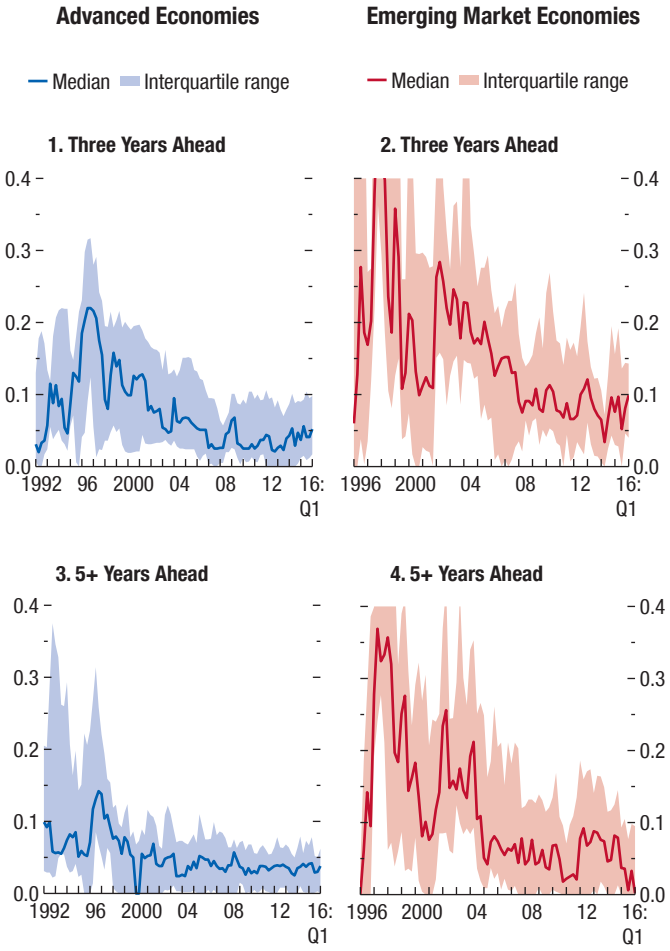
Many central banks have adopted inflation targeting over the past few decades precisely to make their decision-making process more transparent. Comparing the sensitivity of inflation expectations to inflation surprises in each country before and after the adoption of inflation targeting suggests that those monetary reforms are associated with a considerable decrease in sensitivity (Figure 3.18). The drop in sensitivity is observed for all countries in the sample, as evidenced by a relatively narrow interquartile range.[39]

Overall, the results using a static framework suggest that stronger monetary policy frameworks are associated with better-anchored inflation expectations. Allowing the estimate of the sensitivity of inflation expectations (β^b) to vary over time shows that it has declined steadily in both advanced and emerging market economies over the past two decades (Figure 3.19). The decline was steeper at the beginning of the sample period, precisely when many economies significantly improved their frameworks, including

[39]See Levin, Natalucci, and Piger (2004) for a similar finding. Clarida and Waldman (2008) find that higher-than-expected inflation leads to appreciation of the nominal exchange rate in countries with inflation targeting regimes—but not in others—suggesting that inflation targeters are successful in anchoring expectations of inflation and the monetary path required to meet the target.

Figure 3.19. Sensitivity of Inflation Expectations to Inflation Surprises over Time

The sensitivity of inflation expectations to inflation surprises has been steadily declining over time. But this downward trend seems to have come to a halt more recently, especially among advanced economies.



Sources: Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: The figure shows the response of inflation expectations at various horizons to a 1 percentage point unexpected increase in inflation based on time-varying coefficients from country-specific estimations using a Kalman filter. The sensitivity for 5+ years corresponds to the average of estimations using 5- and 10-year-ahead inflation expectations.

by adopting inflation targeting regimes.[40] It has also been broad based across countries, as illustrated by the evolution of the interquartile range. The observation that the sensitivity of inflation expectations to inflation surprises remains lower in advanced economies than among emerging market economies suggests there is scope for further improvements in the monetary policy frameworks in the latter group.

However, the downward trend in the sensitivity of expectations seems to have come to a halt in the mid-2000s, especially among advanced economies. In addition, the sensitivity of medium-term inflation expectations over the recent past has been steadily increasing in countries with policy rates at, or close to, their lower bound than in other countries (Figure 3.20).[41] This has happened even though many of these economies adopted unconventional monetary policies during this period, suggesting that constrained monetary policy may be affecting the degree of anchoring of inflation expectations.

An analysis of the response of inflation expectations to positive and negative inflation shocks also points to constrained monetary policy as the underlying cause of a possible unanchoring of expectations. If constraints on monetary policy are the source of the increased sensitivity of inflation expectations, this sensitivity should be higher for negative shocks than for positive ones—a central bank constrained by the effective lower bound on policy rates can always respond to higher inflation by raising the policy interest rate, but has little scope to reduce it when inflation is declining. This creates an unavoidable asymmetry in the ability of the monetary authority to handle downward and upward inflation shocks.

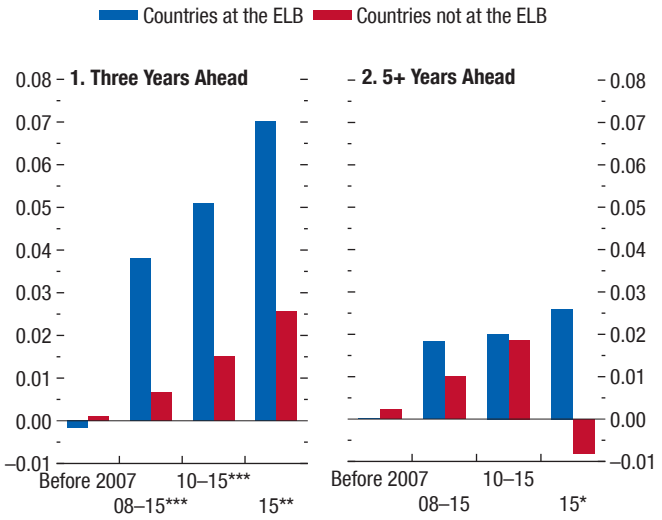
Indeed, most of the increased sensitivity for countries with constrained monetary policy seems to stem from negative inflation shocks (Figure 3.21). After 2009, when policy rates approached their effective lower bounds, the response of medium-term inflation expectations to negative shocks exceeded the response to positive shocks, while the response to positive shocks was

[40]For example, in 1996 only about 20 percent of countries in the sample had an inflation-targeting regime; by 2015 the proportion had increased to about 75 percent. Similarly, the sample average of the transparency indicator increased from 0.55 in 1998 to 0.61 in 2006, and the turnover indicator decreased from 0.29 in 1980–89 to 0.20 in 1995–2004.

[41]In this analysis, the effective-lower-bound constraint refers to the policy rate being equal to or less than 50 basis points. The monetary authorities of the following 19 advanced economies faced this constraint at some point during 2009–15: Canada, the Czech Republic, Estonia, France, Germany, Hong Kong SAR, Italy, Japan, Latvia, Lithuania, the Netherlands, Singapore, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Singapore does not use an interest rate as a monetary policy instrument, but the level of short-term market interest rates is at the effective lower bound. Statistical significance of the difference is tested using Mood's median test. The difference between the two groups is statistically significant for expectations at a three-year horizon and, to a lesser extent, for inflation expectations at a five-year horizon.

Figure 3.20. Change in Sensitivity of Inflation Expectations to Inflation Surprises

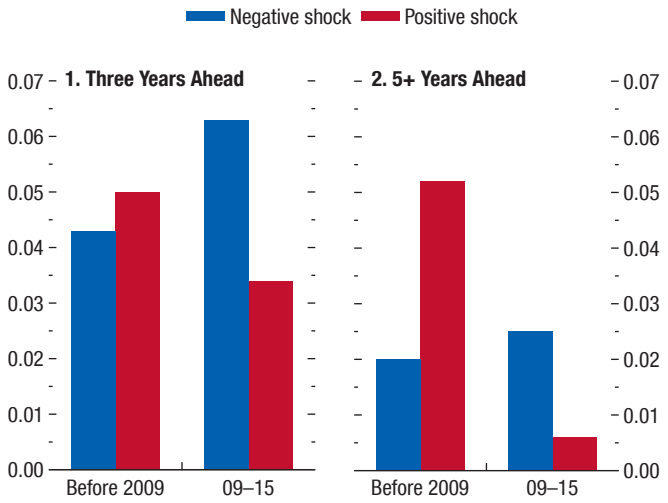
The sensitivity of medium-term inflation expectations to inflation surprises is higher in countries whose monetary policy is constrained.



Sources: Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: ELB = effective lower bound. ***,**,* denote that the differences in the change in sensitivity of inflation expectations between countries at the ELB and the rest are significant at the 1, 5, and 10 percent confidence level, respectively, using Mood's median test. The sensitivity of inflation expectations corresponds to the response of inflation expectations to a 1 percentage point unexpected increase in inflation based on time-varying coefficients from country-specific estimations using a Kalman filter. The sensitivity for 5+ years corresponds to the average of estimations using 5- and 10-year-ahead inflation expectations. The change in sensitivity is constructed as the average deviation of the median sensitivity across countries from a linear trend (an exponential trend) fitted over the period 1997–2007 for countries at the ELB (not at the ELB). Countries at the ELB are defined as those with policy rates or short-term nominal interest rates of 50 basis points or lower at some point during 2008–15 and include: Canada, the Czech Republic, Estonia, France, Germany, Hong Kong SAR, Italy, Japan, Latvia, Lithuania, the Netherlands, Singapore, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Figure 3.21. Average Sensitivity of Inflation Expectations to Inflation Surprises in Countries at the Effective Lower Bound

In countries whose monetary policy is constrained, medium-term inflation expectations are more sensitive to negative than to positive inflation surprises.



Sources: Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: The figure shows the response of inflation expectations at various horizons to a 1 percentage point unexpected positive or negative change in inflation based on coefficients from country-specific time-varying estimation. The sensitivity for 5+ years corresponds to the average of estimations using 5- and 10-year-ahead inflation expectations. Countries at the Effective Lower Bound (ELB) are defined as those with policy rates or short-term nominal interest rates of 50 basis points or lower at some point during 2008–15 and include: Canada, the Czech Republic, Estonia, France, Germany, Hong Kong SAR, Italy, Japan, Latvia, Lithuania, the Netherlands, Singapore, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Japan is excluded from the analysis, because it reached the ELB much earlier than 2009.

larger before 2009.[42] The estimates imply that if countries with policy rates currently at the effective lower bound faced inflation surprises comparable to those over the past two years, long-term inflation expectations would on average drift further down by about 0.15 percentage point. This is not particularly large in absolute terms but still three times larger than if their sensitivity had remained unchanged—while under well-anchored expectations, there should be no impact at all.

The sharp drop in oil prices played an important role in global inflation dynamics over the past few years, and potentially also in the increase in the sensitivity of medium-term inflation expectations to inflation surprises. However, an additional exercise decomposing inflation surprises into oil and non-oil price movements suggests that the latter also contributed to the increase in expectations sensitivity. This result implies that positive inflation shocks stemming from a faster-than-expected recovery in oil prices would only lead to a partial rebound in inflation expectations if economic slack remains significant.[43]

[42]The difference between the sensitivity for positive and negative shocks is generally not statistically significant, probably due to the limited number of observations (Annex 3.5).

[43]For countries with policy rates at their effective lower bound, the sensitivity of inflation expectations to shocks is decomposed between those driven by changes in oil price inflation and those driven by news on core inflation—proxied by the residuals in the regression of inflation shocks on the oil price (see Annex 3.5). The results suggest that, since 2009, the sensitivities of inflation expectations to oil price shocks and core inflation shocks are comparable.

Taken together, this set of results suggests that it is not just the characteristics of recent inflation outcomes—such as the large negative inflation surprises related to the drop in oil prices—that have led to some unanchoring of medium-term inflation expectations. It is rather the combination of such persistent negative inflation surprises and the perception that monetary policy is constrained and may be less effective in bringing inflation back to the central banks' targets that is behind this apparent unanchoring of medium-term inflation expectations.[44]

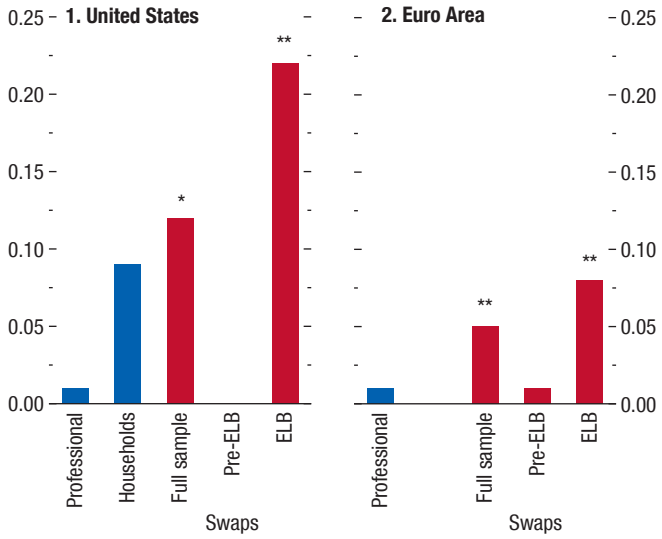
Results—Market-Based Inflation Expectations

The analysis so far provides evidence that: (1) the sensitivity of inflation expectations to inflation surprises depends on monetary policy frameworks and (2) this sensitivity has increased during the most recent period in countries with policy rates close to their effective lower bound, particularly in the case of negative inflation surprises. An analysis using high-frequency data for the United States and the euro area further underscores the relevance of constraints to monetary policy for the unanchoring of inflation expectations. Long-term market-based inflation expectations (approximated by five-year/five-year inflation swaps) are affected by inflation surprises proxied by changes in oil price futures (Figure 3.22). The responses are statistically significant—albeit economically small—both in the United States and in the euro area.[45] Splitting the sample around the time monetary policy rates reached their effective lower bounds shows that the sensitivity of inflation expectations was actually indistinguishable from zero before reaching the lower bound on interest rates, but increased substantially thereafter. The higher elasticities imply that surprises in oil prices can account for about one-third of the decline in market-based inflation expectations since June 2014 in the United States and almost one-fifth in the euro area.[46]

All in all, these empirical findings underscore vulnerabilities at the current juncture, as inflation shocks are predominantly negative and central banks have little space to respond. While the economic significance of the current degree of unanchoring of inflation expectations is still modest, the steady increase in their sensitivity to inflation surprises in cases where monetary policy is constrained is a reason for concern if the undershooting of inflation targets persists.

Figure 3.22. Sensitivity of Longer-Term Inflation Expectations to Changes in Oil Prices

The sensitivity of market-based inflation expectations to inflation surprises in the United States and the euro area increased after policy rates reached their effective lower bounds.



Sources: Bloomberg L.P.; Consensus Economics; University of Michigan Consumer Survey; and IMF staff calculations.
Note: **,* denote significance at the 5 and 10 percent confidence level, respectively. The figure shows coefficient estimates of inflation expectations on changes in oil price futures (simple average of 1-year-ahead Brent and West Texas Intermediate) controlling for changes in the Chicago Board Options Exchange Volatility Index and scaled by a 50 percent drop in oil price futures. Blue bars denote estimation results using survey-based inflation expectations: "Professional" denotes the results using 5-year-ahead inflation forecasts from Consensus Economics; while "Households" denotes results using inflation expectations (5–10 years) from the Michigan survey. Red bars denote results using market-based inflation expectations based on five year/five year inflation swaps. The effective lower bound (ELB) is defined as starting in 2009. The full sample refers to the period 2004–16.

[44]An additional estimation was used to explore whether inflation surprises have a larger impact on inflation expectations when they occur after a long period of relatively large and negative inflation outcomes. There is indeed some evidence that, under constrained monetary policy, protracted deviations of inflation from the target can be associated with increased sensitivity of inflation expectations to inflation surprises. However, the results are somewhat sensitive to the sample periods.

[45]The responses of professional and household survey-based long-term inflation expectations to changes in oil price futures over the same period are in both cases smaller and statistically insignificant.

[46]The results are robust to alternative measures of market-based inflation expectations: inflation compensation embedded in Treasury inflation-protected securities and Treasury inflation-protected securities break-even inflation rates cleaned of a liquidity premium, following Celasun, Mihet, and Ratnovski (2012).

Summary and Policy Implications

Inflation rates have declined substantially in a large number of countries in recent years, with several advanced economies experiencing outright deflation. The decline in inflation is widespread across sectors, but stronger for tradable goods. Its main drivers are persistent labor market slack and weaker import price growth. The results in the chapter suggest the latter are associated with falling commodity prices and widening industrial slack in a few key large economies, particularly in China. At the same time, the part of disinflation not explained by the Phillips curve has tended to become larger in the past few years, especially in advanced economies. This shortfall in inflation relative to model-based predictions could be a sign that price setters' inflation expectations have declined more than what is captured by survey-based measures used in the econometric analysis or that economic slack is larger in some countries.

The chapter finds that monetary policy frameworks play an important role in influencing the sensitivity of inflation expectations to inflation surprises. Improvements in these frameworks over the past few decades have led inflation expectations to be much better-anchored than in the past—although there is scope for further improvements in some emerging market economies.

However, the chapter's analysis also suggests that medium-term inflation expectations in advanced economies with constrained monetary policy have recently become more sensitive to unexpected movements in actual inflation or in commodity prices. Although the increase in this sensitivity is small, it does suggest that faith in central banks' ability to combat persistent disinflationary forces might be diminishing—this sensitivity should be zero if medium-term expectations are perfectly anchored. An implication of this finding is that in advanced economies where perceived monetary policy space is limited, medium-term inflation expectations could become unanchored in the event of further unexpected declines in inflation.

What do these findings imply for the inflation outlook in countries that have experienced sizable disinflation over the past few years? Since most measures of medium-term inflation expectations have not declined significantly and commodity prices are projected to gradually recover, the most likely outcome is a gradual recovery of inflation toward central bank targets as slack diminishes and the effect of past declines in commodity prices fade. But the increase in the sensitivity of inflation expectations to downside inflation surprises, the finding that inflation has become more persistent, and the possibility that slack might be larger than currently estimated in some countries, suggest downside risks to that central forecast. The possibility of a gradual further downward drift in medium-term inflation expectations and consequent prolonged period of low inflation is more than trivial in some countries.

The main findings of the chapter—the broad reach of the disinflation across countries, evidence of cross-border spillovers of disinflationary forces, the increased sensitivity of medium-term expectations to news, as well as the confluence of slack in many large economies—call for a comprehensive and coordinated effort to tackle the risks of low inflation. Given limited policy space in many economies, exploiting synergies between all available policy levers and across countries will be essential.[47]

- In countries with persistent economic slack and inflation consistently below central bank targets, it is crucial to maintain an appropriate degree of monetary accommodation to help keep medium-term inflation expectations anchored and ease the perception that monetary policy has become ineffective. While unconventional monetary policy actions taken in the aftermath of the Great Recession lifted inflation expectations (see footnote 5), estimates of natural interest rates have been revised down substantially over time, suggesting that monetary policy more recently may have been providing less accommodation than previously thought (see Chapter 1 of this WEO for a further discussion). Where medium-term inflation expectations appear to have shifted down, a more aggressive approach should be considered. In particular, a credible and transparent commitment to a modest and temporary overshooting of the inflation target would provide valuable insurance against deflationary and recessionary risks by reducing longer-term real rates even if the nominal policy rate is at the effective lower bound, generating a path of stronger demand and bringing inflation to target sooner (see Box 3.5; IMF 2016c; and Gaspar, Obstfeld, and Sahay forthcoming).
- Other policy levers need to be aligned with accommodative monetary policy in boosting demand.

[47]See Gaspar, Obstfeld, and Sahay (forthcoming) for a further discussion and case studies.

Given the broad-based nature of the disinflation and the corresponding fact that many countries are easing monetary policy at the same time, dampening the downward pressure that monetary policy easing exerts on the exchange rate, monetary policy stimulus on its own may not be sufficient to keep medium-term inflation expectations anchored at central bank targets. A comprehensive package consisting of a more growth-friendly composition of fiscal policy, an expansionary fiscal stance where fiscal space is available, demand-supportive structural reforms, and measures aimed at addressing weaknesses in bank and corporate balance sheets should play a complementary role in mitigating the risk of protracted weak demand and low inflation. Income policies could also be considered in countries with stagnant wages and entrenched deflationary dynamics to set in motion a healthy upward wage-price spiral.

- Distortionary policies that perpetuate overcapacity in tradables sectors should be avoided: they not only worsen resource allocation and, where financed by credit, weaken asset quality in the banking system, but they also exert disinflation pressure in the domestic economy that could spill over to other countries via import prices, reinforcing global disinflation pressures.[48]
- Finally, the breadth of the disinflation and evidence of meaningful cross-border spillovers of disinflationary forces through import prices also point to the value of a coordinated approach to supporting demand across the larger economies. Through positive spillovers, simultaneous action across countries would amplify the effects of each individual country's actions. A coordinated effort to simultaneously tackle weak demand and inflation in advanced economies and to redouble ongoing efforts to reduce overcapacity in countries with elevated industrial slack would be more impactful than a go-it-alone approach.

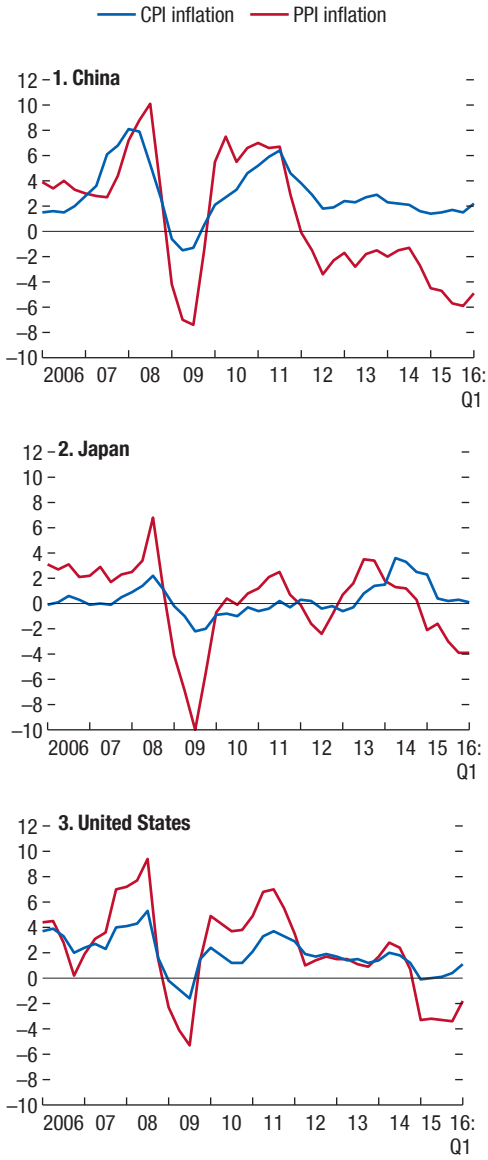
[48]In China, the authorities have already signaled their intent to address overcapacity, starting with the coal and steel sectors where capacity reduction targets have been set, together with the establishment of a fund to absorb the welfare costs for affected workers. Restructuring has begun at the local level in provinces with relatively strong public finances and more diverse economies (IMF 2016b).

Box 3.1. Industrial Slack and Producer Price Inflation

The recent decline in inflation has been much more pronounced in the manufacturing sector than in services. Consistent with this trend, an increasing body of evidence points to marked overcapacity in a range of industrial sectors, with industrial output growth decelerating significantly (National Association of Manufacturers 2016; Organisation for Economic Co-operation and Development 2015).[1] This box presents estimates of slack in the industrial sector in three large economies: China, Japan, and the United States.[2] All three economies have recently experienced outright declines in the producer price index (PPI) and generally subdued trends in consumer price inflation—although to varying extents (Figure 3.1.1). Estimates of slack—output gaps—for each economy as a whole, and separately for the industrial sector, are obtained through an extended multivariate filter that includes information on GDP, consumer price inflation, PPI inflation, and industrial production. The identification strategy relies on equations, for each economy separately, relating inflation to the estimated gaps.[3] The key equation resembles the standard Phillips curve but is confined to the industrial sector. It expresses PPI inflation as a function of the estimated industrial sector output gap; expected inflation; and leads and lags in headline inflation.

The results suggest that the industrial slack in the first quarter of 2016 stood at about 5.5 percent in China, 5 percent in Japan, and 3 percent in the United States (Figure 3.1.2). For China, the estimates incorporate a disaggregated treatment of light and heavy industry, derived from electricity consumption in the two subsectors. This shows a marked difference between slack in light industry (about 4.5 percent)

Figure 3.1.1. Producer Price and Consumer Price Inflation in China, Japan, and the United States
(Percent)



Source: IMF staff estimates.
Note: CPI = consumer price index; PPI = producer price index.

The authors of this box are Kevin Clinton, Zoltan Matyas Jakab, Douglas Laxton, and Fan Zhang.

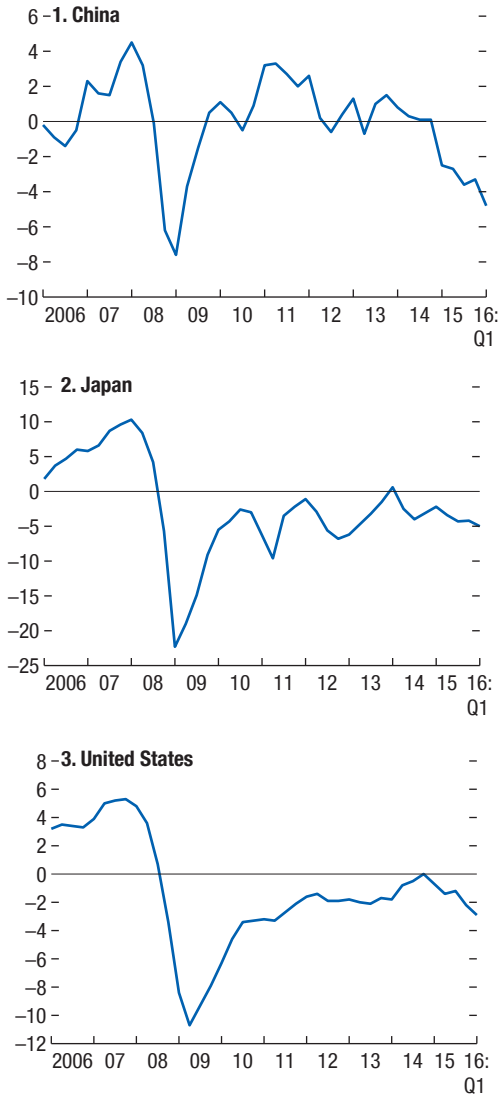
[1]Industrial production comprises manufacturing, mining, and utilities (with relative weights in the United States of 78 percent, 12 percent, and 10 percent, respectively). Total industrial output is used instead of manufacturing output because of limited data. Annual average industrial production growth in the United States fell from about 2.5 percent in 2011–13 to 0.3 percent during 2014:H2–2016:H1. In Japan and China, the growth rate decreased from 0.3 percent to –2.5 percent and from 10.7 percent to 6.3 percent, respectively, over the same period.

[2]Industrial production in China, Japan, and the United States accounts for 45 percent of total world industrial production (as of 2014 and at constant 2005 prices, according to the United Nations National Accounts Main Aggregates Database): United States (19 percent), China (18 percent), and Japan (8 percent).

[3]For details see Alichi and others (2015).

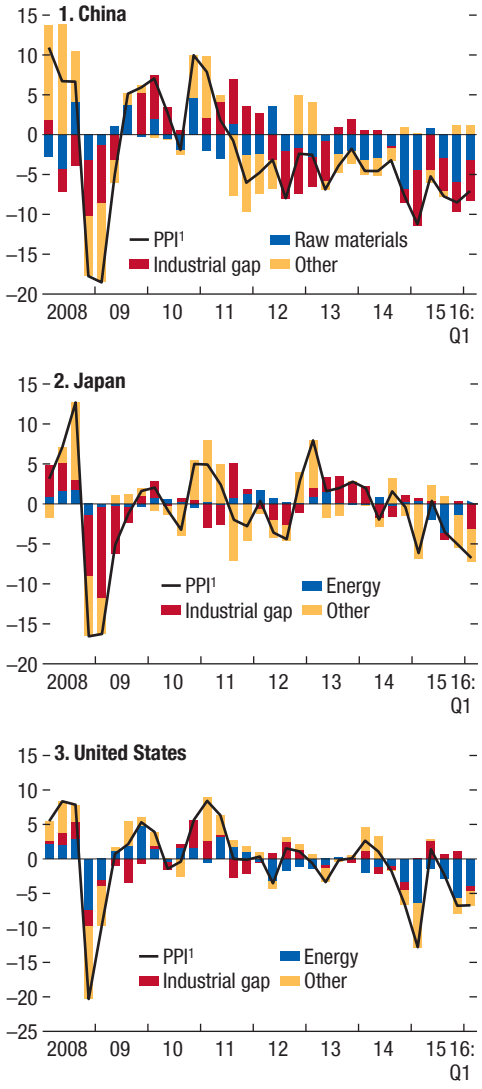
Box 3.1 *(continued)*

Figure 3.1.2. Industrial Slack in China, Japan, and the United States
(Percent)



Source: IMF staff estimates.

Figure 3.1.3. Decomposition for Total Producer Price Inflation for China, Japan, and the United States
(Annualized percentage points)



Source: IMF staff estimates.
Note: PPI = producer price index.
[1] Historical contribution of all shocks (difference between actual values and an unconditional forecast estimated using a vector autoregression model).

Box 3.1 *(continued)*

and in heavy industry (about 10.5 percent). In all three countries, the size of industrial slack correlates with the change in PPI inflation.

Although the filtering approach yields estimates of industrial slack consistent with the steep drop in PPI inflation rates, it does not allow for a decomposition of the relative contributions of various factors. For this purpose, the analysis uses structural vector autoregression models for PPI inflation that include the estimated industrial slack and energy or raw materials prices.[4] The historical decompositions of PPI inflation suggest that the energy shock (or raw material shock in China) has been a key driver of the recent decline in PPI inflation, especially in the United States (Figure 3.1.3). In China and Japan, however, industrial slack has also played an important role. In particular, the estimated contribution of the industrial slack to PPI deflation in China over the past four years is as large as that of raw materials prices.

[4]Producer prices for finished consumer energy goods were used as energy prices in the United States; the electric power, gas, and water component of the Domestic Corporate Goods Price Index was used in the case of Japan (both denoted as "Energy" in Figure 3.1.3). In the case of China, the raw materials component of the PPI was used and is denoted "Raw materials" in the figure. The identifying assumptions are that over the long term: (1) the relative price of energy or raw materials prices (vis-à-vis the PPI) is driven exclusively by energy and raw materials price shocks and not by shocks to industrial slack, (2) industrial slack is affected by both the "Industrial gap" and "Energy" or "Raw materials" shocks, and (3) PPI inflation is driven by all three shocks (Energy, Raw materials, Industrial gap, and by other PPI-specific shocks).

Box 3.2. The Japanese Experience with Deflation

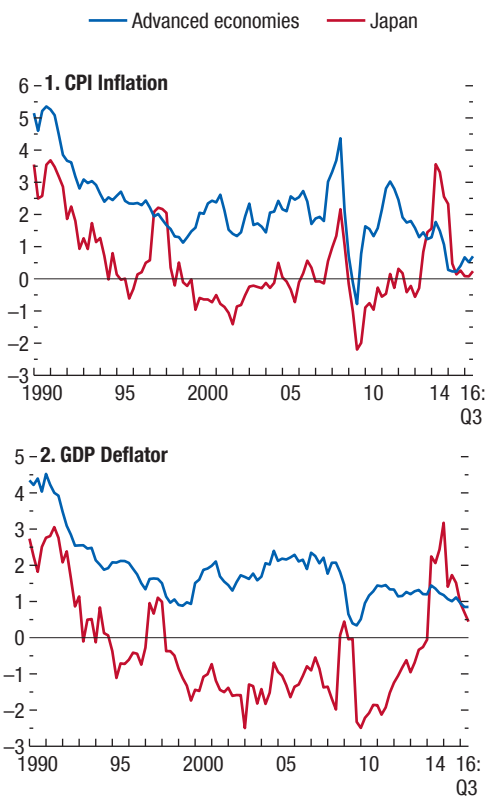
The Japanese economy has experienced weak inflation for most of the past two decades. Inflation measured by the GDP deflator has been particularly low, averaging –0.3 percent between 1990 and 2015 compared with 0.5 percent for consumer price inflation (Figure 3.2.1). Continued efforts to reflate the economy have so far fallen short, highlighting the difficulty in escaping a deflation trap once expectations are anchored around a deflation equilibrium. A great deal of literature has sought to identify the causes and consequences of Japan's deflation experience, offering useful insights into the current disinflation trend in many economies. This box attempts to shed light on the following questions: What drove the Japanese deflation episode that started in the mid-1990s? How has it affected the Japanese economy? How relevant is the Japanese experience to the current disinflation trend?

Drivers of Deflation

The bursting of the asset price bubble in the early 1990s is often mentioned as the initial shock leading Japan into deflation. Inflation and inflation expectations declined gradually as efforts by households, banks, and businesses to strengthen balance sheets and rebuild net worth suppressed demand (IMF 2014; Koo 2008). Supply-side shifts and exchange rate appreciation were also highlighted as factors contributing to deflation momentum during this period (Leigh 2010; Posen 2000). The external shock from the 1997–98 Asian Crisis further weakened demand, and a slow response to the problem of nonperforming loans resulted in a banking crisis, tipping the economy into deflation in 1998. The commodity price boom that started in the early 2000s pushed headline inflation up, offering some temporary relief, but core inflation remained in negative territory (Figure 3.2.1). Further shocks, such as the bursting of the information technology bubble and the 2008–09 global financial crisis, reinforced weak demand, and the output gap remained negative (Figure 3.2.2). The yen appreciation leading up to the introduction of Abenomics in 2013 and the commodity price decline since 2014 have further complicated efforts to reflate the economy.[1] While there has been some recent success in raising core inflation, deflation risks are rising again amid low demand and declining inflation expectations.

Structural factors exacerbated the effect of demand shocks, feeding into deflation pressure. Several of these factors are relevant for many advanced economies today: a decline in labor's bargaining power and an aging and slow-growing population. The decline in labor's bargaining power—evident in the trend fall in unit labor costs starting in the late 1990s (Figure 3.2.2)—together with firms' sluggishness, as seen in large corporate cash holdings, are argued to have

Figure 3.2.1. Inflation Dynamics
(Year-over-year percent change)



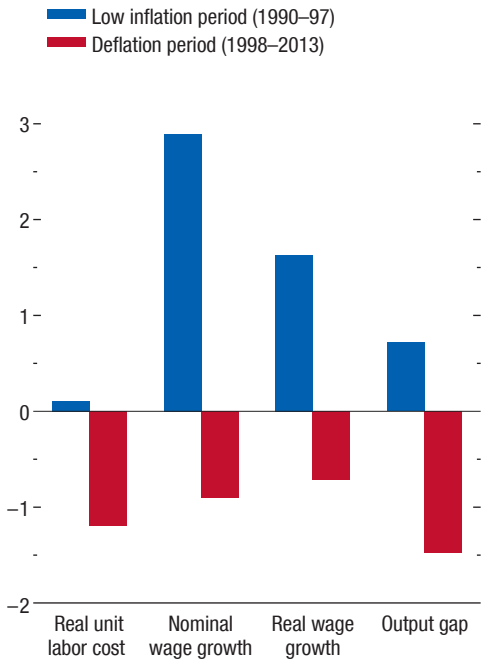
Source: IMF staff calculations.
Note: Quarterly seasonally adjusted data are used and weighted by purchasing-power-parity GDP to aggregate for advanced economies. Advanced economies comprise Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong SAR, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan Province of China, the United Kingdom, and the United States. CPI = consumer price index.

The authors of this box are Elif Arbatli, Samya Beidas-Strom, and Niklas Westelius.

[1]See the main chapter text for an analysis of the impact of commodity prices on headline inflation.

Box 3.2 *(continued)*

Figure 3.2.2. Cyclical and Structural Indicators in Japan
(Average annual percent change)



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.

fed deflation by weakening wage-price dynamics (Porcellacchia 2016). Firms became less likely to hire workers on permanent contracts ("regular workers") in an environment of low expected growth. The share of regular workers among salaried employees fell over this period, contributing to lower unit labor costs, permanent income, and benefits for employees. Japan's aging and declining population growth have also been blamed for deflationary pressure as lower potential growth, and its implication on fiscal sustainability, are cited as holding back demand (Anderson, Botman, and Hunt 2014). At the same time, the aging population could also lead to excess demand and inflation pressure since retirees tend to consume more than they produce (Juselius and Takáts 2015)—even though the net effect of aging on inflation is ambiguous.

The timidity and low credibility of the policy response during the 1990s have also been widely cited as contributors to deflation. In particular, the pace and extent of the initial monetary easing was likely insufficient, and the fiscal policy response has been criticized as ineffective in stimulating growth (Bernanke and Gertler 1999; Ito and Mishkin 2006; Kuttner and Posen 2002; Leigh 2010). The fiscal position remained broadly accommodative throughout the period of deflation (Figure 3.2.3, panel 1), but periodic attempts at consolidation also led to stop-and-go implementation of fiscal policy (Kuttner and Posen 2002; Syed, Kang, and Tokuoka 2009), and its effectiveness was stymied by lack of coordination with monetary policy (Eggertsson 2006). In addition, the Bank of Japan was moving toward independence and a price stability mandate in the 1990s, with an explicit inflation target introduced only in 2013.[2] As a result, long-term inflation expectations in Japan were not well anchored in the 1990s (Figure 3.2.3, panel 2), making the economy more vulnerable to deflation shocks. Finally, cleaning up weak financial sector balance sheets took long and inhibited financial intermediation, contributing to a prolonged recession and deflation pressure (Ito and Mishkin 2006).

Impact of Deflation and Relevance Today

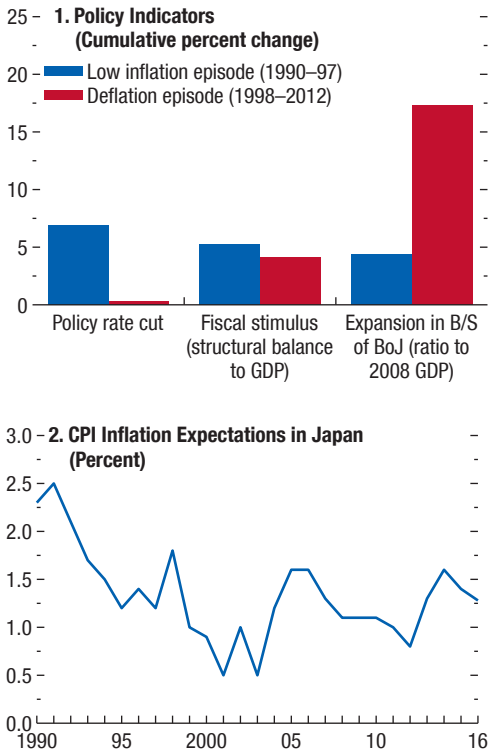
Sustained deflation is generally believed to have acted as a headwind for the Japanese economy. Firms became more reluctant to invest and hire regular workers, and consumers postponed purchases of durable goods in anticipation of future price declines. A vicious cycle of declining prices, decreasing profits, and wage restraint reinforced weak demand in a "coordination failure" (Kuroda 2013). The increase in borrowers' real debt burden raised default risk and reduced asset prices, collateral valuations, and credit intermediation to the real economy. Deflation supported a shift in portfolio allocations toward so-called safe assets, reducing the supply of risk capital.

Persistently weak growth in the GDP deflator, and hence in nominal GDP, worsened the interest-rate-growth differential and contributed to a higher debt

[2]Measures of central bank credibility (Crowe and Meade 2007; Dincer and Eichengreen 2014) suggest that the Bank of England, the Federal Reserve, and the European Central Bank, for example, ranked higher (on policy transparency) going into the global financial crisis than Japan during both its low-inflation and deflation episodes.

Box 3.2 *(continued)*

Figure 3.2.3. Policy Indicators in Japan



Sources: Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: Inflation expectations are the 10-year forecast from Consensus Economics; the policy rate is the uncollateralized average overnight call rate. BoJ = Bank of Japan; B/S = balance sheet; CPI = consumer price index.

burden (End and others 2015).[3] On the monetary side, as nominal interest rates reached their effective lower bounds and inflation expectations declined, real interest rates could not be lowered sufficiently, contracting the economy further. Despite the large expansion in the Bank of Japan's balance sheet through unconventional monetary operations in recent years, inflation remains stubbornly low.

In sum, the Japanese experience underscores the importance of credible, decisive, and strong policy responses to prevent inflation expectations from becoming unanchored. The impact of persistent deflation can be large, and once deflation expectations emerge, it may be difficult to push the economy out of the liquidity trap. Structural factors in many advanced economies, including a secular decline in labor's bargaining power, could generate additional headwinds.[4]

[3]While it is difficult to quantify the impact of deflation on debt accumulation, a mechanical calculation assuming a zero inflation rate for the years with deflation alone suggests a contribution of about 36 percent of GDP since 1990 through automatic debt dynamics.

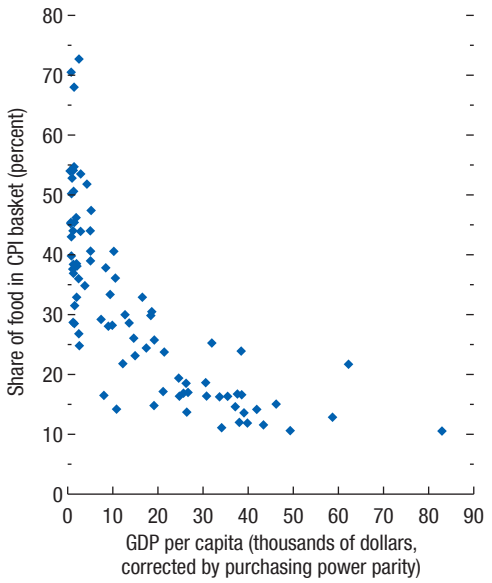
[4]IMF (2016a) and Arbatli and others (2016) discuss the potential role for income policies and labor market reforms to strengthen wage-price dynamics in Japan.

Box 3.3. How Much Do Global Prices Matter for Food Inflation?

Bursts of inflation have often been accompanied or preceded by spiraling food prices.[1] This partly reflects the sizable share of food in consumption, particularly in lower-income countries (Figure 3.3.1). Waning global food prices since 2011 have therefore rekindled interest in the extent to which changes in international food prices pass through to domestic food prices and thus put downward pressure on overall consumer price inflation.

Comparing changes in world prices with changes in the domestic price of food in more than 80 economies, however, points to a low correlation between them.[2] Indeed, the patterns of domestic food inflation are strikingly different from inflation patterns in world food markets (which are denominated in U.S. dollars). In many advanced and especially emerging market economies, such a decoupling reflects exchange rate depreciation relative to the U.S. dollar, which has limited or more than offset the decline in world food prices (Figure 3.3.2, panels 1 and 2). By contrast, the exchange rate has played a lesser role in many low-income developing economies. The rapid increases in domestic food prices in these economies were driven by higher inflation in local food production, which is mostly nontradable (Figure 3.3.2, panel 3). Overall, food inflation has been generally higher than nonfood inflation in all country groups, especially in sub-Saharan Africa and emerging market economies (Figure 3.3.3). Thus, domestic food inflation has generally offset the ongoing nonfood deflationary pressures in many economies.[3]

Figure 3.3.1. Food Weights in Consumption and per Capita GDP



Source: IMF staff calculations.
Note: CPI = consumer price index.

Evidence of limited pass-through from free-on-board (that is, excluding the transportation cost to the final national market destination) food prices to consumer food prices is corroborated by regression analysis for a sample of 81 countries using monthly data for 2000–15 (Figure 3.3.4).[4] Despite the

The authors of this box are Emre Alper, Luis Catão, Niko Hobdari, Daniel Te Kaat, and Ali Uppal.

[1]A statistical horse race between food and oil prices as leading indicators of worldwide inflation over the past four decades points to a prominent role of food over oil (Catão and Chang 2011). For instance, the great inflation of the 1970s was preceded by a faster pace of food inflation relative to both oil and overall consumer prices. The first post–World War II outburst of global inflation in the 1950s was preceded by rising inflation in food commodities but not in oil. More recently, the widespread rise in consumer price index inflation above central bank targets in 2007–08 was largely due to food rather than oil.

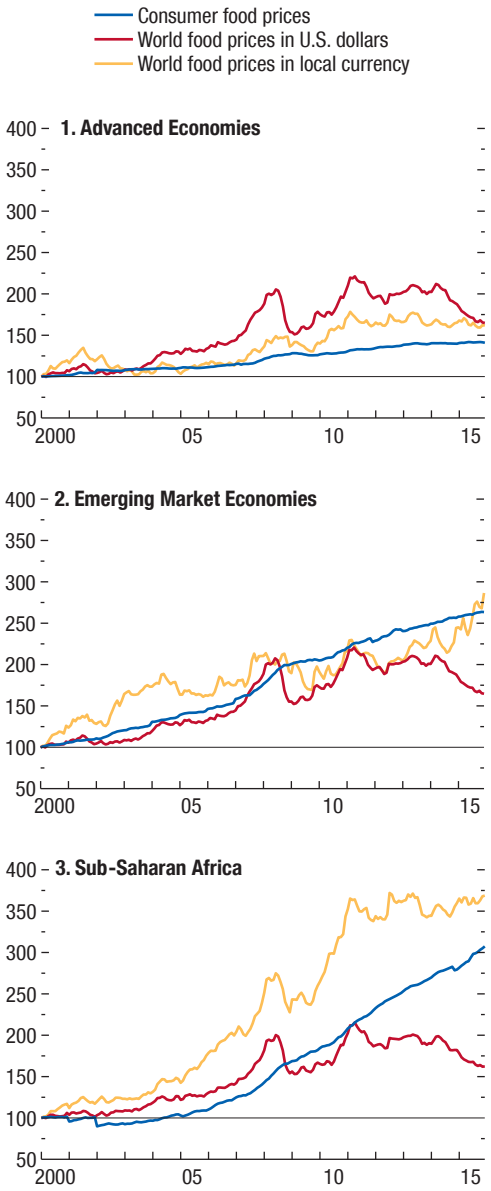
[2]The analysis uses country-specific weights to compute the equivalent world market price of the domestic food consumption basket—that is, the price that consumers of that country would pay if they were to buy that approximate commodity basket in the world market. For sub-Saharan Africa, data availability allowed this computation for 17 of the 41 countries, with mean weights of low-income countries and middle-income countries of that sample applied to the entire sample. The analysis focuses on free-on-board import prices in local currency to control for exchange rate movements.

[3]On average, food inflation exceeded nonfood inflation by 1.4 percentage points a year during 2010–15 in the 41 sub-Saharan African countries comprising the sample. In advanced and emerging market economies, the respective differentials are 0.8 percentage point and 0.5 percentage point during the same period.

[4]The explanatory variables in the individual country regressions are the current and up to six lags of the free-on-board food price inflation index in local currency (computed as the percentage change of the product of the world food price index in U.S. dollars and the country's exchange rate against the U.S. dollar), augmented by lags of domestic food price inflation (with the lag length for each country regression being determined by standard statistical criteria). The pass-through coefficient is then computed as the sum of the coefficients on the free-on-board food inflation divided by 1 minus the sum of the lagged domestic food inflation coefficients (that is, the autoregressive coefficients).

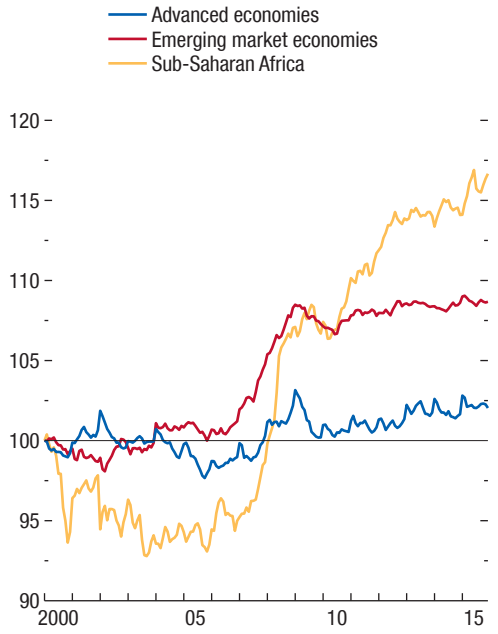
Box 3.3 *(continued)*

Figure 3.3.2. World Food Prices and Consumer Food Prices
(January 2000 = 100)



Source: IMF staff calculations.

Figure 3.3.3. Food Prices Relative to Nonfood Prices
(January 2000 = 100)

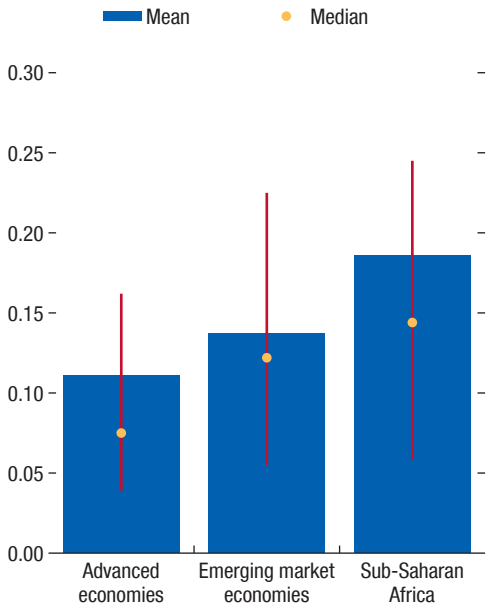


Source: IMF staff calculations.

mass of the distribution of the pass-through coefficients being centered between 0.1 and 0.2 (the median is about 0.12), there is considerable variation across countries. The pass-through is close to 0.4 for some countries and larger than 1 for one outlier (Ethiopia). In general, sub-Saharan Africa not only has a higher average pass-through but also higher cross-country dispersion of pass-through coefficients than advanced and emerging market economies. In addition, when the sample is broken into two subperiods—the first comprising the high food price inflation of 2006–08 and the second the decline in world food prices of 2009 and from 2011 onward—the pass-through appears to be higher on average and more dispersed in the former period (Figure 3.3.5). To explain the dispersion of pass-through coefficients across countries and periods, a regression of the various pass-through coefficients obtained from the full sample period is run on a variety of factors, including those identified by previous studies (for example, Gelos and Ustyugova 2012). The results of this empirical exercise point to the role of

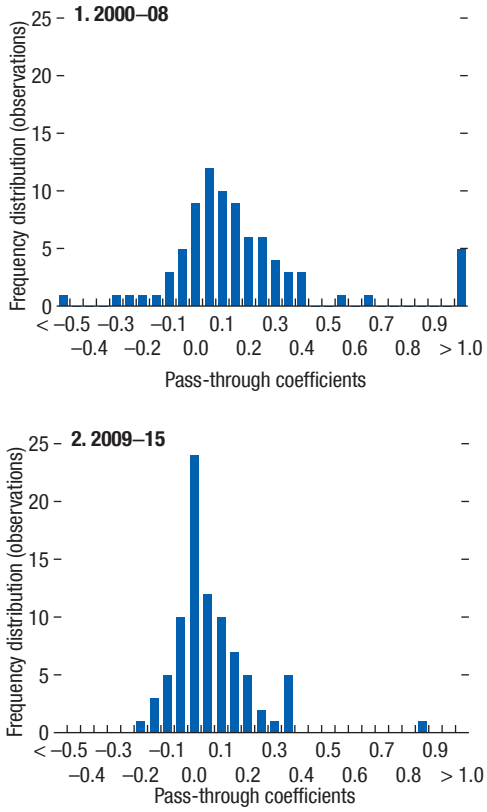
Box 3.3 *(continued)*

Figure 3.3.4. Food Pass-Through Coefficients for Various Country Groups



Source: IMF staff calculations.
Note: Vertical lines denote interquartile ranges.

Figure 3.3.5. Distribution of Food Pass-Through Coefficients



Source: IMF staff calculations.

income levels, exchange rate regimes, openness to food trade, and output volatility in shaping pass-through coefficients (Table 3.3.1):

- *Higher per capita income is associated with lower international food price pass-through.* One explanation for this result is that richer countries on average consume food products with higher value added, for which nontradable components, such as distribution services, represent a larger share of the overall cost.
- *A more stable exchange rate regime is associated with a higher pass-through.* With a fixed exchange rate, free-on-board prices in local currency are a more direct reflection of world prices, mitigating deviations from the law of one price associated with unexpected exchange rate volatility.
- *Countries that are either large net exporters (that is, with food exports exceeding food imports) relative to GDP or larger net importers of food relative to GDP are characterized by higher pass-through.* The rationale for this result is that the tradable component of domestic food is likely to increase with either net food exports or net food imports.
- *Countries with higher average tariff rates on agricultural products have a lower pass-through*, consistent with the notion that tariffs reduce the tradability of some domestic food items.
- *The pass-through is higher in countries where growth is more volatile.* There may be different explanations for this finding. One straightforward explanation is that more volatile economies display less price stickiness, so the pass-through from higher world food prices to retail food prices is higher.

These findings suggest that a low pass-through of international to domestic food prices might not necessarily enhance welfare. This may be, for instance, the case if the pass-through is low as a result of high

Box 3.3 *(continued)*

Table 3.3.1. Cross-Country Determinants of Pass-Through of Free-on-Board Food Prices to Food Consumer Price Inflation

	(1)	(2)
Log of Per Capita GDP	–0.0385***	–0.0333***
	(–3.15)	(–3.31)
Openness	0.0174	
	(0.88)	
Food Trade Balance/GDP	0.00838*	
	(1.71)	
Food Trade Balance/GDP, Squared	0.00124***	0.00151***
	(3.72)	(3.88)
Average CPI Inflation	–0.00135	
	(–1.34)	
Exchange Rate Regime	0.0296**	0.0235*
	(2.3)	(1.96)
Average Agricultural Tariff	–0.00527**	–0.00741***
	(–2.39)	(–4.90)
Growth Volatility	0.0116*	0.0134**
	(1.68)	(2.08)
Quality of Institutions	–0.00484	
	(–0.88)	
Constant	0.168***	0.151***
	(3.32)	(3.06)
Number of Observations	81	81
R^2	0.564	0.517
Adjusted R^2	0.509	0.484

Sources: IMF, National authorities; and IMF staff estimates.
Note: The dependent variable is the estimated pass-through coefficient reported in Fgiure 3.4. Robust t-statistics are in parentheses. CPI = Consumer Price Index. ***, **, * denote significance at the 1, 5, and 10 percent level, respectively.

tariffs that distort resource allocation, or if it reflects a high share of local produce (such as fresh fruits and vegetables) that—given its nontradability—is produced, stored, or transported inefficiently.[5] Indeed when world prices are falling, low tradability limits the benefits of falling world food prices to consumers. Conversely, when world food prices are rising, low tradability tends to limit the benefits of higher world prices to producers and thus postpone needed adjustments to production, which would eventually benefit domestic consumers as well.

[5]See Chapter 1 for evidence on the share of local produce in domestic food consumption and a broad discussion of the role of food in production and consumption.

Box 3.4. The Impact of Commodity Prices on Producer Price Inflation

The chapter documents a generalized decline in producer price inflation across advanced economies over the past few years, especially in manufacturing. The drop in producer price inflation has been particularly marked among commodity importers, suggesting that international input linkages are a key channel through which deflation pressure spills across countries (Figure 3.4.1). Against this backdrop, this box uses sectoral data from four selected advanced economies—France, Germany, Korea, and the Netherlands—to explore how much of the decline in producer price inflation can be attributed to weakening international commodity prices and other import prices.[1]

The empirical approach used to decompose the contribution of different input prices to sector-level producer price inflation follows the methodology developed in Ahn, Park, and Park (2016). In particular, the following specification is used to estimate the effect of domestic input prices (DOM_{it}), imported input prices (IMP_{it}), and labor costs (ULC_{it})on domestic producer prices (P_{it}) at the country-sector level:[2]

$$ln(P_{it}) = \beta_1 \alpha_{i,DOM} ln(DOM_{it}) + \beta_2 \alpha_{i,IMP} ln(IMP_{it}) + \beta_3 \alpha_{i,ULC} ln(ULC_{it}) + \varepsilon_{it}, \quad (3.4.1)$$

in which it denotes sector i at time t, ln denotes logs, and $\alpha_{i,X}$ is the share of each type of input in the total cost structure of sector i (with $\sum_X \alpha_{i,X} = 1$), obtained from input-output tables.[3] The degree of pass-through from input prices to producer prices (β) is allowed to vary across inputs to account for a possible heterogeneous response to underlying cost shocks. The equation is estimated separately in panel settings for Korea (including sector fixed effects) and for the three European economies (with country-sector fixed effects). An error correction setup is used to take into account the potential cointegrating relationship between nonstationary producer and input prices.

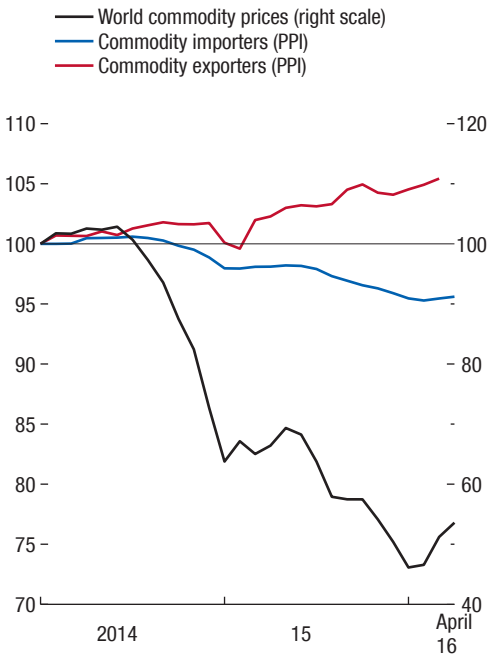
Following the novel approach in Ahn, Park, and Park (2016) and Auer and Mehrotra (2014), input-output tables and sector-level price data are combined to construct input price and labor cost indices for each domestic sector i. For instance, the imported input price index for sector i is obtained as:

$$ln(IMP_{it}) = \sum_j (\alpha_{ij,IMP}/\alpha_{i,IMP}) ln(I_{jt}), \quad (3.4.2)$$

in which $\alpha_{ij,IMP}$ is the share of imported inputs from sector j in total inputs used for sector i's production from input-output tables, and I_{jt} is the price index of sector j imported goods from sector-level import price data.[4] Imported inputs can be further split into

Figure 3.4.1. Commodity Prices and Producer Prices

(January 2014 = 100; simple average by country groups)



Sources: Bank of Korea; Eurostat; Haver Analytics; and IMF, International Financial Statistics database.
Note: Commodity importers: 18 euro area countries, China, Japan, Korea, United Kingdom, United States; Commodity exporters: Brazil, Chile, Colombia, South Africa. PPI = producer price index.

The author of this box is JaeBin Ahn.

[1]The focus on these four advanced economies is based on high-frequency sector-level price data availability.

[2]A possible limitation of the methodology is that prices in other sectors as well as exchange rates—which affect import prices denominated in local currency—are taken as given in the estimation. Also, by relying on a reduced-form specification, the analysis does not take a stand on the underlying source of variation in commodity or other imported input prices.

[3]The source for input shares is the World Input-Output Table (http://www.wiod.org/).

[4]All the price series data are available from the Statistics Database at the Bank of Korea (Economic Statistics System), which is publicly accessible on the Web (ecos.bok.or.kr), or from the Eurostat database (http://ec.europa.eu/eurostat/data/database).

Box 3.4 *(continued)*

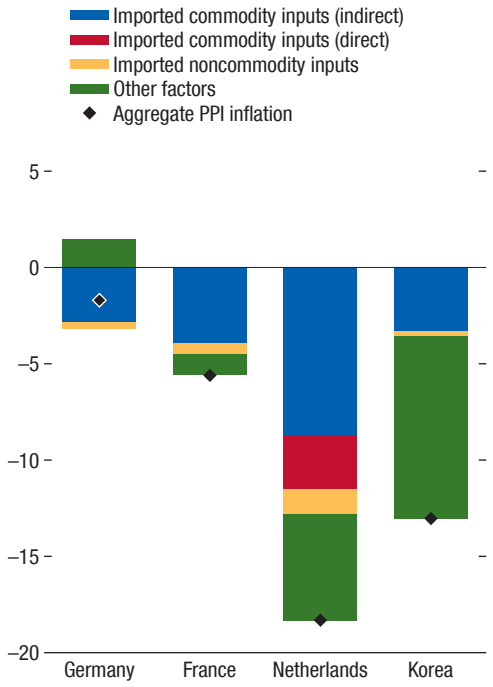
commodity and noncommodity components, allowing for separate estimation of their contributions to producer price inflation.[5] The sector-specific domestic input price and unit labor cost indices are constructed analogously using input-output tables, sector-level domestic producer price indices, and sector-level unit labor cost indices.

The results suggest that the pass-through from import prices to domestic producer prices is high. The short-term pass-through from commodity to domestic producer prices in Korea is about 40 percent and reaches about 60 percent over the long term. The pass-through from commodity input prices is even higher in the three European countries—90 percent in the short term and almost 100 percent in the long term.[6] The estimated pass-through coefficients from noncommodity import prices are comparable.

Combining these pass-through estimates with actual sector-level import prices over the past two years suggests the following results:

- The sharp drop in commodity prices was a major driver of aggregate producer price deflation in France, Germany, and the Netherlands over the past two years (Figure 3.4.2). Its contribution was somewhat smaller but still important in the case of Korea.
- The differences across countries in the relative contribution of commodity import prices to aggregate producer price inflation are mostly due to variations in input weights—rather than to differences in import price dynamics.
- Most of the impact of commodity prices on aggregate producer price deflation during this period is indirect—stemming from a decline in input prices for domestic noncommodity sectors. The direct contribution—through commodity imports by the domestic commodity sector—is almost zero in all countries except the Netherlands where oil re-exports are significant—and even there it accounts for only one-fifth of the total commodity price contribution.
- The contribution of noncommodity import prices to aggregate producer price inflation over the past two years is much smaller. This is mainly due to the fact that international manufacturing prices declined much less than international commodity prices over the past two years—rather than due to differences in pass-through coefficients or differences in the relative weights of commodity versus noncommodity inputs in production.

Figure 3.4.2. Contribution to Cumulative Producer Price Inflation
(Percent, January 2014 – March 2016)



Sources: Bank of Korea; Eurostat; Haver Analytics; IMF, International Financial Statistics database; and IMF staff calculations.
Note: The direct contribution of imported commodity inputs captures the commodity sector's own use of imported commodities, and the indirect contribution reflects other sectors' use of imported commodities as inputs. PPI = producer price index.

[5]The commodity sector is defined as the "mining and quarrying" industry at the two-digit industry classification.

[6]The difference in the estimated coefficients across country groups might reflect, among other factors, distinct market structures and degree of competition.

Box 3.5. A Transparent Risk-Management Approach to Monetary Policy

A risk-management approach to monetary policy seeks to avoid severe outcomes, including deflation. Policymakers do not worry about small deviations from desired outcomes but they attach an increasing marginal cost to inflation and output gap deviations as they grow larger. This implies prompt and aggressive actions to move the economy away from situations in which the risk of conventional policy instruments losing their effectiveness becomes larger—such as in a context of persistent economic slack and low inflation with the policy interest rate at the effective lower bound (ELB).

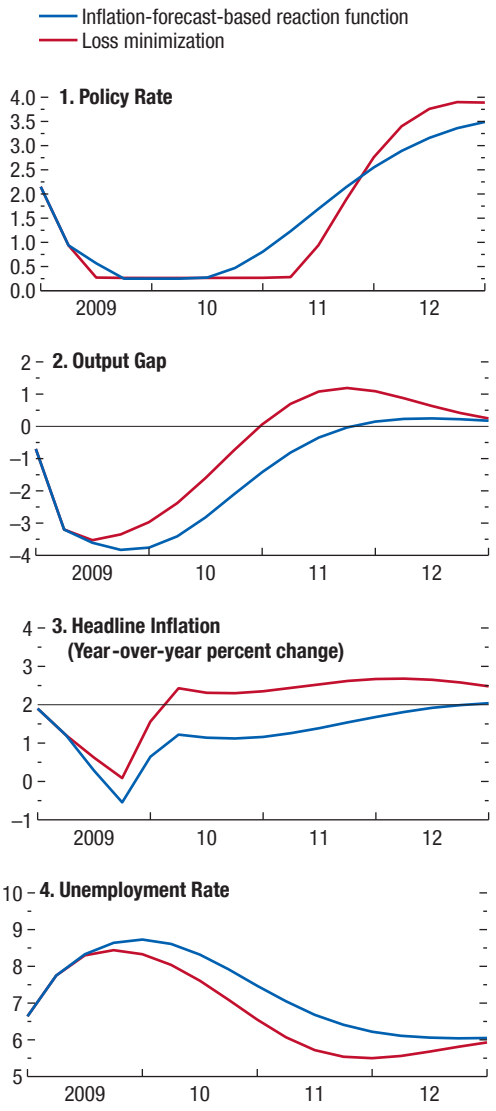
Expectations play a crucial role in the effectiveness of monetary policy. Adjusting the central bank's conventional policy instrument—a very short-term interest rate—in itself has a negligible effect on the overall economy. Its impact stems from its influence over market expectations about the future path of short-term interest rates which, in turn, affect the medium- and longer-term interest rates at which households and firms invest and borrow.

However, the path for policy interest rates that can bring inflation to the central bank's target is not unique. For example, the central bank may intend to pursue a strategy that returns inflation to target gradually, with small steps in the policy instrument over a period of several quarters. Or it may be planning a quick, aggressive approach. In the absence of direct guidance from policymakers, market expectations will not necessarily match the central bank's intended path for policy rates.

This box presents model simulations to illustrate how a credible and transparent commitment to aggressive monetary accommodation can reduce the risk of recession and deflation even if the monetary policy rate is at the ELB.[1] A standard New Keynesian model of the Canadian economy is used to simulate a counterfactual repeat of the history of the global financial crisis under two alternative policy strategies. In the first strategy, based on the principle of risk management, the central bank minimizes a loss function imposing a steeply increasing marginal cost on output gaps and deviations of inflation from the target. The second policy strategy follows a linear inflation forecast–based policy reaction function—that is, a forward-looking Taylor rule. The counterfactual simulated scenarios start in the second quarter of 2009 and are summarized in Figure 3.5.1:

- The risk-management strategy (red line) implies holding the policy rate at the ELB (assumed here to be 0.25 percent) until the first quarter of 2011, long enough to result in a temporary overshooting

Figure 3.5.1. Forecast as Envisaged at 2009:Q2: Loss-Minimization versus Linear Reaction Function
(Percent, unless noted otherwise)



Source: IMF staff estimates.

The authors of this box are Kevin Clinton, Douglas Laxton, and Hou Wang.

[1]See Obstfeld and others (forthcoming) for further details.

Box 3.5 *(continued)*

of the inflation target. As the public is aware of this intention, expectations for longer-term nominal interest rates shift down and medium-term inflation expectations increase. This reduces real interest rates, which in turn increases asset prices and depreciates the local currency, boosting output and inflation. The inflation overshoot makes up for the initial undesired well-below-target inflation and, on average, inflation ends up being very close to the target.

- The linear policy reaction function plan (blue line), in contrast, implies raising the policy rate already by mid-2010 and a much slower convergence to the target—en route, this means wider output gaps and deviations of inflation from the target and higher unemployment than under the risk-management strategy.

The logic for a more aggressive strategy that deliberately overshoots the inflation target is straightforward. Further negative demand shocks in a context of policy rates already at the ELB pose the risk of pushing the economy into a deflation situation from which escape is increasingly difficult. Relative to this, the prospect of a short period with inflation above target is acceptable.

But transparency is a key ingredient of this strategy. Publishing the expected path of all the variables used at policy decision meetings, including the projected path for the policy interest rate, would help the central bank give a credible public account of its strategy.[2] This would reinforce public confidence in the central bank's inflation objective and strengthen the transmission of policy actions to the economy: if the published path for policy interest rates is credible, the term structure of interest rates and asset prices, such as the exchange rate, will move in support of the policy objectives. In contrast, forecasting an overshooting of the inflation rate without communicating the whole breadth of the central bank's strategy might undermine confidence in the nominal anchor—it might look as though the central bank is doing "too little, too late" in terms of normalizing interest rates.

[2]See Poloz (2014) for arguments in favor of forward guidance, including by publishing the projected path of policy rates, when interest rates are at the effective lower bound but not in normal times.

Annex 3.1. Sample and Data

Country Sample

The broadest sample used for regression analysis in this chapter comprises 44 advanced and emerging market economies, listed in Annex Table 3.1.1. These economies are selected based on the availability of their inflation expectation measures from the Consensus Forecasts database.

Data Sources

The primary data sources for this chapter are the Organisation for Economic Co-operation and Development Economic Outlook and Structural Analysis databases, CEIC China database, Consensus Economics Consensus Forecasts database, Global Data Services database, IMF World Economic Outlook database, World Bank World Development Indicators database, and Haver Analytics and Bloomberg L.P. All variables are of quarterly frequency (with the exception of the variables used in the analysis of market-based inflation expectations, which are available at daily frequency). Medium-term inflation expectations from the Consensus Forecasts database are interpolated to quarterly frequency from biannual surveys. The coverage of GDP and import price deflators is expanded by interpolation from annual data. Annex Table 3.1.2 lists all indicators used in this chapter as well as their sources.

Annex 3.2. Model Simulations

Model simulations are used to assess the deflationary effects of depressed demand and subdued import prices in three large economies—the United States, the euro area, and Japan—when monetary policy is constrained and inflation expectations become unanchored.[49] The simulations are carried out under two alternative macroeconomic environments. In both environments, monetary policy is assumed to be constrained—that is, the policy rate is at its effective lower bound. The second assumes, in addition, that inflation surprises have a direct effect on inflation expectations.[50]

[49]Simulations are performed using the IMF's G20MOD model.

[50]The effect of inflation on inflation expectations is introduced in the model via shocks to the expected inflation term that enters the model's reduced-form Phillips curve. An inflation surprise equal to 1 percentage point that occurs in year 1 would shift inflation expectations by 0.25 percentage point in year 2, 0.10 percentage point in year 3, 0.05 percentage point in year 4, and would decline to zero in year 5 and beyond. These magnitudes are based on the empirical evidence in the chapter on the degree to which inflation surprises shift the private sector's inflation expectations at various horizons.

Annex Table 3.1.1. Sample of Advanced and Emerging Market Economies

Advanced Market Economies	Emerging Market Economies
Australia, Canada, France, Germany, Hong Kong SAR, Italy, Lithuania, Netherlands, New Zealand, Norway, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan Province of China, United Kingdom, United States	Argentina, Brazil, Bulgaria, Chile, China, Colombia, Estonia, Hungary, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Romania, Russia, Thailand, Turkey, Ukraine, Venezuela

Annex Table 3.1.2. Data Sources

Variable	Source
Commodity Prices	Bloomberg L.P., Haver Analytics, IMF Commodity Price System
Consumer Price, Core Consumer Price, Producer Price, and Wage Indices	Haver Analytics; IMF, World Economic Outlook database; Organisation for Economic Co-operation and Development
Import Value, Import Volume, and Import-Price Deflator	CEIC database; Haver Analytics; IMF, World Economic Outlook database; Organisation for Economic Co-operation and Development; World Development Indicators database
Industrial Production Index	IMF, World Economic Outlook database
Nominal and Real GDP, and GDP Deflator	Haver Analytics; IMF, World Economic Outlook database; Organisation for Economic Co-operation and Development; World Development Indicators database
Nominal Effective Exchange Rates	Global Data Services database
Output Gap	IMF, World Economic Outlook database
Unemployment Rate	Bloomberg L.P.; Haver Analytics; IMF, World Economic Outlook database; Organisation for Economic Co-operation and Development; Thomson Reuters Datastream
Inflation Swaps, Stock Market Indices, and Treasury Bill Interest Rates	Bloomberg L.P.; Haver Analytics
Survey-Based Inflation Expectations	Bank of England, Survey of External Forecasters; Consensus Economics; European Commission, Business and Consumer Surveys; IMF, World Economic Outlook database; University of Michigan, Survey of Consumers
Unemployment Expectation	Consensus Economics
Central Bank Transparency and Governor Turnover Rate	Crowe and Meade 2007
Inflation-Targeting Regime	*World Economic Outlook*, October 2011, Chapter 3

The first shock considered in the simulations is a temporary decline in domestic demand of 1 percent in each of the three economies. The results reported in Figure 3.4 show that even if monetary policy is constrained, the economy would escape from the deflation trap within a reasonable timeframe as long as inflation expectations remained well anchored. But if inflation expectations drifted down, it could take a very long time for the economy to emerge from deflation.

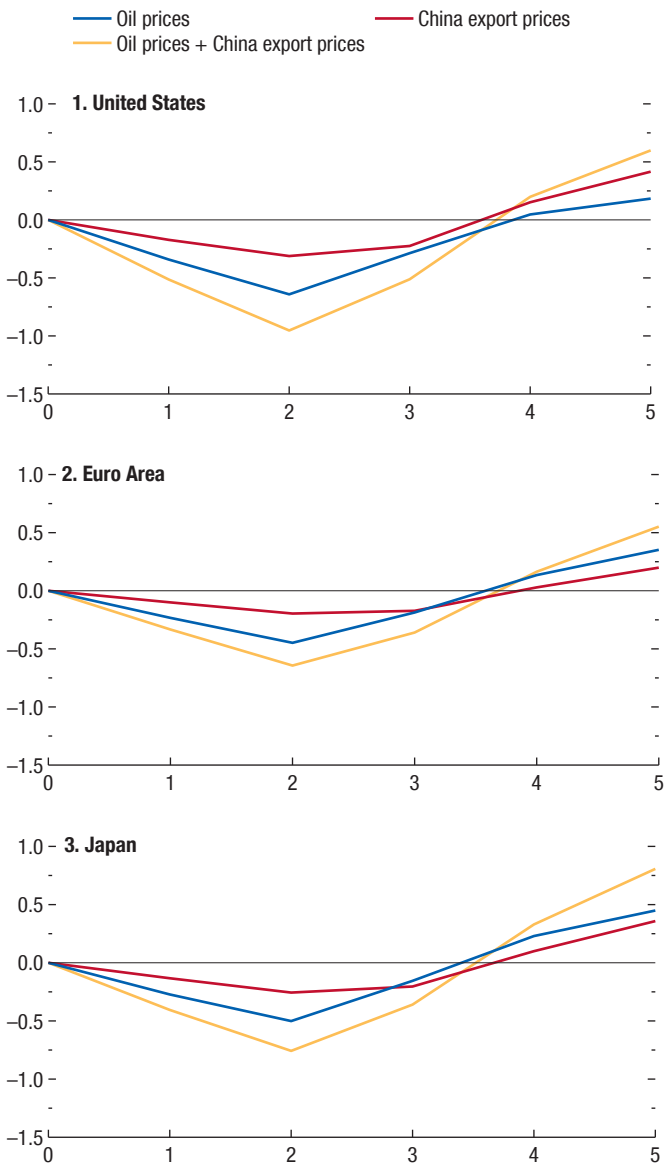
The results in the chapter suggest that reduced import prices have also played an important role in driving inflation down in many economies over the recent past. While in normal circumstances import prices typically have temporary effects on inflation and therefore should not be a source of concern for inflation dynamics going forward, they could be potentially worrisome at the current juncture of constrained monetary policy and evidence of inflation expectations becoming unanchored.

To gauge the possible deflationary consequences of these developments, two shocks to import prices are considered. The first shock is a sharp decline in oil prices.[51] The second shock is a decline in China's export prices—taken as an example of a shock to global prices of tradable goods stemming from manufacturing slack in a key large economy.[52] The results reported in Annex Figures 3.2.1 and 3.2.2 show that shocks to import prices may lead to persistent disinflation pressure when monetary policy is constrained and medium-term inflation expectations become unanchored:

- *Constrained monetary policy*—In countries with constrained monetary policy, lower prices for oil and manufactured goods from China may keep inflation below the baseline—that is, the path in the absence of shocks—for up to four years (Annex Figure 3.2.1). A decline in import prices directly reduces inflation in the short term but also indirectly reduces it through lower demand. The indirect effect arises from lower inflation interacting with the unchanged nominal policy rate: real interest rates rise, putting downward pressure on both consumption and investment. However, in the medium term, the decline in import prices raises households' wealth, which stimulates consumption enough to more than offset the downward pressure exerted by higher real interest rates. Higher consumption

Annex Figure 3.2.1. Effect of Disinflationary Shocks on Core Inflation in Advanced Economies under Constrained Monetary Policy

(Percentage points; years after the shock on x-axis)

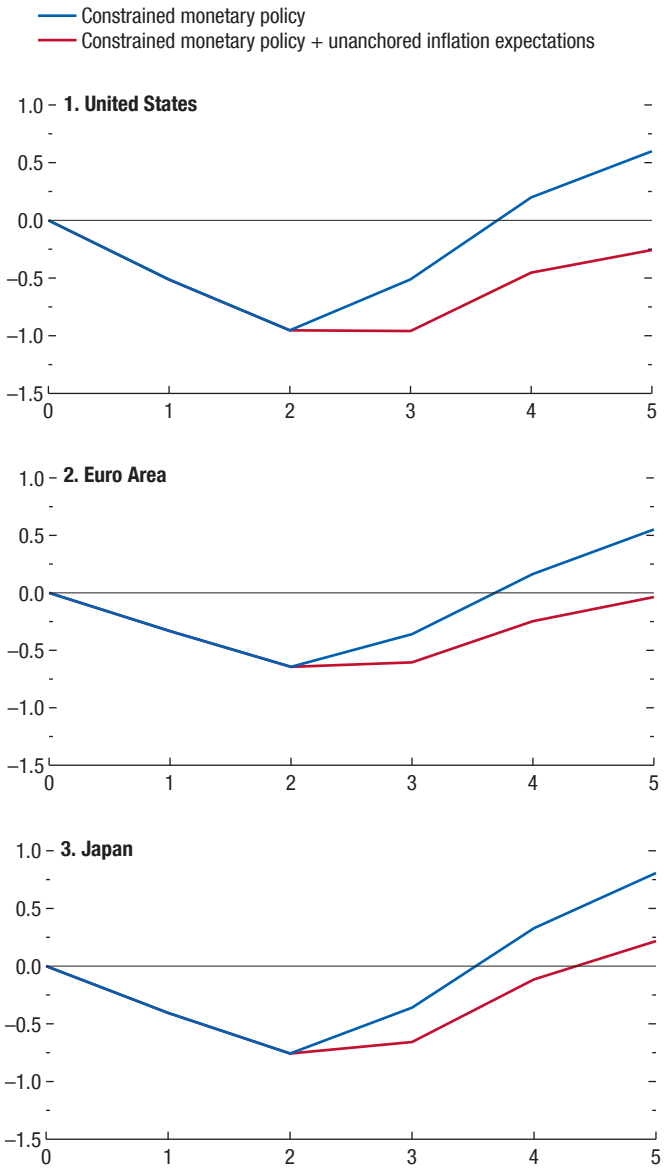


Source: IMF staff estimates.
Note: The figure reports the responses of core inflation after a shock to international oil prices and a shock to China's export prices. The model assumes that conventional monetary policy is constrained at the effective lower bound on nominal interest rates in all countries.

[51]The shock to oil prices is calibrated so that its magnitude matches the actual drop in international oil prices in 2014 and its persistence is consistent with prices in the futures market.

[52]The decline in China's export prices has been set to broadly match the impact of excess capacity in China on consumer price inflation in key advanced economies in 2015 documented in the chapter.

Annex Figure 3.2.2. Effect of Disinflationary Shocks on Core Inflation in Advanced Economies under Constrained Monetary Policy and Unanchored Inflation Expectations
(Percentage points; years after the shock on x-axis)



Source: IMF staff estimates.
Note: The figure reports the responses of core inflation after a combined shock to international oil prices and China's export prices. The model assumes that conventional monetary policy is constrained at the effective lower bound on nominal interest rates in all countries. The alternative scenario (red line) assumes also that inflation expectations are affected by inflation shocks.

demand and lower input costs also stimulate investment. The resulting increase in domestic demand is eventually sufficient to halt and then reverse the decline in inflation. The effect of lower import prices on inflation varies by economy depending on (1) its degree of dependence on oil imports, (2) the extent of its trade links with China, (3) the wealth effect generated by lower import prices, and (4) the degree of flexibility in wages and prices.

- *Constrained monetary policy and unanchoring of inflation expectations*—If monetary policy is constrained and inflation expectations become unanchored, lower import prices may lead to persistent disinflation. Inflation rates remain below the baseline for more than five years (Annex Figure 3.2.2). The result is driven by additional deflation pressure stemming from lower inflation expectations, which may more than offset the positive inflation effects associated with increased household wealth effects in the medium term. The results of this scenario suggest that if inflation expectations become unanchored, mitigating the impact of declining import prices on core inflation could be quite challenging without additional measures to stimulate demand.

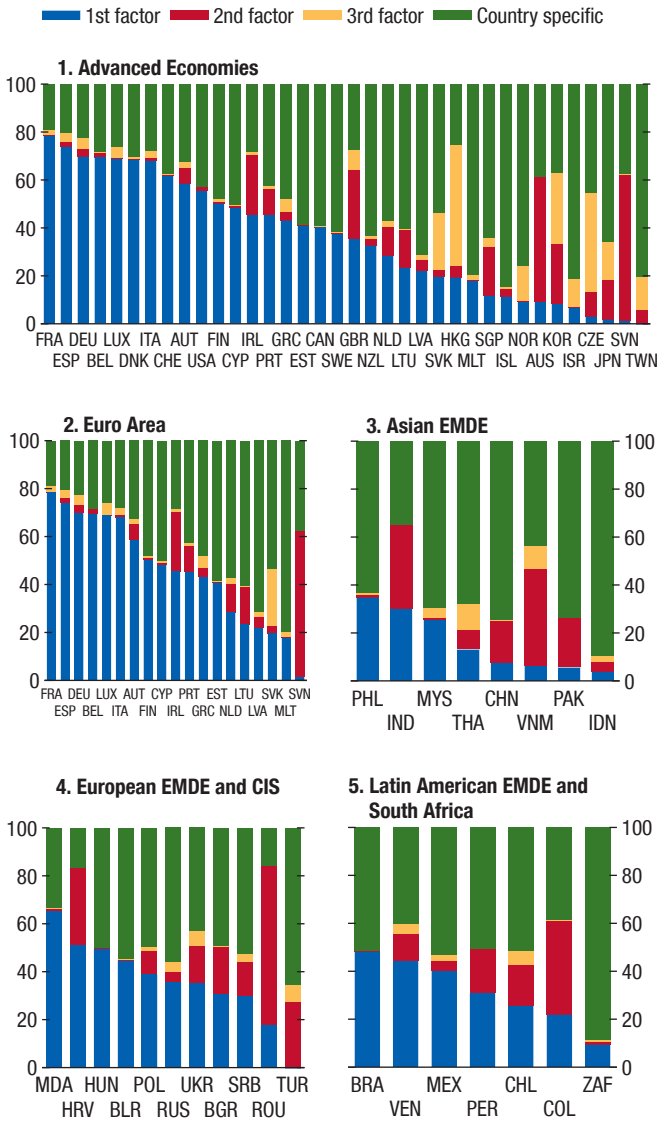
Annex 3.3. Principal Component Analysis

A principal component analysis is used to assess the extent to which the recent decline in inflation is common across countries.[53] The results of the analysis suggest that the first three common factors explain about 80 percent to 90 percent of the variation in inflation among advanced economies in 2000–08 and 2009–15, respectively, and about 75 percent among emerging market and developing economies in both subperiods. There is, nonetheless, significant heterogeneity across countries in the importance of these factors. For example, common factors play a larger role in France and Spain, while country-specific factors play a larger role in countries such as Iceland, Israel, and South Africa (Annex Figure 3.3.1).

While numerous variables may be correlated with the first three common factors, the evolution over time of the first common factor, for instance, is closely related to changes in commodity prices

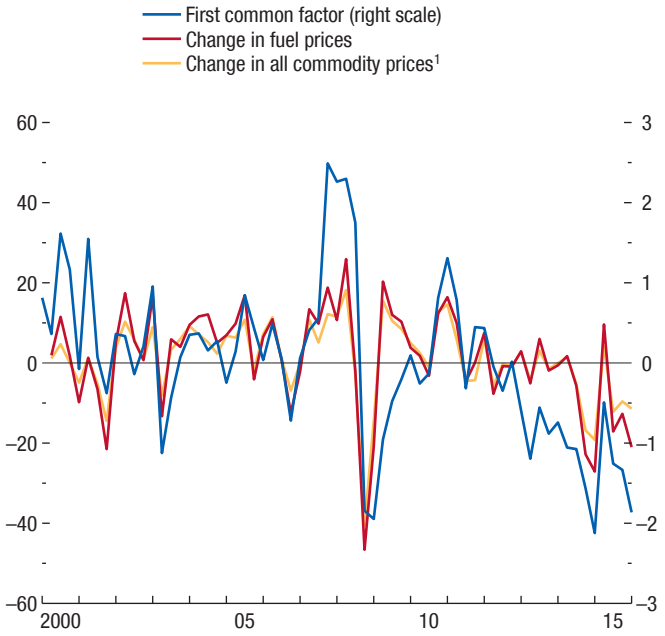
[53]The principal component analysis is a statistical procedure that transforms the data into a set of values of linearly uncorrelated variables—principal components. See Rabe-Hesketh and Everitt (2007).

Annex Figure 3.3.1. Share of Consumer Price Inflation Variation Explained by Different Factors
(Percent)



Sources: Haver Analytics; and IMF staff estimates.
Note: CIS = Commonwealth of Independent States; EMDE = emerging market and developing economies. Data labels in the figure use International Organization for Standardization (ISO) country codes.

Annex Figure 3.3.2. First Common Factor and Commodity Prices
(Percent)



Sources: Haver Analytics; IMF, Primary Commodity Prices database; and IMF staff estimates.
[1] Price index using weights based on 2002–04 average world export earnings.

(Annex Figure 3.3.2).[54] Additional analyses using Bayesian modeling average and weighted least squares find that, indeed, commodity prices stand out among several variables—including slowing global industrial production, growth disappointments in emerging market economies, and financial market conditions—as being strongly linked with the first common factor.

[54]See the April 2015 *Regional Economic Outlook: Asia and Pacific* and the IMF's *2015 Spillover Report* (IMF 2015) for similar evidence.

Annex 3.4. Drivers of the Recent Decline in Inflation

Empirical Framework

The following version of the Phillips curve equation is estimated:

$$\pi_t = \gamma_t \pi^e_{t+h} + (1-\gamma_t)\,\tilde{\pi}_{t-1} + \theta_t u^c_t + \mu_t \pi^m_t + \varepsilon_t, \quad (3.4.1)$$

in which π_t denotes annualized quantity headline consumer price inflation, π^e_{t+h} denotes inflation expectations h years ahead (with 10-year-ahead expectations used in the baseline specification), $\tilde{\pi}_{t-1}$ is the moving average of inflation over the previous four quarters, u^c_t denotes cyclical unemployment, π^m_t denotes the relative price of imports (defined as the import-price deflator relative to the GDP deflator), and ε_t denotes the residual.

The coefficients and the nonaccelerating inflation rate of unemployment (NAIRU) are assumed to follow constrained random walks ($\gamma_t \in (0,1), \theta_t < 0$,

$\mu_t > 0$, and no restrictions on NAIRU). Cyclical unemployment is assumed to follow an AR(1) process: $u_t^c = \rho u_{t-1}^c + \varepsilon_t^u$, with $u_c^t = u_t - u_t^*$, in which u_t denotes the unemployment rate, u_t^* denotes the NAIRU, and ε_t^u is assumed to follow $N(0, \sigma_u^2)$.

The model is estimated country-by-country using maximum likelihood based on a constrained nonlinear Kalman filter for a sample of 44 advanced and emerging market economies from the first quarter of 1990 to the first quarter of 2016.

An important feature of the model is that it allows for time variation in all parameters to capture changes in the structure of each economy. The advantages of such a model compared with rolling regressions are fourfold: (1) it allows use of all observations in the sample to estimate the magnitude of the parameters in each year—which by construction is not possible in rolling regressions; (2) changes in the parameters in a given period come from innovations in the same period, rather than from shocks occurring in neighboring periods; (3) it reflects the fact that economic structures typically change slowly and depend on the immediate past; and (4) it allows for possible nonlinearities (Swamy and Mehta 1975).

Decomposition

The decomposition of inflation dynamics is conducted in a way similar to Yellen (2015). The exercise is constructed in terms of deviations of inflation from inflation targets—using the average of 10-year-ahead inflation expectations during 2000–07 as a proxy for inflation targets. The contribution of each explanatory variable is obtained by setting its value to zero and comparing the model's prediction with that when all explanatory variables are set at their historical values.[55] The contribution of import prices to inflation is further decomposed into the contribution of import prices in U.S. dollars and variations in the domestic exchange rate vis-à-vis the U.S. dollar. The contribution of labor market slack is computed by substituting the cyclical unemployment series estimated with the Kalman filter—and possibly subject to end-sample bias—with a measure derived from output gap estimates in the IMF World Economic Outlook database and country-specific Okun's law coefficient estimates reported in Ball, Furceri, and Loungani (forthcoming); the residuals are adjusted accordingly. The simulation is dynamic in that the lagged inflation term is set to its simulated values. Therefore, the decomposition incorporates the effects of changes in lagged inflation that are attributable to previous movements in the explanatory variables—which become more relevant as inflation is more persistent.

Robustness Checks

Inflation expectations measure—The baseline specification is estimated using 10-year-ahead inflation expectations from Consensus Economics, for two reasons: (1) long-term inflation expectations are a close proxy for central banks' inflation targets, so that the parameter γ can be interpreted as the degree to which the headline inflation is linked to the central bank's target—a phenomenon typically referred to as "level anchoring" (Ball and Mazumder 2011) and (2) long-term inflation expectations are less correlated with current and lagged inflation and hence are less subject to problems of multicollinearity and reverse causality.

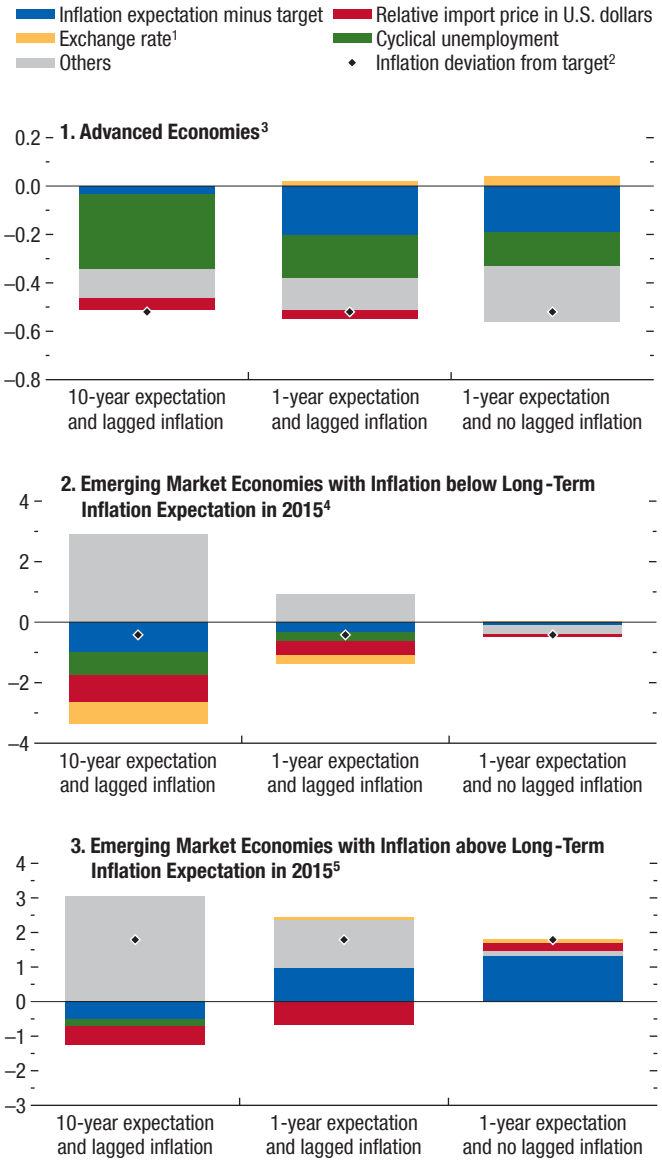
To test for the robustness of the results, two alternative versions of equation (3.4.1) are estimated. The first uses 1-year-ahead inflation expectations instead of 10-year-ahead expectations. The second one uses 1-year-ahead inflation expectations but omits the lagged inflation term. For advanced economies, the results are broadly similar to those obtained in the baseline (Annex Figure 3.4.1, panel 1).[56] In emerging market economies, however, using shorter-term expectations results in substantially smaller residuals, especially in countries with inflation above long-term expectations (Annex Figures 3.4.2, panels 2 and 3).

Cyclical unemployment measure—Estimates of cyclical unemployment are typically subject to large uncertainty. To check the robustness of the results, two alternative estimates of cyclical unemployment are used: (1) the Hodrick-Prescott filtered unemployment rate and (2) deviations of unemployment rates from five-year moving averages. The results presented in Annex Figure 3.4.2 suggest that the contribution of import prices to inflation is robust to alternative proxies of economic slack, but the contribution of slack itself and other factors varies somewhat when different measures are used.

[55]The analysis assumes that labor market slack and import prices do not affect 10-year-ahead inflation expectations, which is supported by additional analysis of the effect of these two variables on inflation expectations.

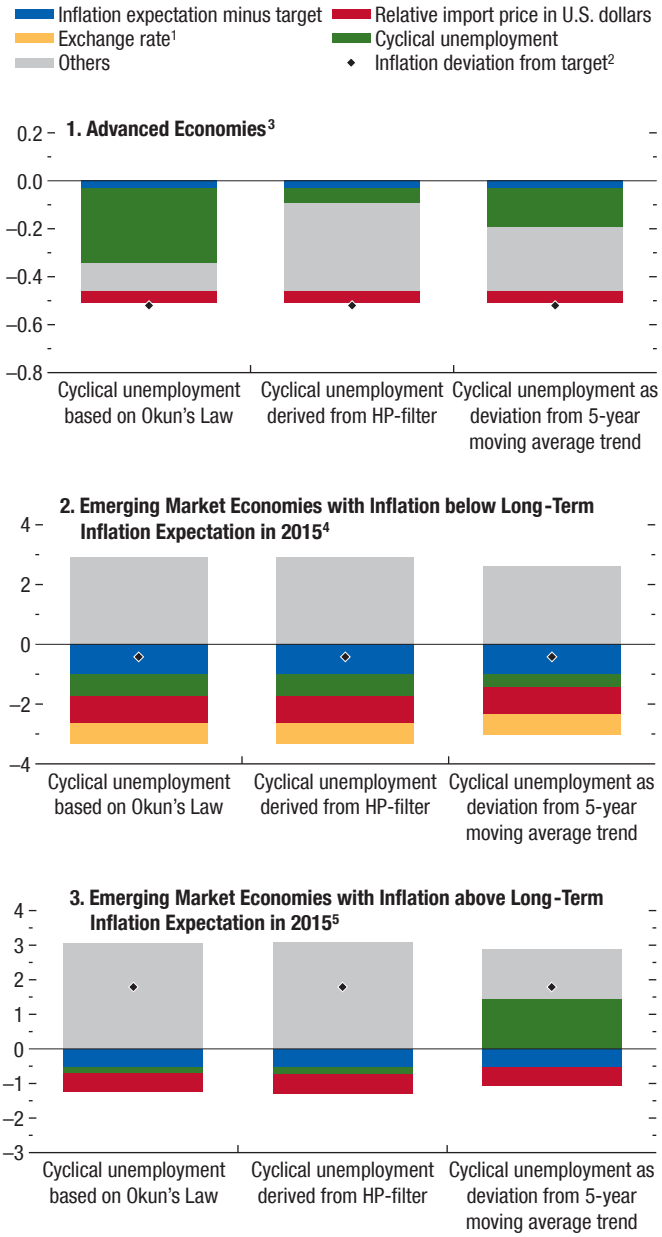
[56]The results of two-year- or three-year-ahead inflation expectations (not reported here due to space constraints) are broadly similar to those of one-year-ahead inflation expectation.

Annex Figure 3.4.1. Contribution to Inflation Deviations from Targets Using Various Measures of Inflation Expectations



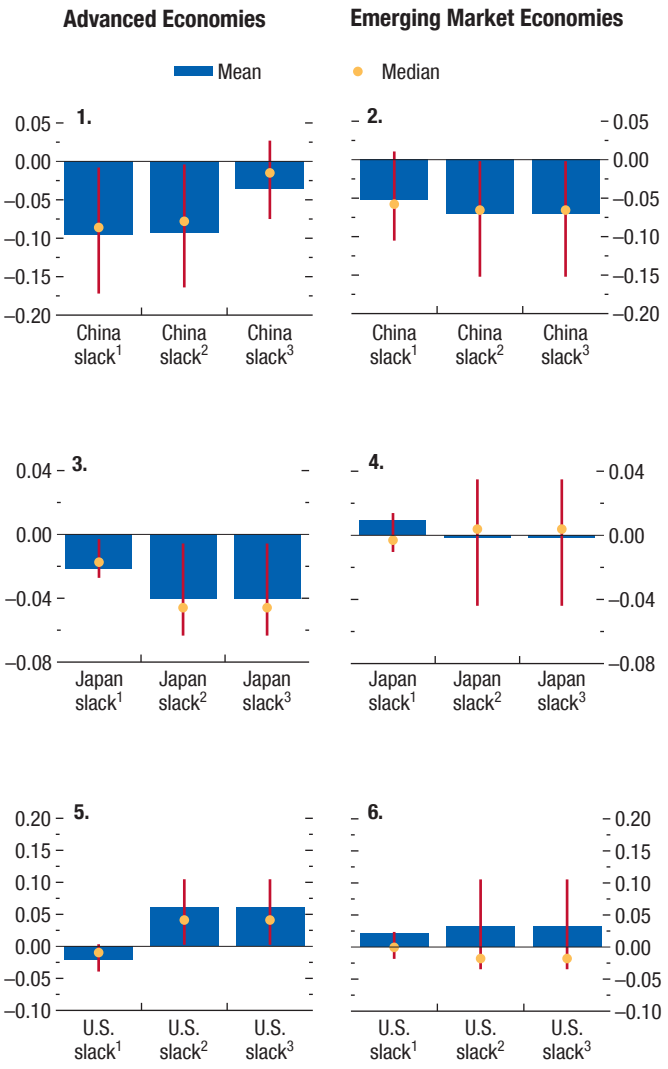
Sources: Consensus Economics; Haver Analytics; Organisation for Economic Co-operation and Development, Economic Outlook database; and IMF staff calculations.
Note: The figure reports average contributions in 2008–15.
[1] Exchange rate is defined as currency value per U.S. dollar.
[2] The target is defined as the average of 10-year inflation expectation in 2000–07. Okun's law coefficients come from Ball and others 2016.
[3] Advanced economies in Annex Table 3.1.1. Estonia, Lativa, Lithuania, the Slovak Republic, and Slovenia are excluded as outliers.
[4] Bulgaria, China, Hungary, Malaysia, Mexico, Philippines, Poland, Romania, Thailand.
[5] Argentina, Brazil, Chile, Columbia, India, Indonesia, Peru, Russia, Turkey.

Annex Figure 3.4.2. Contribution to Inflation Deviations from Targets Using Various Measures of Cyclical Unemployment



Sources: Consensus Economics; Haver Analytics; Organisation for Economic Co-operation and Development, Economic Outlook database; and IMF staff calculations.
Note: The figure reports average contributions in 2008–15.
[1] Exchange rate is defined as currency value per U.S. dollar.
[2] The target is defined as the average of 10-year inflation expectation in 2000–07. Okun's law coefficients come from Ball and others 2016.
[3] Advanced economies in Annex Table 3.1.1. Estonia, Lativa, Lithuania, the Slovak Republic, and Slovenia are excluded as outliers.
[4] Bulgaria, China, Hungary, Malaysia, Mexico, Philippines, Poland, Romania, Thailand.
[5] Argentina, Brazil, Chile, Columbia, India, Indonesia, Peru, Russia, Turkey.

Annex Figure 3.4.3. Correlation of Manufacturing Slack in China, Japan, and the United States with Import Price Contribution to Inflation in Other Economies



Sources: Consensus Economics; Haver Analytics; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: Vertical lines denote interquartile ranges. The figure shows the coefficients of manufacturing slack from regressions of the import price contribution to inflation on manufacturing slack and other variables.
[1] No controls.
[2] Controlling for manufacturing slack in the other two economies, change in oil prices, and global output gap.
[3] Controlling for global output gap and change in oil prices in current and previous four quarters.

Manufacturing Slack in China, Japan, and the United States, and Inflation in Other Economies

To explore the relationship between manufacturing slack in key large economies—China, Japan, and the United States—and inflation developments in other countries, the following equation is estimated for each of the 44 advanced and emerging market economies in the sample:

$$I_{i,t} = \alpha + \beta S_t^j + \delta X_t + \varepsilon_{i,t}, \qquad (3.4.2)$$

in which I is the contribution of import price to inflation as estimated using equation (3.4.1), S denotes manufacturing slack; j refers to China, Japan, or the United States; and X is a set of control variables, including global factors such as current and past changes in oil prices and global output gap—defined as the U.S.-dollar-GDP-weighted average of the output gap across countries.[57]

The results of the analysis suggest that the contribution of import prices to inflation in many advanced and emerging market economies is significantly correlated with manufacturing slack in China, Japan, and the United States. The association is particularly strong, robust, and more precisely estimated for China. In particular, a 1 percentage point increase in manufacturing slack in China is, on average, associated with a decline in inflation in other economies of about 0.04 percentage point to 0.1 percentage point (Figure 3.14), with the relationship being stronger in advanced economies than in emerging market economies (Annex Figure 3.4.3).

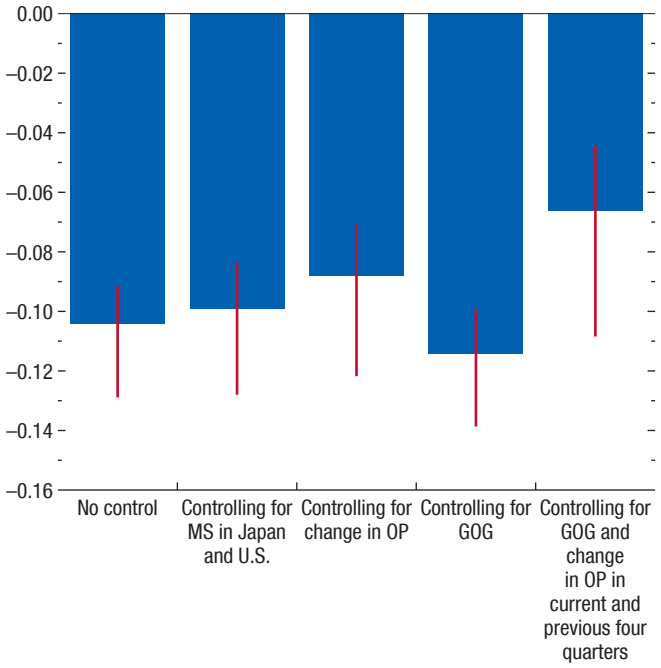
Equation (3.4.2) is also estimated in a panel setting with country-fixed effects. The results show that the correlation with manufacturing slack in China is significant at the 90 percent confidence interval and robust to controlling for global variables (Annex Figure 3.4.4). Finally, further analysis finds that this correlation is higher in countries with stronger trade links with China, providing additional evidence of spillover effects through tradable goods.

Annex 3.5. The Effect of Inflation Shocks on Inflation Expectations

The econometric approach to assess the effect of inflation shocks on inflation expectations follows the one used in Levin, Natalucci, and Piger (2004), which relates changes in inflation expectations to changes

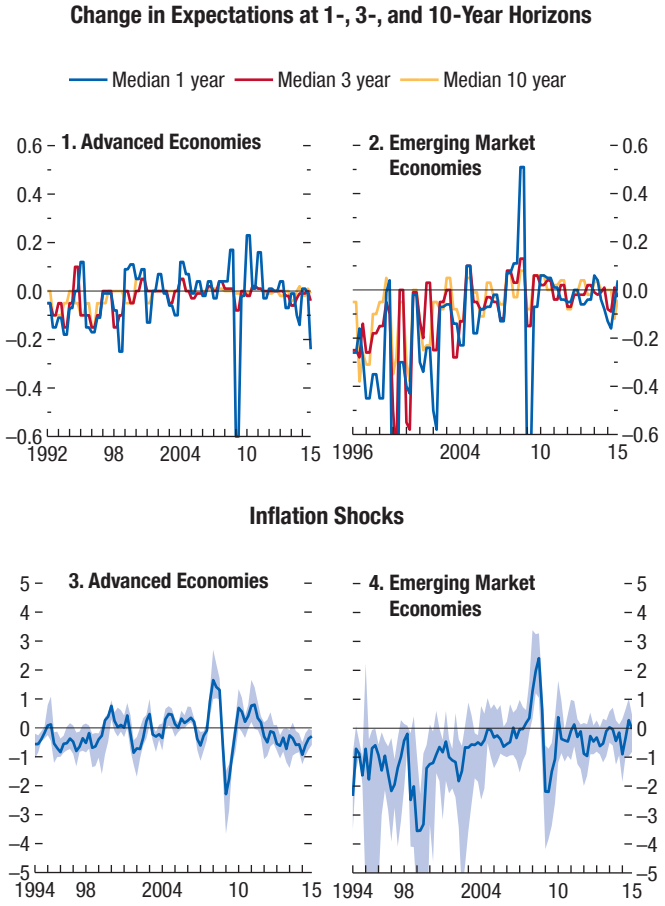
[57]The contribution of import prices to inflation is used as a dependent variable to provide a direct measure of the association between excess capacity in manufacturing in large economies and inflation rates in other advanced and emerging market economies. Similar results are obtained when import prices are used as the dependent variable (and the effect of manufacturing slack on inflation is computed by rescaling the effect of manufacturing slack on import prices by the effect of import prices on inflation).

Annex Figure 3.4.4. Correlation of China Manufacturing Slack with Import Price Contribution to Inflation in Other Economies: Results from Panel Regressions



Sources: Consensus Forecasts; Haver Analytics; Organisation for Economic Co-operation and Development, Economic Outlook database; and IMF staff calculations.
Note: The figure reports the coefficients of manufacturing slack in China from panel regressions. Bars denote coefficient median values. Vertical lines denote 90 percent confidence intervals. MS = manufacturing slack; OP = oil prices; GOG = global output gap.

Annex Figure 3.5.1. Change in Inflation Expectations and Inflation Shocks
(Percentage points)



Sources: Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: Data used in this figure are quarterly. In panels 3 and 4, blue lines denote the median of inflation shocks, and shaded areas denote interquartile ranges.

in inflation. In particular, the following equation is estimated country by country:

$$\Delta\pi^{e}_{t+h} = \beta^{h}_{t}\pi^{news}_{t} + \epsilon_{t+h}, \qquad (3.5.1)$$

in which $\Delta\pi^{e}_{t+h}$ denotes the first difference in expectations of inflation h years in the future; π^{news}_{t} is a measure of inflation shocks—defined as the difference between actual inflation and short-term inflation expectations from Consensus Economics; and the coefficient β^{h} captures the degree of anchoring in h-years-ahead inflation expectations—a term usually referred to as "shock anchoring" (Ball and Mazumder 2011).

Annex Figure 3.5.1 shows the evolution of the left-hand-side (top panel) and right-hand-side (bottom panel) variables in equation (3.5.1) for advanced and emerging market economies. Changes in inflation expectations have been more volatile at shorter horizons for both groups of countries. Expectations were on a downward path throughout the 1990s in both advanced and emerging market economies as monetary frameworks were improving and inflation was falling. This trend was particularly strong in emerging market economies. Inflation expectations have been remarkably stable throughout the 2000s in advanced economies, especially at longer horizons, but recently their volatility has increased. In contrast, for emerging market economies the volatility of expectations during 2009–15 has been lower than in the previous decade.

Inflation shocks have been relatively modest in advanced economies, except for the period surrounding the global financial crisis. These shocks were mostly negative in the 1990s as inflation was declining, but have been close to zero in the 2000s. Since 2011, the

median inflation shock in advanced economies was negative. In emerging market economies, inflation shocks were negative on average in the 1990s and early 2000s, but less so more recently.

Robustness Checks

It is possible that changes in current and expected inflation are both driven by changes in expectations about the future state of the economy. For example, if firms and households expect that the economy will be in a recession in the near future and inflation will be lower than today, they will start cutting their consumption and investment expenditures now, putting downward pressure on inflation today. In that case, both inflation expectations and inflation would decline, but this would be driven by a third factor (expectations of future slack), rather than a causal link from inflation shocks to inflation expectations—especially on short-term horizons.

To check whether the results are simply driven by this mechanism, the baseline specification is augmented with the change in expectations about the future state of the economy, proxied by the change in one-year-ahead unemployment rate expectations from Consensus Forecasts (Δu^e_{t+1}):[58]

$$\Delta\pi^e_{t+h} = \beta^h_t \pi^{news}_t + \delta_t \Delta u^e_{t+1} + \epsilon_{t+h}. \qquad (3.5.2)$$

The results reported in Annex Figure 3.5.2 suggest that the sensitivity values obtained controlling for expectations about future slack are not statistically different from those presented in the baseline.

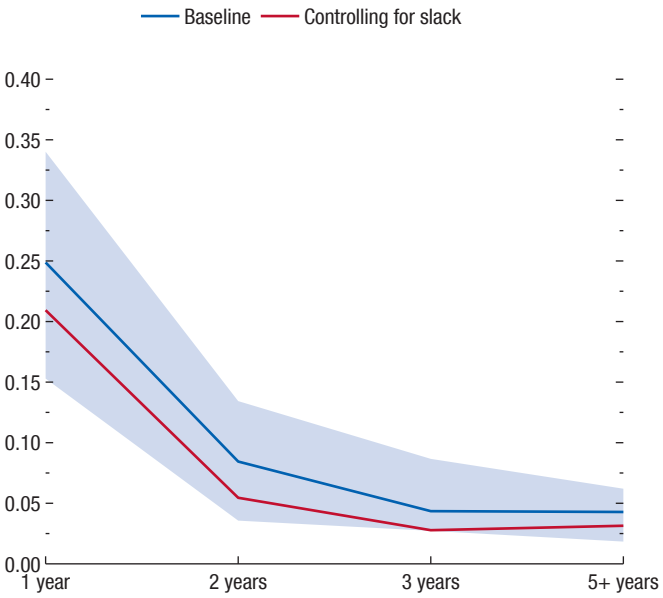
Finally, the results are also robust when considering changes in inflation or deviations of inflation from targets as alternative measures of inflation shocks.

Oil Price Inflation versus Core Inflation

For countries with a zero-lower-bound constraint, the sensitivity of inflation expectations to shocks is further decomposed into those originating from changes in: (1) oil price inflation and (2) core inflation. To do this, inflation surprises are first regressed on oil price inflation country by country:

[58]While it would be preferable to include the change in expectations of the unemployment rate at the same horizon as inflation expectations on the left-hand side, such data are not available. Moreover, even one-year-ahead unemployment rate expectations are collected only for 12 advanced economies; therefore, the sample in this robustness check is smaller than that in the main part of the analysis.

Annex Figure 3.5.2. Sensitivity of Inflation Expectations when Controlling for Slack: Advanced Economies



Sources: Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: The figure shows the response of inflation expectations at various horizons to a 1 percentage point unexpected increase in inflation based on coefficients from country-specific static regressions. The alternative specification (red line) controls for the change in one-year ahead unemployment rate expectations. The sensitivity for 5+ years corresponds to the average of estimations using 5– and 10–year–ahead inflation expectations. Solid lines denote the median response of inflation expectations across countries while the shaded area denotes the interquartile range of the responses under the baseline specification.

$$\pi^{news}_t = \alpha + \beta\,\pi^{oil}_t + \epsilon_t, \qquad (3.5.3)$$

in which π^{oil}_t is the oil price inflation. Inflation shocks are then decomposed into the part driven by changes in oil prices (fitted values) and the part unrelated to oil prices (residuals). Finally, the following equation is estimated for countries with policy rates at their effective lower bounds over the period 2009–15:[59]

$$\Delta\pi^e_{t+h} = \alpha + \vartheta\,\pi^{news,oil}_t + \gamma\,\pi^{news,core}_t + \epsilon_{t+h}, \qquad (3.5.4)$$

in which $\pi^{news,oil}_t$ denotes the inflation shocks driven by changes in oil prices, and $\pi^{news,core}_t$ is the inflation shocks unrelated to changes in oil prices.

This analysis suggests that the sensitivity of three-year-ahead inflation expectations to oil price shocks over the recent past in countries facing the effective-lower-bound constraint was very similar

[59]Zero-lower-bound economies are defined as advanced economies whose policy rates or short-term nominal interest rates were 50 basis points or lower at some point during 2008–15.

to that of core inflation shocks. Both sensitivities were around 0.03. The qualitative pattern remains the same when examining inflation expectations at longer-year horizons (five years and beyond) and overall commodity prices instead of oil prices. The results imply that inflation expectations did not become unanchored solely because of the sharp drop in oil and other commodity prices.

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CHAPTER 4

SPILLOVERS FROM CHINA'S TRANSITION AND FROM MIGRATION

Spillovers are a key factor shaping the path of the global economy and the risks around it, but their nature is changing. The growing clout of emerging markets means that shocks originating there—including those of a noneconomic nature—are playing an increasingly important role around the world. Illustrating these trends, this chapter examines the global impact of China's rebalancing towards a more sustainable growth model, and the effects of increasing migration flows on the originating and recipient economies. While the source and transmission channels of these spillovers vary, a common theme is that, despite the negative short-term impact on recipient economies, they offer potential gains in the long term. If handled well, China's economic transition will eventually result in more sustainable global growth, and migration can help reduce challenges from population aging in recipient countries. Based on recent IMF publications and new analytical work by the IMF Spillover Taskforce, this chapter documents these spillovers and discusses policy implications at the national and multilateral level.[1]

Introduction

As in the past, economic spillovers across national borders continue to shape global prospects, but their scope has expanded. While previous spillover analysis has mostly focused on economic shocks emanating from advanced economies—such as shifting monetary policies in systemic economies—the increasing clout of emerging market economies, which explained the bulk of global growth over the past decade and now represent more than 50 percent of global GDP in purchasing-power-parity terms, suggests that they are a significant source of spillovers shaping the global outlook. In addition, noneconomic shocks are playing a more important role.

The global repercussions of China's welcome transition to a more balanced growth path furnish a case in point. China's rapid, investment-driven growth in the past decade fostered a remarkable expansion of global trade and boosted commodity prices (Figure 4.1). More recently, China's necessary slowdown in investment and its current transition to consumption-led growth has coincided with a very sharp decline in global trade growth.[2] Given the size and openness of the Chinese economy—the sharp increase in its share of global imports over the past decade has made it a main source (top ten) of export demand for over 100 economies that account for about 80 percent of world GDP—the potential for large spillover effects has increased. This suggests that China's transition has the potential to change the global outlook and the risks surrounding it. Not surprisingly, possible bumps around China's transition count among the risks to the global recovery, along with the persistent weak demand and low productivity growth in some key advanced and emerging market economies (see Chapter 1).

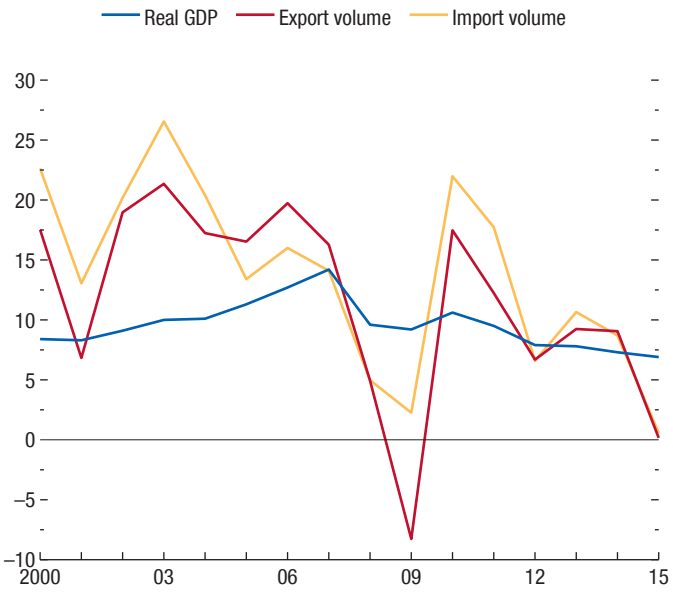
The rising trend in migration, compounded by refugees fleeing geopolitical conflicts, is an example of noneconomic developments with significant spillovers. The rapid increase in economic migration has become a pressing issue, and the ongoing refugee crisis in the Middle East and North Africa has added

The authors of this chapter are Patrick Blagrave, Sweta Saxena, and Esteban Vesperoni (team leader), with research and editorial support from Chanpheng Fizzarotti, Gabi Ionescu, and Jeffrey Lam. It is based on work by the IMF's Spillover Taskforce, with contributions from Patrick Blagrave, Alan Dizioli, Davide Furceri, Jesus Gonzalez-Garcia, Ermal Hitaj, Ben Hunt, Joao Jalles, Florence Jaumotte, Christina Kolerus, Ksenia Koloskova, Wojciech Maliszewski, Montfort Mlachila, Nkunde Mwase, Papa N'Diaye, Hiroko Oura, Frantisek Ricka, Christian Saborowski, Sweta Saxena, Katya Svirydzenka, Esteban Vesperoni, Arina Viseth, Mustafa Yenice, Aleksandra Zdzienicka, and Yuanyan Zhang.

[1]The IMF introduced specific reports on spillovers in 2011. Until 2013, these reports focused on the external effects of domestic policies in five systemic areas: China, the euro area, Japan, the United Kingdom, and the United States. Since 2014 the reports took a more thematic approach focusing on global, cross-cutting issues centered on economic policies. Beginning with this *World Economic Outlook* report, spillovers analysis will be highlighted in every other report.

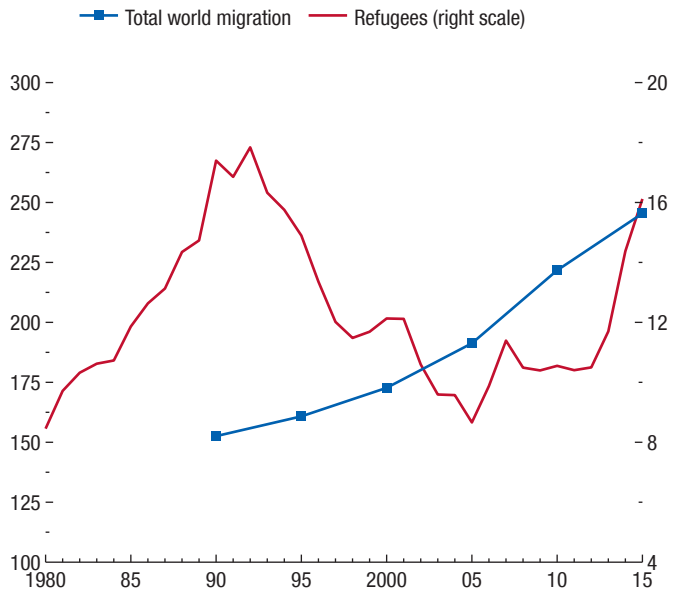
[2]See Chapter 2 in this *World Economic Outlook* report.

Figure 4.1. China: GDP and Trade Growth
(Percent change, year-over-year)



Source: IMF staff calculations.

Figure 4.2. Number of International Migrants and Refugees
(Millions)



Sources: United Nations High Commissioner for Refugees; and IMF staff calculations.

to this trend.[3] The number of international migrants increased from 150 million in 1990 to 250 million as of the end of 2015 (Figure 4.2). And refugee flows—driven by geopolitical factors, wars, and conflict—have surged over the past couple of years, and continue, with over half a million applications for asylum during the first half of 2016. This surge increased the number of refugees to about 16 million as of the end of 2015—although they still represent a small share in total migration. Large migration, whether triggered by economic or noneconomic forces, has significant repercussions both for sending and for receiving countries. Moreover, against a background of low growth along with rising inequality in many countries, migration can add to anxiety about globalization, and feed a political climate that stalls structural reforms and growth.

The first part of this chapter focuses on the impact of China's transition on the global economy, with an emphasis on the complexities of its diverse transmission channels. The following section focuses on migration issues and their impact on source and recipient economies. Both sections document spillovers and discuss policy issues at the national and multilateral level.

[3]Migrants are defined as individuals who are living in countries other than their country of birth.

China's Transition

Rapid growth has made China one of the largest economies in the world, and its increasing global links lifted trade and economic activity across the world during its expansion. In this context, China's economic transition toward more balanced growth also has global repercussions, transmitted through trade and commodity markets and amplified by financial markets. These repercussions entail a negative direct impact on global demand, an indirect impact through prices—notably for commodities—and an effect on exchange rates and asset markets. However, some countries stand to gain, such as commodity importers—including some emerging markets—and producers of labor-intensive goods, as China moves up the value chain and imports more consumption goods. A well-managed transition will benefit the global economy in the long term: it will result in more sustainable growth in China, improved resource allocation, and a reduction of risks of a disruptive adjustment—which credit booms have often triggered in other economies. China can help by managing its transition well, notably by accepting

the slowdown and by clearly communicating its policy intentions. Globally, it will be important to avoid protectionism and continue to facilitate trade-integration initiatives.

Slowdown, Rebalancing, and Transmission Channels of Spillovers

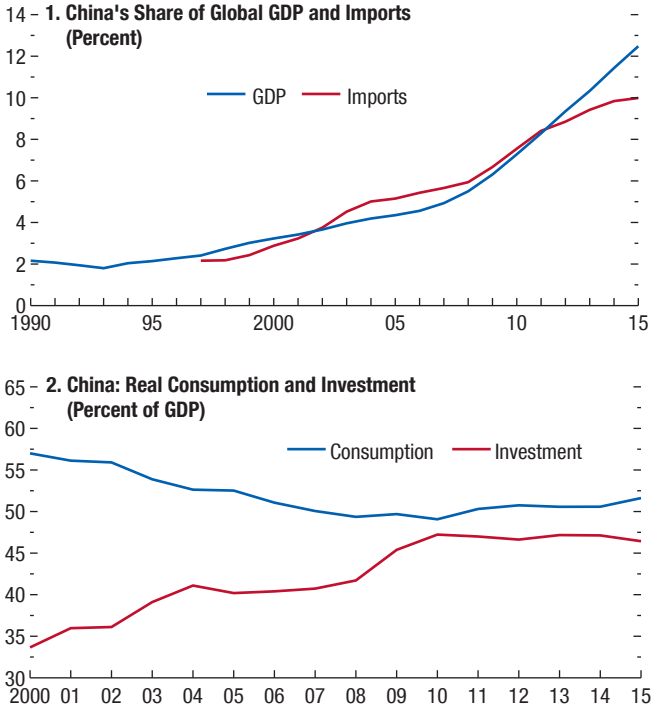
As the second largest economy in the world, China has become a significant source of global demand. GDP growth averaged 9.6 percent since 2000, increasing China's share of global GDP from about 3 percent to almost 13 percent in 2015 (Figure 4.3, panel 1).[4] Since the early 2000s this growth has been fueled by investment and exports as the economy built infrastructure and housing, and leveraged its abundant labor supply to boost manufacturing. Reinforcing this trend, China's response to the global financial crisis prompted a further push to infrastructure investment in 2009–10—increasing by an average of 17 percent in each of those years. The large size of the economy implies that developments in China had significant spillovers to the global economy through its demand for trade-partner exports. Given the key role of infrastructure investment in China's expansion, commodity exporters also benefited from the boost in prices caused by stronger demand in China, particularly for base metals.

More recently, China has begun to rebalance its economy from investment and exports towards consumption, partly reversing its contribution to global trade growth in previous years.[5] Economic growth has slowed, and rebalancing implies that investment has slowed faster than consumption—between 2010 and 2015, the consumption share of GDP rose from about 49.1 percent to 51.6 percent, while the investment share fell from about 47.2 percent to 46.4 percent, both in real terms (Figure 4.3, panel 2). This implies a sharper decline in demand for imports and commodities than the slowdown in headline GDP growth would suggest, given that investment activity is more import intensive and relies more heavily on commodities. In fact, a striking development of the slowdown in the Chinese economy in 2014–15 is the disproportionate deceleration in exports and imports—GDP growth fell from 7.8 percent in 2013 to 6.9 percent in 2015,

[4]Based on GDP at market exchange rates.

[5]For a richer discussion of China's economic rebalancing, see IMF (2015g).

Figure 4.3. China: Global Clout and Rebalancing



Source: IMF staff calculations.

while export and import growth fell by 7 percentage points and 8 percentage points, respectively, over this same period.

Spillovers from China are transmitted primarily via trade links. A deceleration in China's domestic demand affects imports from trading partners—and more generally, global trade. But this impact differs among countries—creating winners and losers from China's rebalancing—and the analysis of the trade channel is not straightforward, for several reasons:

- China has become deeply integrated into global supply chains, which implies that it often transmits shocks from other countries. The analysis of spillovers needs to differentiate China's direct impact on global demand by disentangling variations in GDP growth due to its own demand from those associated with global shocks.
- Countries have different exposures to China's final demand. While total exposure—the share of exports to China relative to total exports—plays a role, countries differ in terms of sectors of the Chinese economy to which they are exposed. With China's investment demand slowing disproportionately,

exporters of investment goods—such as some countries in the euro area—will be more affected than exporters of consumption goods. Finally, China is now producing at home some previously imported intermediate goods (onshoring), adding complexity to the analysis.

- As China moves up the value chain, reducing its production of some labor-intensive goods, opportunities are being created for countries with abundant labor to take its place in the production of these goods, particularly in southeast Asia.

Another important transmission channel relates to China's impact on global prices, particularly in commodity markets. China is both a large producer and consumer of commodities. Its demand for commodities surged since the early 2000s, particularly in energy and base metals markets; by the end of 2014 China's demand for metals accounted for more than 40 percent of global demand. Its large footprint in commodity markets suggests that a slowdown in China's demand can have a material and lasting impact on prices, particularly given short-term price-inelasticity of supply in commodity markets and the additional increases in the supply of metals in recent years.[6] Chinese industries may also be contributing to global "overcapacity" in some sectors, for example, steel and cement. Subsidies on key production inputs—such as energy—as well as credit flows to loss-making enterprises have contributed to an excessive expansion of capacity in these industries and are hindering their adjustment, depressing global prices.

Direct spillovers through financial channels are still limited but will increase, and developments in China are already affecting global asset prices. China's financial integration into global markets remains limited, which suggests that direct financial spillovers from China—for example, through the adoption of domestic financial regulation affecting credit growth or China's foreign assets and liabilities—have been modest so far. However, financial linkages are increasing, and the scope for financial spillovers is likely to increase, as China eases capital-account restrictions. Moreover, developments in China are already affecting volatility in financial markets. For example, policy uncertainty over the past year—related to the exchange rate regime and renminbi depreciation, and the response to a domestic-equity-market adjustment—was coupled with falling global equity prices and exchange rate depreciation in emerging market economies.

[6]See IMF (2015a).

Increasing Clout in Global Trade

As China became a larger and more open economy after its accession to the World Trade Organization, spillovers to the rest of the world increased. Its rapid growth over the past 15 years has made China a key player in global trade—its share in global imports increased from 3 percent in 2000 to approximately 10 percent as of 2015. The gradual increase in China's trade suggests that spillovers could vary over time. Furceri, Jalles, and Zdzienicka (2016) perform time-varying coefficient analysis using local projection methods on a sample of 148 countries over 1990–2014, and show that spillovers from a 1 percentage point negative shock to China's final demand growth have nearly doubled over the past two decades (Figure 4.4). These shocks now have a cumulative impact on global GDP of about 0.2 percent, after two years, with comparable effects in emerging market and advanced economies. This coefficient is broadly in line with those in other studies, which find spillovers between 0.1 percent and 0.2 percent on global GDP, but this new research better exploits rich cross-time dynamics and showcases the increased importance of spillovers from China in recent years and their potential to increase in the future.[7]

Trade links stand out as the main transmission channel of spillovers from China in this recent research, which finds that countries' exports to China, and a larger share of manufacturing exports in total exports, increase the magnitude of spillovers.[8] In particular, a 10 percent rise in exports to China is associated with an increase in the spillover coefficient of about 0.01—that is, close to 5 percent.

Given the importance of this channel, what is the direct impact of China's transition on global

[7]Other work on GDP-to-GDP spillovers includes Cashin, Mohaddes, and Raissi (2016); Cesa-Bianchi and Stratford (2016); Dizioli, Guajardo, Klyuev, Mano, and Raissi (2016); IMF 2014; Hong and others (2016); Duval and others (2014); and Dizioli, Hunt, and Maliszewski (2016).

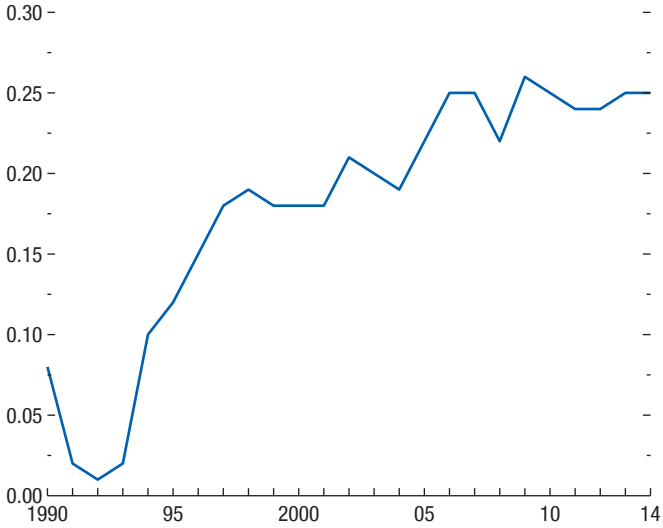
[8]See Furceri, Jalles, and Zdzienicka 2016, which introduces the countries' time-varying coefficients into a rich panel environment. The panel captures the importance of different factors in explaining the evolution of spillover coefficients, including exports to China, the composition of such exports (commodities and manufacturing), and financial factors—as captured by the Chicago Board Options Exchange Volatility Index (VIX).

trade? New research (Blagrave and Vesperoni 2016) addresses two critical empirical challenges to answering this question. First, to capture China's direct role as a source of spillovers, China-specific final demand shocks—that is, those not associated with external demand—were estimated. Second, the Organisation for Economic Co-operation and Development (OECD) Trade in Value Added (TiVA) database was used to build country-specific China-demand shocks to account for the impact of rebalancing, which implies that spillovers depend on countries' exposures to various sectors in China, specifically its secondary sector (associated mainly with investment) as opposed to its tertiary sector (mainly consumption).[9]

The evidence suggests that China's transition has played a role in the recent slowdown in global exports and that its impact has differed across countries.[10] Panel vector autoregression estimates for a sample of 46 advanced and emerging market economies show that for a country with an average trade exposure to China, a 1 percentage point negative shock to China's final demand growth (in one quarter) reduces export growth rates by 0.1–0.2 percentage point over the course of a year.[11] This finding suggests that, just as China fostered strong global-trade growth during the expansion, its transition is likely playing a role in the current slowdown. Estimated impacts differ across countries, with those in Asia most affected: in level terms, following a 1 percent shock to China's final demand, exports in these countries are reduced by nearly 1 percent after a year (Figure 4.5). Commodity exporters and countries with stronger trade linkages to China's manufacturing sector are also affected significantly, with much smaller effects in other countries.[12] In line with these results, in-sample projections help explain the dynamics of the recent deceleration in global trade (Figure 4.6). These projections suggest that about a sixth of Asia's export-growth slowdown in 2014–15 could be explained by China's transition, with smaller impacts elsewhere.[13]

Demand rebalancing—from public investment to private consumption—has a negative, albeit modest, impact on global activity. Disentangling the impact of a general slowdown from that of demand rebalancing is challenging. Hong and others (2016), using TiVA data, find that the impact of growth-neutral rebalancing is likely to be modest, but stronger in emerging Asia. Using the IMF's Flexible System of Global Models (FSGM), Dizioli, Hunt, and Maliszewski (2016) reach a similar conclusion.[14] Simulating a scenario in which public investment in China declines by 1.5 percent of GDP each year for five years, and transfers to liquidity-constrained households rise by an equivalent amount, demand rebalancing would reduce import demand from China: investment is more import intensive than consumption, and a shift

Figure 4.4. Spillovers from China over Time
(Average response of GDP to a 1 percentage point shock to growth in China, percent)



Source: Furceri, Jalles, and Zdzienicka, 2016.
Note: Sample includes 148 advanced and emerging market economies.

[9]These data allow for the identification of partners' exports that are directed to specific sectors in China's final demand, even if those exports reach China indirectly, through a third country.

[10]A broader analysis of the determinants of the global trade slowdown (which the China-specific impact provided here complements) is provided in Chapter 2 of this *World Economic Outlook* report. The chapter finds that overall weakness in economic activity has been the primary restraint on trade growth, which is consistent with results suggesting that weaker demand in China played a role in the reduction of global export growth.

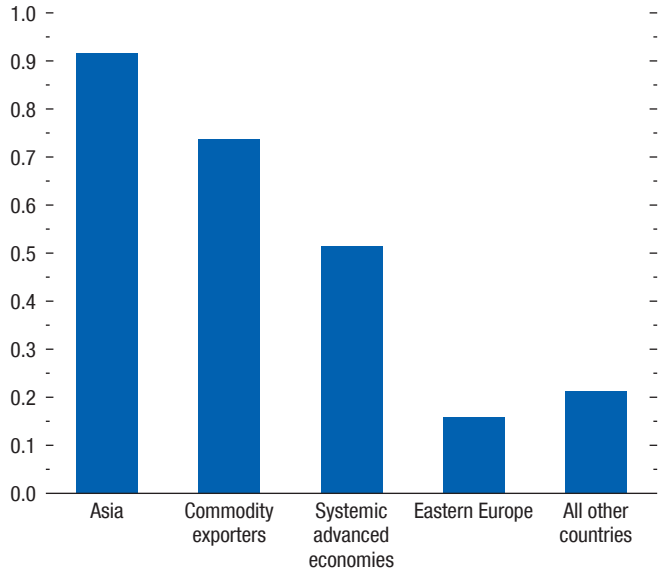
[11]The limited availability of TiVA and quarterly trade volume data requires the use of a relatively small sample (2013:Q1–2015:Q3).

[12]Although data limitations prevent an examination of trade spillovers for low-income and developing countries in this analysis, Drummond and Xue Liu (2013) point to an important role for changes in China's investment in explaining export dynamics in sub-Saharan Africa.

[13]Since the first quarter of 2014 China's transition may have depressed average export growth rates in a group of six Asian countries by about 1 percentage point a quarter, and less than half this amount in advanced and other emerging market economies.

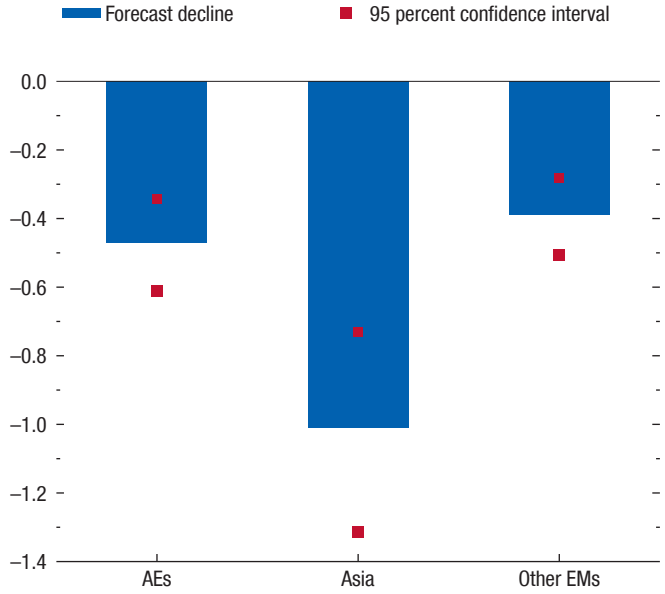
[14]For details on the FSGM, see Andrle and others 2015.

Figure 4.5. Impact on Exports of a 1 Percent Shock to China's Demand after One Year
(Percent; GDP-weighted average)



Source: Blagrave and Vesperoni 2016.
Note: Asia = HKG, IDN, KOR, PHL, SGP, THA. Commodity exporters = AUS, BRA, CHL, COL, RUS, ZAF. Eastern Europe = CZE, EST, HUN, LTU, LVA, POL, SVK, SVN, TUR. Systemic advanced economies = DEU, JPN, USA. All other countries = ARG, AUT, BEL, CAN, CHE, DNK, ESP, FRA, FIN, GBR, GRC, ISR, IRL, ISL, ITA, LUX, MEX, NLD, NOR, NZL, PRT, SWE. Data labels in the figure use International Organization for Standardization (ISO) country codes.

Figure 4.6. Decline in Average Export Growth Rate Attributed to China Demand, 2014:Q1–2015:Q3
(Percent)



Source: Blagrave and Vesperoni 2016.
Note: Blue bars depict the marginal impact of weaker GDP growth in China (relative to the January 2012 *World Economic Outlook* (WEO) forecast) on average export growth rates from 2014:Q1 to 2015:Q3. They represent the difference between an unconditional forecast (with China's growth rates based on the January 2012 WEO baseline) and a conditional forecast with the same information set, but adding estimated China demand shocks. AE = advanced economy; EM = emerging market economy.

in demand toward the latter triggers a net reduction in imports. The effect on China's GDP depends on assumptions about the impact of public investment on productivity—that is, if the latter is negligible, GDP would fall in the short term but then recover afterwards. Assuming some impact on productivity, however, would imply a permanent decline in GDP below baseline. From a global perspective, under both scenarios, GDP falls by less than 0.1 percent after five years, with emerging Asia most affected.

Finally, structural shifts and higher wages in China's transition play a role as well, affecting both trade volumes and global prices. One such shift is China's move to a higher position in the value chain, which prompted a return to domestic production (onshoring) of previously imported intermediate goods, but led to opportunities for some countries. Another shift relates to the persistent buildup of capacity in some sectors of the Chinese economy, which is likely affecting global prices. More specifically,

- *On-shoring*—China is increasingly producing intermediate inputs domestically (Figure 4.7).[15] IMF (2016c) provides evidence that the gradual increase of production of domestic intermediate goods in China has displaced imports from trade partners. This effect has been strongest in recent years and seems to be affecting imports of more sophisticated goods as China increasingly produces more complex medium-high-technology, capital-intensive goods—generally referred to as moving up the value chain. Dizioli, Hunt, and Maliszewski (2016) show that onshoring in China likely entails little change

[15]A number of indicators support this conclusion, including recent increases in the domestic-value-added content of China's exports (from about 50 percent in 2000 to just under 60 percent in 2011, according to Organisation for Economic Co-operation and Development–World Trade Organization Statistics on Trade in Value Added data), a steady decline in processing trade, and declining import intensity in some sectors. See Dizioli, Guajardo, Klyuev, Mano, and Raissi (2016).

to global GDP, but could have a mild negative effect on countries that trade more with China. To produce a greater share of exported goods domestically, China must increase its capital stock, implying stronger investment. Although China's import demand declines because of onshoring, which depresses activity in Asia and the euro area, the boost to domestic investment offsets these negative spillovers, resulting in little change to global GDP or commodity prices.

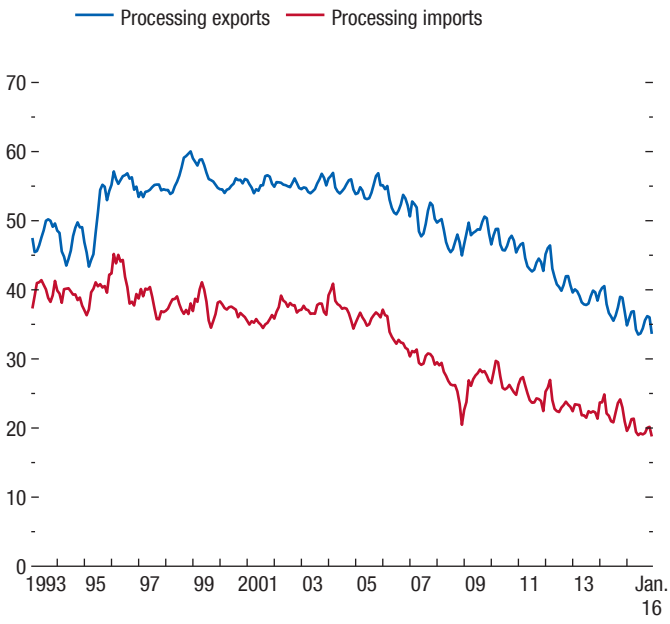
- *Market shares in labor-intensive goods*—Some countries stand to benefit from China's move up the value chain. This is the case for economies positioned to replace China's production of labor-intensive goods or to supply consumer goods to the Chinese market. The decline in China's export market shares of some labor-intensive consumer goods suggests a loss of competitiveness in these categories in recent years (see IMF 2016c and Abiad and others 2016). IMF 2016b discusses how countries such as Cambodia, Lao P.D.R., Myanmar, and Vietnam stand to benefit from China's rise up the value chain.
- *Overcapacity*—In the context of economic expansion during the 2000s, China has built up large capacity in certain sectors, notably those associated with infrastructure investment (for example, steel and cement). As the Chinese economy slows, excess capacity in these sectors has the potential to drive down global prices. Measuring overcapacity is complicated, and a thorough analysis of the issue is beyond the scope of this chapter, but a number of economic indicators—including declining profit margins in some sectors, as well as more conventional measures of capacity relative to total demand—point to overcapacity in some industries in China.[16] An analysis of the spillovers to trade-partner inflation from overcapacity in China is provided in Chapter 3 of this *World Economic Outlook* report—it suggests that lower prices across a number of goods have been associated with lower import prices from China.

A Large Footprint in Commodity Markets

As with intermediate and final goods, China's demand for commodities has increased markedly over the past two decades. Since the mid-1990s China's share of global demand for base metals—iron ore, aluminum, copper, and nickel—has risen from about 3 percent to about 40 percent (Figure 4.8, panel 1), while its share of demand for oil has increased from about 1 percent to 11 percent. Some food items show the same pattern—for instance, China's share of demand for soybeans represents 60 percent of global demand.[17] At the same time, China is a major producer of some metals, and domestic supply has increased substantially over the same period.

This large footprint in commodity markets implies that both China's boom and its ongoing economic transition have had a significant impact on commodity markets. China's rapid economic growth in the 2000s likely played a role in the sharp increase in prices. In particular, the infrastructure-investment-led stimulus following the global financial crisis (which arguably created incentives for commodity producers—including China—to build capacity), contributed to higher commodity prices. Subsequently, China's growth transition and the ensuing slowdown in demand for com-

Figure 4.7. China: Processing Trade
(Percent of total exports, 3-month moving average)

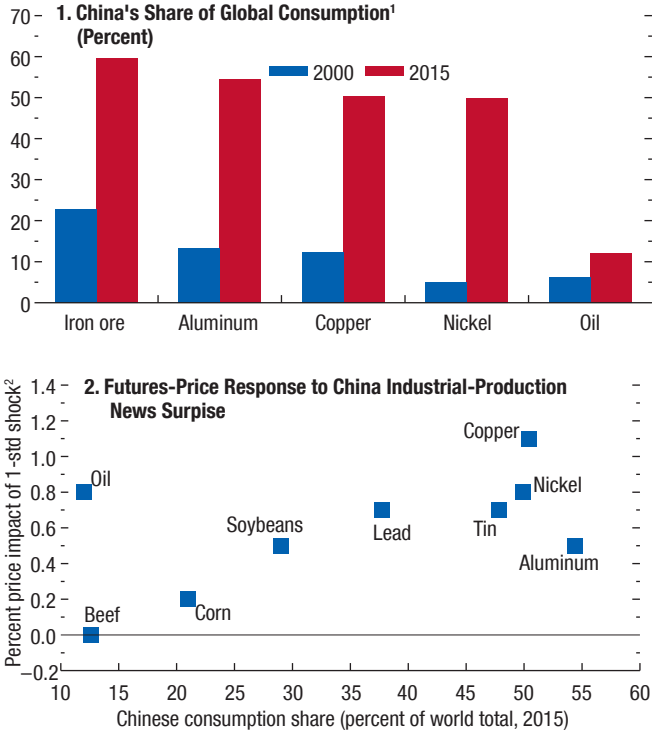


Sources: CEIC China database; and IMF staff calculations.

[16]See IMF 2016f, IMF 2016i, Morgan Stanley 2016a, and 2016b, among others.

[17]For a more thorough discussion of global base metals demand and supply, see IMF 2015a.

Figure 4.8. A Large Footprint in Commodity Markets



Sources: Bloomberg L.P.; Kolerus, N'Diaye, and Saborowski 2016; World Bureau of Metal Statistics; U.S. Department of Agriculture;. and IMF staff calculations.
[1] Latest available data for oil are from 2014.
[2] 1-std = one standard deviation.

modities have proved suppliers' previous production decisions overly optimistic. The result is oversupply and lower prices in many commodity markets. This has likely affected economies that are beyond production value chains in which China plays a critical role. Moreover, analysis in Nose, Saxegaard, and Torres (2016) indicates that there are spillovers from extractive to nonextractive sectors within these economies, which implies that the effects of negative terms-of-trade shocks are not limited to the extractive sector.

Shocks to economic activity in China have a significant impact on commodity prices, which is stronger in markets in which China's footprint is larger. Kolerus, N'Diaye and Saborowski (2016) assess this impact under two analytical approaches. One gauges the response of commodity prices in futures markets to surprises in Chinese industrial-production data announcements using high-frequency data, while the other uses a more structural approach to assess the cumulative impact of shocks to China's demand on commodity prices at quarterly frequency.[18] These are complementary approaches that look both at market pricing of new information and at the economic significance of the price response to activity shocks. Both find that China's shocks have a significant impact on commodity prices; effects are larger in markets in which China represents a greater share of global demand (Figure 4.8, panel 2). Results from a structural vector autoregression also suggest that these effects are economically significant—over a one-year horizon, a 1 percentage point change in industrial production growth leads to a 5–7 percent increase in metal prices and a rise in fuel prices by about 7 percent.[19] Conversely, high-frequency data offer an additional insight, showing that initial market reactions in commodity futures markets are larger when financial market uncertainty—as proxied by the Chicago Board Options Exchange Volatility Index (VIX)—is higher.

China's commodity price clout has increased over time. Structural vector autoregression estimates of one-year price elasticities to China's demand estimated over a 10-year rolling window—estimated consecutively for each year, beginning in 1986–95, and ending with the 2006–15 window—show that the sensitivity of commodity prices to China's demand was negligible before China's accession to the World Trade Organization (Figure 4.9). However, since the early 2000s the sensitivity of oil and metal prices to China's demand has become statistically significant and has increased. For instance, the impact of developments in China on the price of iron ore rose throughout the sample period, in line with its increasing footprint in this market—from 3.5 percent of total demand in 1986 to 52 percent in 2015. Similar patterns are observed for copper and aluminum.

In line with these findings, recent IMF research suggests that weak demand in China accounts for a significant portion of the decline in commodity prices since 2013. Analysis in IMF 2016c builds on the strong common factor in commodity-price fluctuations—typically interpreted as a reflection of global economic conditions—and estimates a factor-augmented vector autoregressive model for a sample of about 40 com-

[18] In the first approach, future commodity prices at daily frequency are regressed on China's industrial production announcement surprises—that is, deviations of industrial production growth from the median Bloomberg consensus before the announcement. The second approach employs a structural vector autoregression to estimate the reaction of commodity prices to Chinese demand using quarterly data from 1986 to 2015.

[19] Aastveit and others (2012); Gauvin and Rebillard (2015); Roache (2012); and Roache and Rousset (2015) also find that shocks to China's demand have a significant impact on commodity prices.

modity prices and shocks to economic activity in China and in the rest of the world. The estimates suggest that most of the decline in commodity prices is explained by shocks to economic activity in the rest of the world until 2013, but that China's demand shocks have played a significant role since then, and that the effect on nonfuel commodity prices is larger. These estimates are corroborated by simulations using the IMF's FSGM.[20]

The decline in commodity prices will benefit commodity importers, including some emerging market and developing economies. Lower prices may dampen spillovers from trade in some countries, notably in Asia. Dizioli, Hunt, and Maliszewski (2016) conduct simulations of a gradual slowdown in China over the course of five years that reduces the level of GDP by about 5 percent by 2020 compared with a baseline in which it does not decelerate (Figure 4.10). This shock entails a reduction in investment and consumption in China and thus compression of its demand for imports. Weaker demand also depresses commodity prices—oil and metals prices are lower by about 7 percent. The simulation suggests that oil exporters are significantly worse off: Latin America suffers moderate output losses, and emerging Asia, the euro area, and Japan experience losses in between. Lower commodity prices are behind the positive impact in the United States.[21] An interesting insight from this exercise is that, despite being strongly affected through trade channels, spillovers to emerging Asia are comparable to those in the euro area because the region's heavy reliance on imports of commodities curbs direct spillovers from trade. Indeed, staff calculations indicate that while the impact of lower commodity prices in Asian economies partially offset spillovers through trade, commodity exporters in all regions have experienced negative spillovers from both channels (Figure 4.11).[22]

Financial Markets

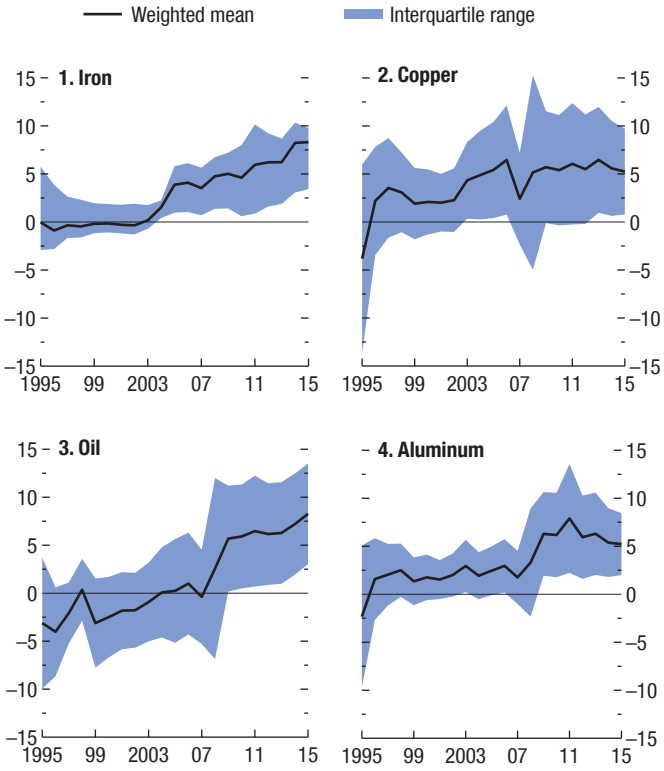
Direct transmission of spillovers through financial channels is still limited, but developments in China

[20]Simulations are presented in IMF 2016e.

[21]The impact of lower commodity prices is complex. For exporters, it will reduce export values and negatively impact the terms of trade, but will also affect domestic growth more broadly, by tightening credit conditions and weakening balance sheets, which can also erode the fiscal position (see IMF 2015b, IMF 2015f, and IMF 2016g). The impact on commodity importers depends on the pass-through of lower prices to consumers and their impact on real interest rates in the presence of monetary policy constraints—that is, the zero lower bound.

[22]Calculations are based on the empirical analysis in the previous two sections and on country shares of commodity exports in Gruss (2014).

Figure 4.9. Cumulative One-Year Price Impact from a 1 Percent Shock to China's Industrial Production
(Percent)

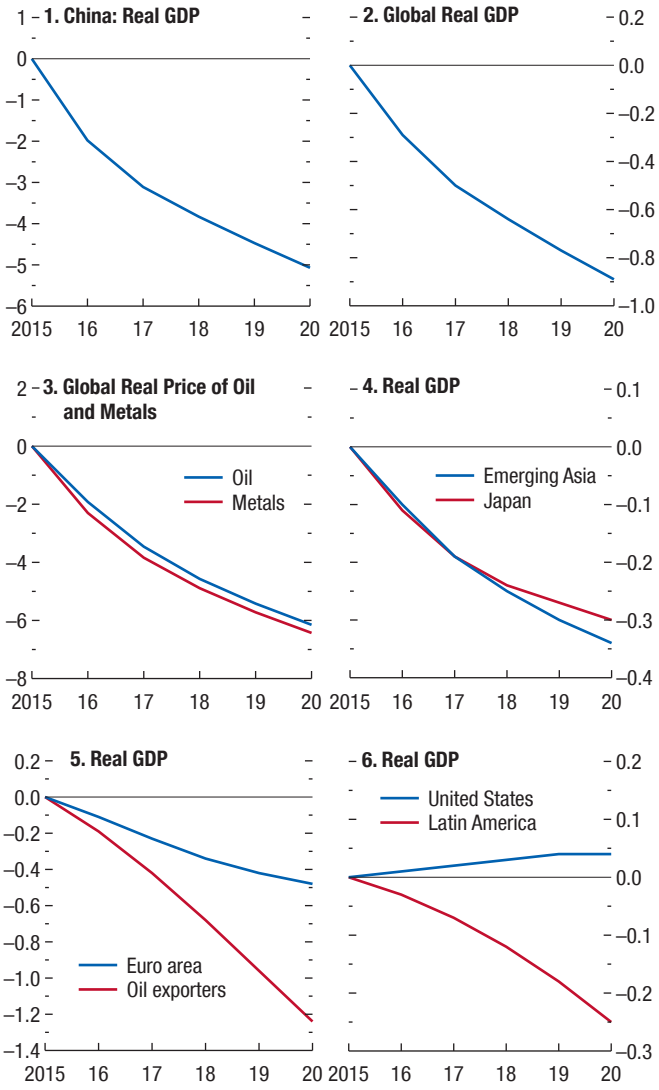


Source: Kolerus, N'Diaye, and Saborowski 2016.
Note: *x*-axis indicates the last year of a rolling ten-year period.

are increasingly affecting asset prices globally and likely amplifying the impact of real shocks. The relatively limited transmission of financial shocks so far is associated with China's integration into global markets—there are still significant capital-account restrictions, including limitations on inward foreign direct investment, quotas on portfolio flows, and caps on foreign borrowing by domestic residents. However, financial linkages are increasing, and the impact of events in China on financial markets over the past year suggests that they can amplify real shocks by affecting asset prices and hence financing costs, especially in emerging markets. Increasing financial vulnerabilities in China could also lead to a disorderly deleveraging that could trigger contagion in emerging market financial markets and exchange rates by affecting confidence.[23] A closer look at the comovement of China's and global asset prices and the repercus-

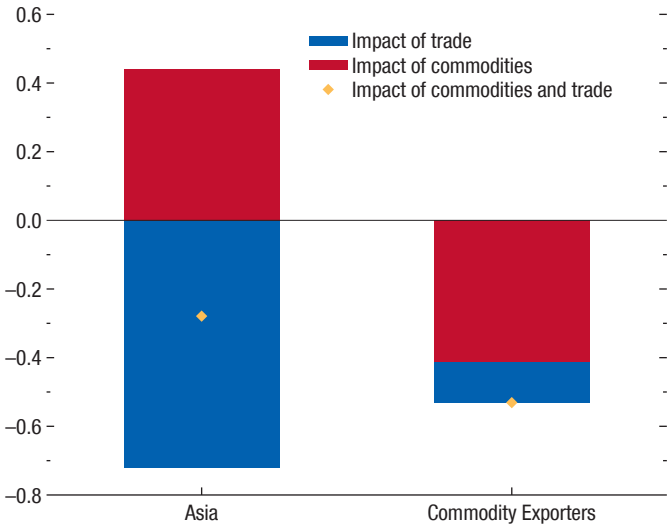
[23]See IMF 2016g.

Figure 4.10. China: Slowdown Scenario
(Percent deviation from no-slowdown baseline)



Source: Dizioli, Hunt, and Maliszewski 2016.
Note: This scenario considers a gradual slowdown in China's GDP growth over a five-year period. This slowdown is assumed to be driven by weaker productivity growth, and leaves the level of real GDP five percent lower than it would have been if no slowdown occured.

Figure 4.11. Spillovers from China
(Percent of GDP)[1]



Source: IMF staff calculations.
Note: Asia = HKG, IDN, JPN, KOR, PHL, SGP, THA; Commodity Exporters = AUS, BRA, CAN, CHL, COL, ISL, NOR, RUS, ZAF. Data labels in the figure use International Organization for Standardization (ISO) country codes. "Impact of trade" denotes the impact on exports as a percent of GDP from a 1-percent shock to Chinese final demand. "Impact of commodities" denotes the impact on exports as a percent of GDP from a change in commodity prices due to a 1-percent shock to Chinese industrial production. "Impact of commodities and trade" denotes the aggregate spillovers from trade and commodity channels.
[1]Nominal GDP; average 2011–13.

sions of policy uncertainty in China on global financial markets can shed some light on these issues.

Comovement between asset prices in China and elsewhere has strengthened. Mwase and others (2016) assess this comovement using the connectedness indicator proposed by Diebold and Yilmaz (2011).[24]

They show that comovement between stock market returns and exchange rates in China and elsewhere has increased since mid-2015 (Figure 4.12, panel 1), and that the latter are larger in economies with stronger trade links with China—notably in emerging Asia—and in commodity producing countries. The overall magnitude of comovement attributed to China has increased, although it remains relatively modest—it explains about 1 percent of the forecast error variance elsewhere, even during events over the past year.[25] This may in part be related to the inability of Diebold and Yilmaz's (2011) framework to identify structural shocks originating in China.

Developments in China—including policy uncertainty—have an impact on asset prices, particularly in emerging market economies and in countries with stronger trade links to China. Mwase and others (2016) also use a stronger identification strategy of China's shocks

[24]This indicator has also been applied, for example, to assess directional connectedness in IMF 2016d and Guimaraes-Filho and Hong 2016.

[25]To put this in context, financial market comovements attributed to China are about one-fifth the magnitude of those attributed to the United States but are similar to those attributed to Japan.

developed by Arslanalp and others (2016)—relying on information on asset prices, global developments, and China-specific news—to get further insights into China's role in driving events since early 2015. They find that adverse shocks in China reduce equity prices both in advanced and in emerging market economies, with stronger effects on countries with higher trade exposure to China (Figure 4.12, panel 2).[26] Exchange rates in emerging markets depreciate while those in advanced economies appreciate, in particular in safe haven economies. Arslanalp and others (2016) focus on Asian financial markets and also find that spillovers through financial channels are increasing and are larger for countries with greater trade exposure to China. These results, and the timing of the events, suggest that recent policy uncertainty—related to the exchange rate regime and renminbi depreciation and the policy response to a domestic-equity-market adjustment—affected asset prices elsewhere. The event study evidence is corroborated by structural vector autoregression analysis, which suggests that a decline in equity prices and weak industrial production lead to lower U.S. and emerging market economy stock valuations and weaker oil and metal prices. It also shows that adjustments in China's exchange rate have a large impact on commodity prices, equity prices, and exchange rates in emerging markets. Over the past year, market reactions to renminbi depreciations have been strong because, compared with other asset prices, adjustment in exchange rates have implications beyond financial market developments.

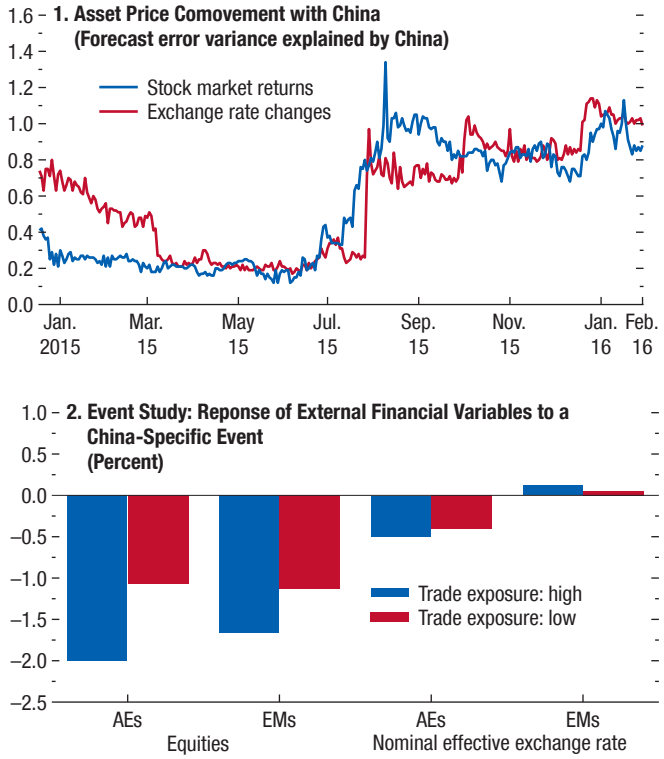
China's large foreign assets and liabilities imply that the financial channel will be more relevant in the future as the capital account opens up. China's international investment position is large, it is long on debt and short on equity, and its main assets are reserve holdings and foreign direct investment.[27] At $3.3 trillion as of June 2016, China's foreign exchange reserves represent about 30 percent of global reserves. Changes in the latter could have a material impact on the price of China's holdings, most of which are U.S. Treasury bonds, although to date there has not been a strong correlation between China's reserve accumulation and U.S. Treasury bond yields.[28] China's foreign direct investment is especially important for low-income countries in particular because it holds large investments in small emerging Asian and sub-Saharan African economies (see Box 4.1). As for liabilities, cross-border banking linkages are comparable to some Group of Seven economies. Foreign banks' claims on Chinese entities stood at less than $1 trillion as of the first quarter of 2016, declining by more than 25 percent compared with the end of 2014, and is concentrated within a few large systemically important financial institutions. Stress testing suggests that even a substantial shock from Chinese banks would not lower banking system capital below Basel III requirements in countries with exposure to China.

[26]These findings echo those of IMF 2016d.

[27]Mwase and others (2016).

[28]The recent fall in reserves—$750 billion between June 2014 and June 2016, of which about $240 billion were U.S. Treasury bonds—was met with declining yields, as they took place amid risk-off global conditions.

Figure 4.12. Transmission of Spillovers through Financial Channels

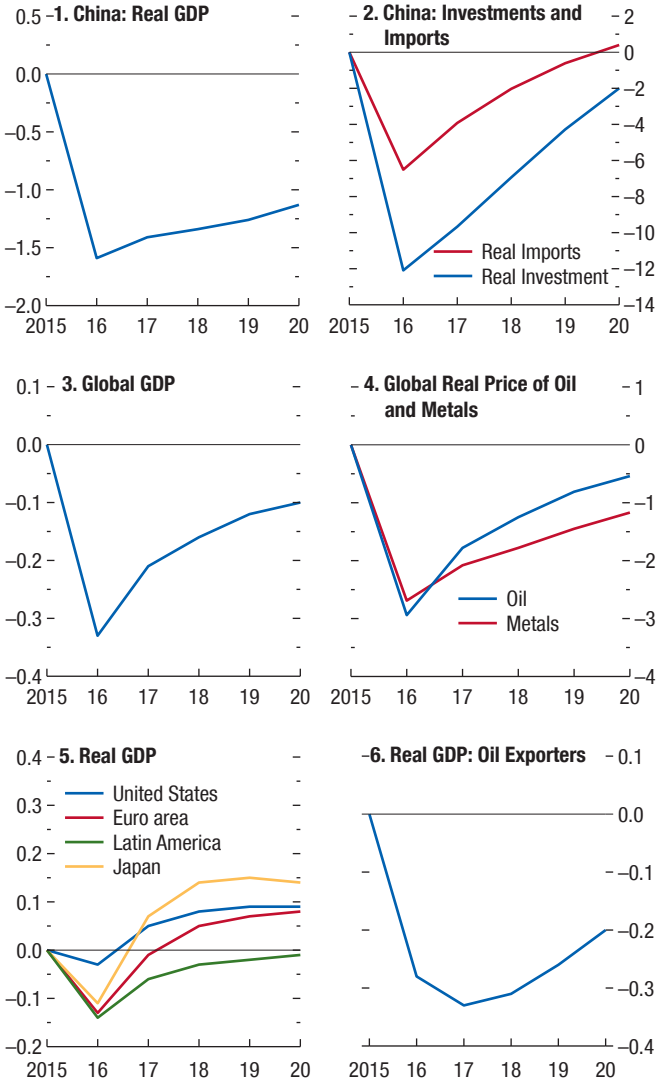


Source: Mwase and others 2016.
Note: AE = advanced economy, EM = emerging market economy.

Policy: The Importance of Managing the Transition

China's slowdown has spillover implications, but a smooth transition will benefit the global economy over the long term. Just as rapid growth in China fostered global growth in the past, the ongoing slowdown and rebalancing entail significant spillovers through trade, and a large impact on commodity prices. Spillovers

Figure 4.13. China: Cyclical Slowdown Scenario
(Percent deviation from no-slowdown baseline)



Source: Dizioli, Hunt, and Maliszewski 2016.

through these channels have become larger over time, as has the impact of events in China on asset prices elsewhere, amplifying spillovers from the real economy. Even a smooth transition will require China's trading partners to adjust to slowing demand in the short term, developing new export markets and reallocating resources away from the most affected sectors. However, a well-managed transition will reduce the risk of a disorderly adjustment with larger spillovers and ensure more sustainable growth with potential gains for the global economy. Sustaining progress on reforms and tackling vulnerabilities will reduce downward risks, which can boost sentiment and lift investment in trading partners. China's announced capacity reductions in coal and steel production, if implemented, could have a sizable effect on global markets. Moreover, some elements of China's rebalancing—such as its move up the value chain and the prospective boost to domestic consumption growth in the years ahead—will create opportunities for some economies, notably in emerging Asia, and the increase in services trade and China's investment abroad are likely to produce short-term benefits for some countries.[29]

In contrast, a bumpy or incomplete transition may exacerbate spillovers. Policy uncertainty since mid-2015 highlights growing challenges to management of China's slowdown in a highly leveraged economy and may give rise to a disruptive transition. Dizioli, Hunt, and Maliszewski (2016) build a scenario in which a reassessment of risk in China illustrates the possible costs of such a transition (Figure 4.13).[30] A decline in asset prices by 10 percent and an increase in the corporate risk premium by 150 basis points during the first year would reduce investment and private consumption in China by about 10 percent and 2.5 percent, respectively, and real GDP by about 1.5 percent. Despite some offset from lower commodity prices, spillovers would be uniformly negative, and worse than those on the global economy under a smooth transition.

This highlights the benefits of a transition in which China strengthens transparency—especially in communicating policy objectives—and accepts lower growth. Clear communication of policy intentions, including further steps to move toward a floating exchange rate regime, are of the essence. Policy uncertainty and financial sector risk may trigger large adjustments in equity prices and exchange rates, which are destabilizing for global growth. Accepting lower growth entails keeping credit growth in check by tackling its root causes—notably, the pursuit of unsustainably high growth targets—and can produce higher and better-quality growth in the long term. A comprehensive plan to address vulnerabilities in the financial sector is needed, including restructuring or resolving weak firms, requiring banks to recognize and manage impaired assets and

[29]For a discussion on short-term costs and long-term gains of China's transition, see IMF 2016f and Hong and others 2016.

[30]This exercise can be thought as one in which China does not rebalance, only to suffer a larger fall in activity later. The reassessment of risk in China would be related to a continued building of vulnerabilities in the financial sector due to rapid credit growth. An explicit risk scenario without reforms in the short term and a larger fall in activity over the medium term is shown in IMF 2015g.

boosting their buffers, hardening budget constraints by reducing access to credit of weak firms, creating a more market-based system to resolve distressed debt, reining in shadow bank and product risks, and dampening excessive housing price growth. On the fiscal front, the large deficit should be reduced over the medium-term to ensure debt sustainability. Temporary, targeted, on-budget, proconsumption fiscal stimulus can be used if growth threatens to fall excessively. Off-budget public investment should be scaled down.

As for recipient economies, efforts to boost trade and integrate them into value chains are called for, as are structural reforms to foster growth or change existing growth models. Policy responses will depend on countries' circumstances—and, in particular, their trade links with China and their export mix. More specifically,

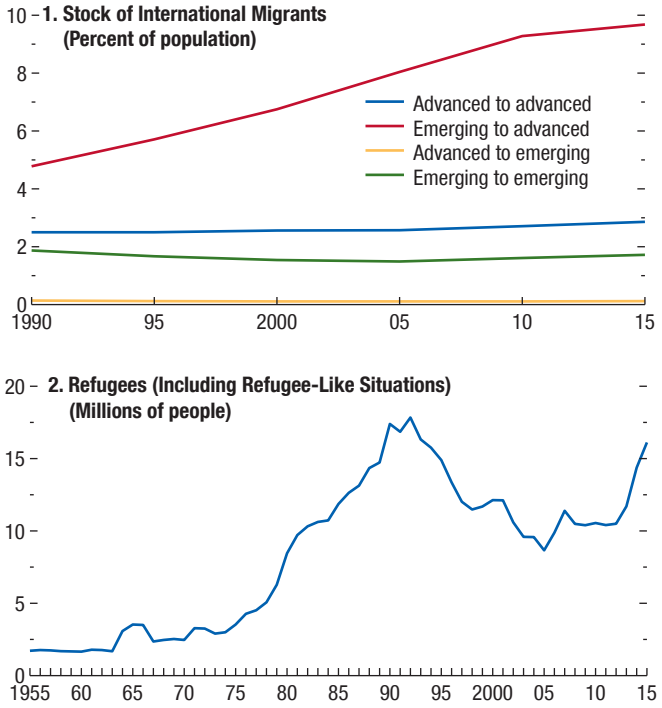
- In countries with significant trade links to China—while available policy space and exchange rate flexibility should be used to cushion the negative impact of weaker external demand—adjustment is needed to permanently lower demand from China. Achieving this goal may imply a reduction in domestic absorption with a possible depreciation of the real exchange rate unless alternative exports markets can be developed (see below).
- Global and regional agreements can bolster trade. These also provide opportunities to push the frontier on such issues as services and regulatory cooperation, and foreign direct investment policies, which can boost efficiency and productivity through greater investment, technology transfer, and integration into global value chains. But it is also important to move ahead with an ambitious agenda in the World Trade Organization, and to leverage its unique reach and well-developed legal and institutional structure to help ensure coherence across the global trading system. Flexible negotiation approaches should allow for different speeds and depths of liberalization among countries.
- Because commodity prices are likely to remain low as a result of weaker demand from China, commodity exporters should use buffers where available, but also plan for adjustment, including through reduced and more efficient public expenditures and stronger fiscal frameworks, and the mobilization of new revenue sources. Some countries may also need to pursue new growth models. Commodity importers stand to benefit from lower prices; the appropriate use of windfall savings in these countries would depend on their cyclical and fiscal positions.
- China's transition creates an opportunity for low-wage, labor-rich countries to increase their production of labor-intensive goods, as well as for producers of consumption goods. To support such an increase, sound structural policies are important, including improvements in infrastructure, governance, the business climate, and trade openness.

From a global perspective, protectionist policies must be avoided, as these would be detrimental to trade over the long term. Spillovers from China's transition may prompt countries to pursue trade restrictions to protect domestic producers against weaker external demand or perceptions that China is contributing to oversupply in some markets. Such protectionist measures—not necessarily in response to developments in China—have likely played some role in depressing global trade over recent years, and could deter it over the long term. In the past, legal commitments, Group of Twenty pledges, and the recognition of potential economic damage from trade restrictions have discouraged countries from imposing new restrictions, particularly during the global financial crisis. Global leadership and a collective effort should promote trade agreements that would counteract movement toward protectionism. Moreover, trade reforms can complement other reforms in goods and services markets as they boost productivity by enhancing efficiency, promoting competition, and encouraging innovation and adoption of existing technologies.

The Challenges and Opportunities of Migration

Geopolitical conflicts and economic disparity are contributing to large migration flows with far-reaching social and economic repercussions and, especially in the case of refugees, humanitarian issues. Migration may stir social tensions and provoke a political backlash in recipient economies, but past experience suggests it may also offer gains in terms of higher growth, productivity, and relief from population aging. Swift labor market integration is key to harnessing the gains in terms of growth, increasing the contribution of migrants to the fiscal accounts, and reducing tensions. In source countries, migration can take a toll on long-term growth prospects as the young and the educated population leave, which can be mitigated by remittances. Depending on the underlying drivers of migration, source countries need policies to address brain drain and maximize the benefits from remit-

Figure 4.14. International Migrants and Refugees



Sources: United Nations High Commissioner for Refugees; and IMF staff calculations.

tances and diaspora networks. Global cooperation is needed to address humanitarian issues.

Trends, Drivers, and Challenges of Migration

Migration has risen steadily over recent decades. The stock of international migrants increased from 150 million in 1990 to 250 million in 2015.[31] While the number of migrants between emerging market economies is the largest, it comprises a small and stable proportion of their population—about 2 percent. Migration from emerging to advanced economies has been larger in relative terms and more dynamic: the share of migrants in the population of host countries almost doubled from about 5 percent to 10 percent between 1990 and 2015 (Figure 4.14, panel 1), with significant country differences. In 2015, migrants represented about 5 percent of the population in Finland and about 30 percent in Australia. There are two types of migrants: economic (voluntary, in search of better prospects) and humanitarian (refugees, escaping conflict and strife).

[31]This number and the analysis in the chapter exclude illegal migration.

The stock of international migration is dominated by economic migrants, but the recent surge in refugees has raised their number close to record levels. Economic migrants constitute almost 95 percent of the total stock of migrants, and they appear to be on a stable and increasing rise, whereas refugees represent a relatively small share, but their numbers have been volatile. The recent civil war in Syria and unrest throughout the Middle East have raised the number of refugees to the highest level since the 1990s (Figure 4.14, panel 2). The flow of new refugees surged in 2014–15, reaching 4.5 million—about half of the flows of total migration over those years. Jordan, Lebanon, and Turkey were the main recipients, hosting about 2.2 million new refugees over the same period. The European Union also received an unparalleled number of refugees recently—about 1.25 million first-time asylum applications were submitted in 2015, and applications continued to increase in 2016, although at a decreasing rate.

Total international migration is dominated by people of working age but, among refugees, the number of children is much larger. More than 70 percent of the stock of migrants is in the 20–64 age group (Figure 4.15, panel 1). In fact, migrants represent a significant share of the labor force in many advanced economies. Their presence increases the working age population and reduces dependency ratios; in some countries, they have contributed about half of the growth in the working-age population between 1990 and 2010 (Figure 4.15, panel 2). The stock of refugees has a stronger presence of children; in 2015, for instance, more than half of refugees were under the age of 18.

Increasingly, migrants to advanced economies have high- and medium-level skills, although the number of low-skill migrants is still higher compared with the latter.[32] By 2010, high-skilled migrants constituted about 6 percent of the population across advanced economies—up from 2 percent in the 1990s—while medium- and low-skilled migrants represented about 4 percent and 5 percent, respectively (Figure 4.15, panel 3). This likely reflects in part the global rise in educational attainment over the past decades. Skill-based immigration policies, particularly in some Anglo-Saxon countries, which tend to have a larger proportion of high-skilled migrants, may have played a role as well. The share of migrants with low-skills in continen-

[32]The skill level refers to education level: higher than high-school leaving certificate or equivalent (high-skilled); high-school leaving certificate or equivalent (medium-skilled); primary or no schooling (low-skilled).

tal Europe and medium-skills in Nordic countries (Denmark, Finland, Norway, and Sweden) remains relatively high—although skill levels of migrants have been on the rise there as well.

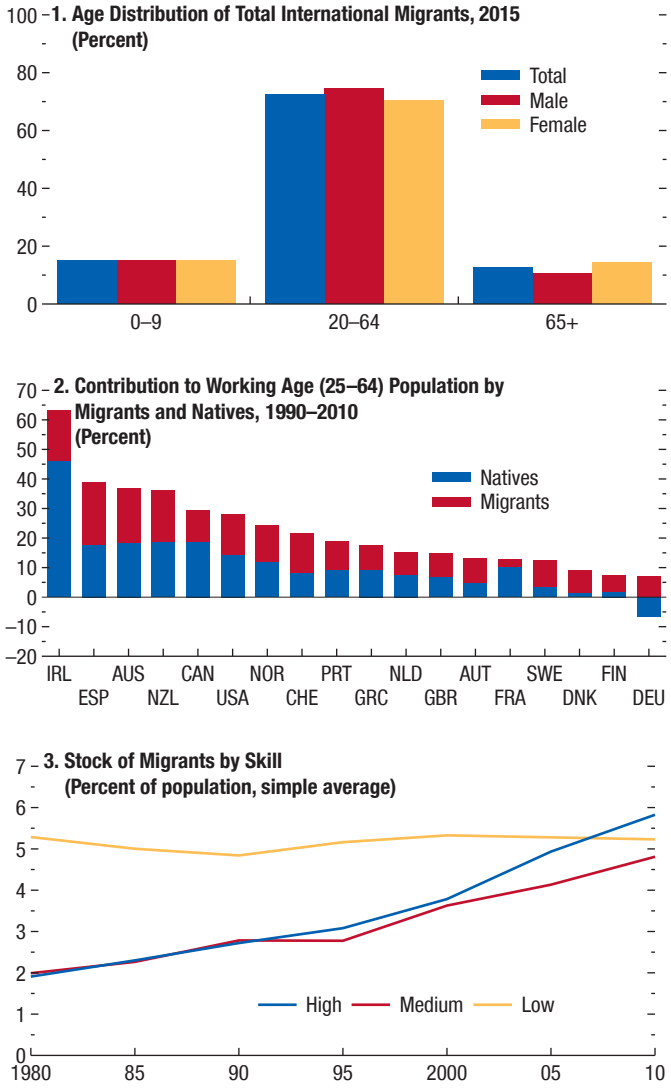
Migration is shaped by a combination of social and economic conditions at home and abroad, raising difficult humanitarian issues and potential tensions in recipient countries. Refugee flows are driven by the need to flee violence and persecution, leaving people no choice but to leave their homes amid political instability and conflicts. As for economic migration, a number of factors are at play. Lack of opportunities and deteriorating economic conditions in source countries can push migrants to greener pastures abroad. Pull factors in recipient economies are more complex and determine not only the extent of migration but also its distribution among host countries (Jaumotte, Koloskova, and Saxena 2016). First, economic conditions in recipient economies are critical. There is a positive association between long-term real GDP per capita growth and the change in the share of migrants (Figure 4.16, panel 1). Second, some structural factors matter. For migrants, the choice to move entails important geographic and cultural factors, such as distance to destination countries, common language, contiguous borders, and common colonial links (Figure 4.16, panel 2). Third, immigration policies in host countries affect migration flows. Reforms that tighten entry laws reduce migration flows, while less restrictive laws—as a result of signing the Maastricht treaty, for example—have the opposite effect (see Ortega and Peri 2009). Despite the opportunities associated with migration, it also poses challenges for both sending and recipient countries, mainly the loss of human capital in the former and potential social tensions with political consequences in the latter.

Recipient Countries: Challenges and Long-Term Gains

International migration is both a boon and a challenge for host countries. Migrants can boost the labor force and have a positive impact on growth and public finances over the long term, especially in countries with aging populations. However, receiving migrants poses challenges. There are concerns about displacement of native workers and short-term fiscal costs, especially in the case of refugees. This can add to possible social tensions related to differences in culture and language—given the compositional effects that migration may have on the population—and security related incidents in some countries.[33] These tensions may prompt a political backlash, as demonstrated by the referendum in the United Kingdom on European Union membership, in which migration played a role.

The speed of integration is key. Past experience suggests that swift integration into labor markets is critical to harness the economic gains from migration, both in

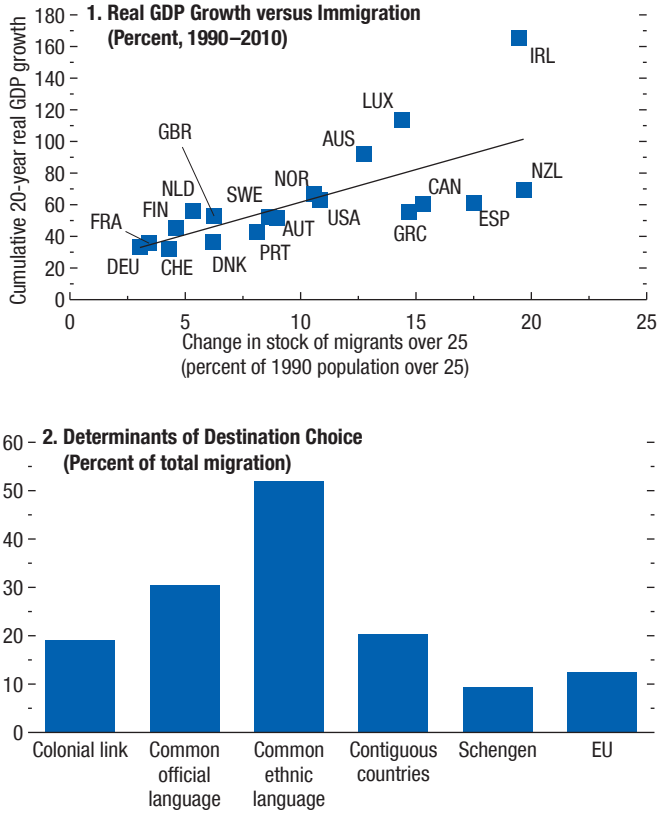
Figure 4.15. Migration by Age and Skill



Sources: IAB; United Nations Department of Economic and Social Affairs, Population Division 2015 and *World Population Prospects* 2015 Revision; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

[33]See Card, Dustmann and Preston 2009, who show that people have stronger concerns about migration than trade.

Figure 4.16. Determinants of Migration



Sources: CEPII database; United Nations Global Migration database; and IMF staff calculations.
Note: The numbers are based on total stocks of migrants between all origin and 18 destination countries, that share the listed characteristics. The numbers are expressed as a percent of the total stock of migrants in 18 destination countries. Schengen = Schengen area countries that allow free movement of their citizens across their borders. Data labels in the figure use International Organization for Standardization (ISO) country codes.

the short and the long term. It can also speed up the positive impact on fiscal accounts, bolstering positive spillovers in recipient economies. Arguably, swift economic integration can accelerate and deepen social integration, with positive feedback effects between the two, although it may create tensions in the short term as well, especially when unemployment is high.

Labor Markets: The Central Role of Integration

The impact of migration on labor markets depends on complementarity between migrants and native workers. In principle, migrants with skills similar to those of natives would compete with them in the labor market and affect employment and wages, especially in the short term—before the capital stock adjusts to more labor. However, if migrants' skills complement those of native workers, the impact could be positive (Aiyar and others 2016). This may be relevant, for instance, in a number of countries where labor market participation of highly-skilled native women tends to be greater when there are lower-skilled female labor migrants (Jaumotte, Koloskova, and Saxena 2016, see Figure 4.17). The availability of relatively low-cost workers in the services or health care sector may allow high-skilled women to enter the labor force or work longer hours, increasing productivity.

Past experience suggests that migration has little effect on employment rates and average wages of native workers, although it may have an impact in certain labor market segments. Most of the academic literature suggests that the impact of migration on average wages or employment of native workers is very limited.[34] Instead, the literature suggests that migrants can contribute to labor markets through the complementarities just mentioned, which allow for: (1) natives to move into different segments of labor markets, often performing more complex tasks that promote skill upgrading and hence foster efficient specialization; (2) an increase in female labor market participation; (3) more efficient market functioning, with migrants filling up occupations for which natives are in short supply; (4) contributions of high-skilled migrants to technological progress; and (5) an increase in demand, which is likely to boost consumption in the short term and investment over the medium term.[35] Some studies, though, find a negative impact on wages of low-skilled workers.[36]

The labor market performance of migrants themselves suggests that labor market integration is complex. Aiyar and others (2016) find that migrants have lower participation, employment rates, and wages than natives in advanced economies (Figure 4.18, panel 1). The earnings and employment gaps are pronounced in the initial years and fall as migrants gain language proficiency and obtain more relevant job experience—migrants from

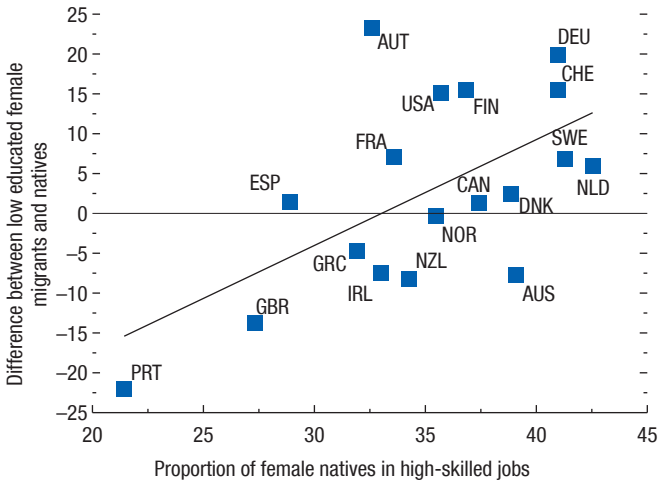
[34]See Peri 2014a, 2014b for a survey of studies on the impact of immigration on employment and wages of native workers. See also IMF 2015c and Aiyar and others 2016, and references therein. Some case studies have also found no significant impact of migration on labor markets for natives, for example Card 1990 for the Mariel boatlift in early 1980; and Akgunduz, van den Berg, and Hassink 2015, for the impact of the recent flow of Syrian refugees into Turkey.

[35]See, for example, Alesina, Harnoss, and Rapoport 2013; Cattaneo, Fiorio, and Peri 2015; D'Amuri and Peri 2014; Farré, González, and Ortega 2011; Hunt and Gauthier-Loiselle 2010; Ortega and Peri 2014; Peri, Shih, and Sparber 2014; and Peri and Sparber 2009.

[36]Borjas (2003, 2006) and Aydemir and Borjas (2007, 2011) document a negative impact on low-skilled natives' wages in the U.S. labor market.

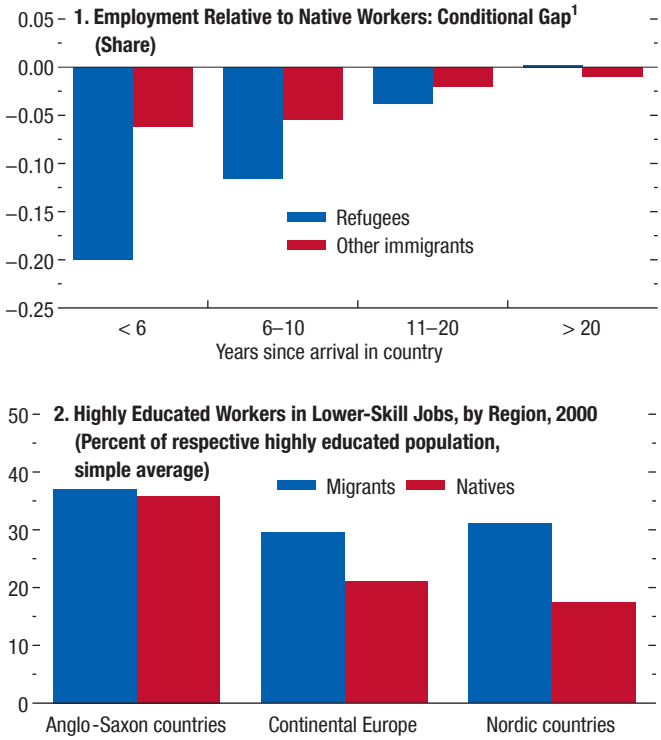
Figure 4.17. Females: Low Education versus High Skilled, 2000

(Percent of total)



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

Figure 4.18. Labor Market Performance



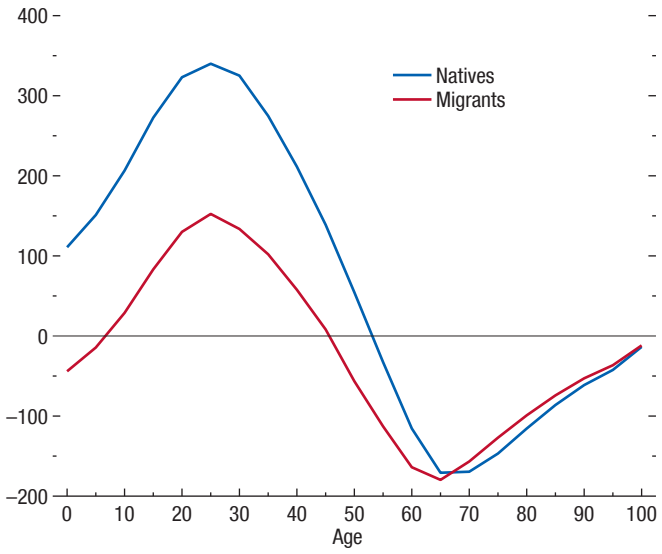
Sources: European Social Survey, Rounds 1–6; Organisation for Economic Co-operation and Development; and IMF staff calculations.
[1]Conditional gap measures the difference in the relevant outcome between natives and immigrants; depending on age, sex, years of education, language skills, host country, and time period.

advanced economies or with better initial language skills often do better than other groups. Challenges for female migrants and refugees seem to be particularly acute; their labor market outcomes are worse, especially in the short term (Aldén and Hammarstedt 2014; Ott 2013). The challenges at play include:

- *Skill recognition*—Migrants tend to be underrepresented in high-skill jobs and over-represented in low-skill jobs.[37] This may be in part justified by differences in education—for instance, a degree in the country of origin may not be of the same quality as one in host countries—but it may also reflect policies, a lack of recognition of skills, or disadvantages linked to cultural differences. These translate into a missed opportunity for the host country. For example, benchmarking against natives, continental European and Nordic countries have a higher proportion of highly educated migrants employed in lower-skill occupations than other countries. In contrast, the opportunities for highly educated migrants and natives tend to be similar in Anglo-Saxon countries (Figure 4.18, panel 2).
- *Labor market regulations*—Excessive employment protection or high taxes and social security contributions can take a toll on employment, in particular for workers whose productivity is a priori uncertain (see, for example, Blanchard, Jaumotte, and Loungani 2013). Employment rates for migrants are higher in countries with low entry-level wages and less employment protection (Ho and Shirono 2015).
- *Additional challenges for refugees*—Uncertainty about refugees' legal status—the acceptance of their application for asylum—can delay their labor market entry. While their applications are being considered, asylum seekers often face legal barriers to employment (Hatton 2013) and, in European countries, application processing may take from two months to a year. Finally, given that migration drivers for refugees are less determined by pull factors—such as high growth in the host country—arrival in an environment of high unemployment may lower their employment rates and wages for a prolonged period (Äslund and Rooth 2007),

[37]See, for example, Aleksynska and Tritah 2013 for occupation-educational mismatch of immigrants in Europe.

Figure 4.19. Germany: Present Value of Expected Future Net Fiscal Contribution by Age Group
(Thousands of euros, based on generational account approach; base year = 2012)



Source: Bonin 2014.

highlighting the importance of the phase of the business cycle in the integration process.

Migration and Fiscal Challenges

Labor market integration also plays a critical role in the fiscal impact in recipient economies. Over time, given their impact on the working-age population and economic activity, migrants can generate additional tax revenues and social contributions. But integration takes time, especially in the case of refugees, which means there will be a delay before they begin making a fiscal contribution. In the short term, they may need recourse to welfare services and claim social benefits—notably, healthcare and social assistance. Migration may also affect natives' use of fiscal resources to the extent that the presence of migrants increases natives' unemployment rate or lowers their wages.[38] The impact of migration on fiscal accounts depends not only on migrants' income, but also on the generosity of the social security system in host economies.

Over their lifetime, migrants tend to contribute less than natives to the fiscal accounts, mainly because they pay less in taxes and social security payments. This points again to the importance of their integration into labor markets—their smaller contributions reflect less time in the labor force and lower-paying jobs.[39] Migrants depend more on some social transfers, but differences between them and natives do not seem to have large budgetary implications. Relative to unemployed native-borns, unemployed migrants are more likely to receive social assistance, but less likely to receive generally more generous unemployment benefits. The case of Germany illustrates that both natives and migrants have an increasing contribution as they approach working-age, which diminishes during retirement (Figure 4.19)—the contribution of migrants, though, tends to become positive later, peak at a lower level, and turn negative at an earlier stage (see Aiyar and others 2016 and IMF 2015c).

Past experience suggests that the net fiscal impact of migrants is small for OECD countries. Estimates depend critically on a number of assumptions—notably the many elements that determine the employment prospects of migrants (as noted above), their age profile, and how the analytical approach takes into account the dynamic macroeconomic effects of migration. OECD (2013) presents a cross-country study based on a static accounting (cash flow) model that assesses the tax and social security contributions as well as receipt of social security benefits and government services of the stock of migrants in 27 OECD countries between 2007 and 2009. The impact, either positive or negative, rarely exceeds 0.5 percent of GDP in a given year and is about zero on average. There is a positive fiscal impact in 19 countries—that is, 70 percent of the sample of countries.

Higher short-term costs of caring for refugees, however, could add fiscal pressure in recipient economies. On arrival, refugees receive housing, subsistence, and integration support. Moreover, as noted above, they are often not allowed to work until their legal status is cleared. This lowers their short-term fiscal contribution relative to that of other migrants and natives. Less developed countries have typically shouldered the largest burden associated with refugees—for instance,

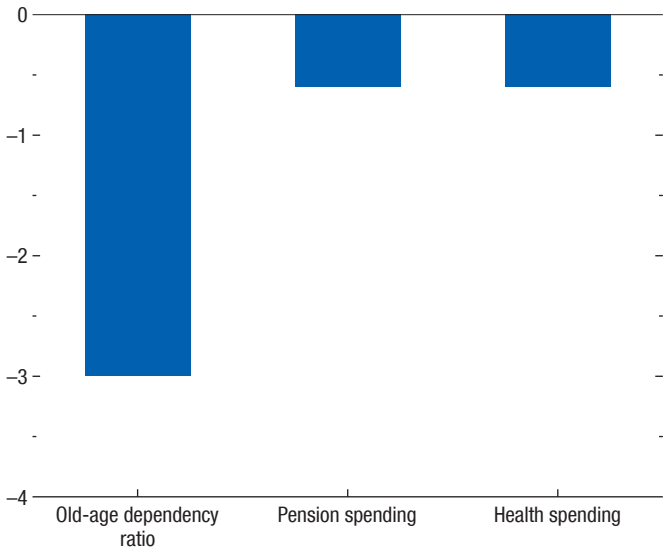
[38]As discussed, most of the literature suggests that such effects are small. These effects could also be mitigated if migration increases the income from capital accruing to natives (Borjas 1999). Conde Ruiz, Ramón Garcia, and Navarro 2008 document such effects for Spain in the early 2000s.

[39]This also explains the rationale of labor migration management systems. In the Australian system, for example, age has a strong weight—up to 38 percent of the pass mark—and there are maximum-age thresholds for admission.

in Jordan, Lebanon, and Turkey, spending on refugees is estimated at 2.4 percent, 3.2 percent, and 1.3 percent of GDP, respectively, during the recent surge.[40] But this is also relevant for many European countries, which have relatively generous welfare systems and a significant number of humanitarian migrants. IMF staff estimates for the euro area suggest that average budgetary expenditures on refugees could reach 0.2 percent of GDP in 2016, with Austria, Finland, Germany, and Sweden expected to shoulder the largest spending increases. For Sweden, expenditure on migration is expected to be 1 percent of GDP in 2016.

Over the longer term, migration has the potential to reduce fiscal pressure related to population aging in recipient countries (Figure 4.20). For example, continued migration in line with current trends could slow the expected increase in the old-age dependency ratio and associated health care and pension spending relative to GDP (Clements and others 2015; European Commission 2015). These effects will be larger, the larger the impact of migration on GDP growth. Migration cannot fully address challenges from population aging, but it can provide time to phase in entitlement and other reforms, which are still necessary in many countries.

Figure 4.20. Estimated Impact of Migration in More Developed Economies, 2100
(Percent of GDP)



Source: Clements and others 2015.
Note: The impact of migration is calculated as the difference between the baseline scenario, which assumes the continuation of current migration trends, and the zero migration scenario.

Positive Growth Effects over the Longer Term

Migration can boost aggregate income in recipient countries over the long term. It can do so through several channels. First, by expanding the labor force, migration can boost capital accumulation and labor productivity. Second, properly integrated into labor markets, migrants can increase the employment-to-population ratio. Finally, migrants can foster labor productivity through complementarities with native workers and by increasing diversity in productive skills. This section explores the impact of migration on output per capita over the long term.

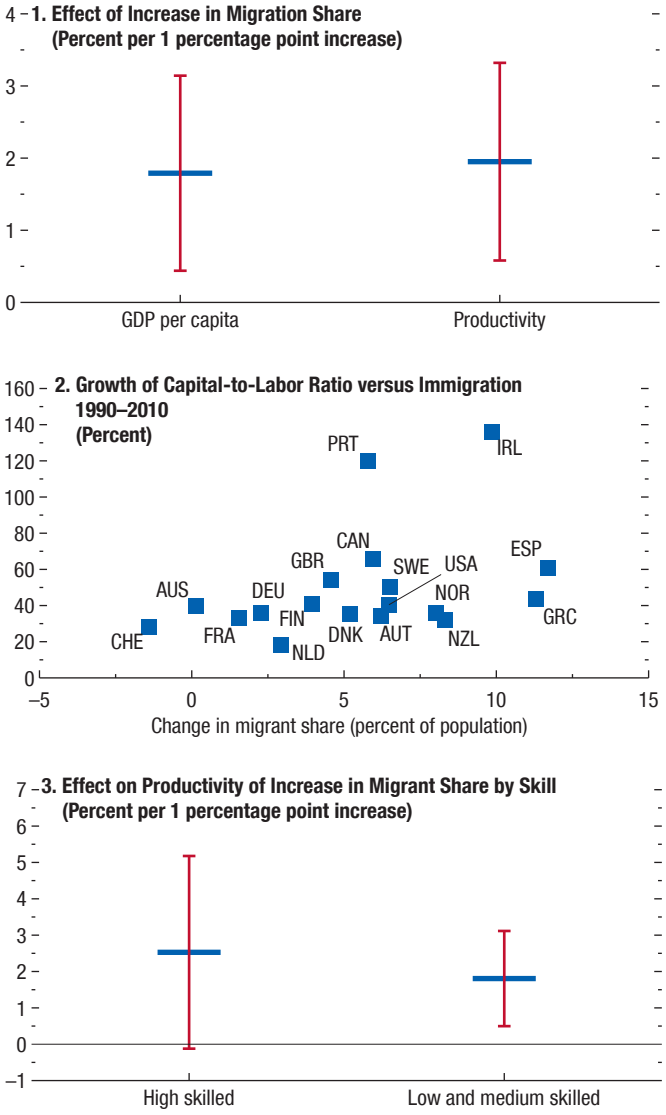
Past experience suggests that migration could indeed have a positive impact on output per capita in host countries. While much of the literature on migration is microeconomic and focuses on employment, innovation, or productivity, some studies have analyzed the macro relevance of these channels. But such analysis is complicated by the fact that some of the pull factors driving migration can bias the findings—for example, if migrants settle in countries experiencing high GDP growth, it would be easy to conclude that migration is "causing" that growth. To circumvent this complication, Alesina, Harnoss, and Rapoport (2013) and Ortega and Peri (2014) use a gravity model to disentangle the effects of migration driven by push factors. In a cross-sectional setting, they find a large positive impact of migrants on output per capita in recipient countries. They relate this to a positive impact on employment, capital accumulation, and labor productivity from high-skilled migrants, which not only increases productivity on its own, but also fosters diversity in the labor force.

Recent research suggests that migration improves GDP per capita in host countries by boosting investment and increasing labor productivity. Jaumotte, Koloskova, and Saxena (2016) estimate that a 1 percentage point increase in the share of migrants in the working-age population can raise GDP per capita over the long term by up to 2 percent (Figure 4.21, panel 1).[41] While this impact is somewhat lower than previous estimates, it is economically significant. Decomposing these estimates into the effect on employment and on labor productivity, they find that migration has a positive and

[40]IMF 2015d, IMF 2015e, IMF 2016h.

[41]To address endogeneity issues, the study uses a pseudo-gravity model to estimate migration caused by push factors from source countries, such as socioeconomic and political conditions, and by bilateral costs of migration, factors that are largely independent of host countries' income levels.

Figure 4.21. Migration: Positive Longer-Term Growth Effects



Sources: Jaumotte, Koloskova, and Saxena 2016; Organisation for Economic Co-operation and Development; United Nations Global Migration database; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. Red lines indicate 95 percent confidence interval.

significant impact on labor productivity.[42] In addition, they find no relationship between the long-term growth in the capital-to-labor ratio and the change in the stock of migrants, consistent with investment adjusting over time to a larger pool of potential workers (Figure 4.21, panel 2). Moreover, the impact is distributed evenly across income groups—that is, migration has a positive effect on the incomes of both the top earners and of those of the rest of the population, although the impact of high-skilled migrants is larger for top earners.

Both high- and low-skilled migrants increase productivity. High-skilled migrants are likely to have a larger impact on GDP per capita through their larger impact on productivity. However, lower-skilled migrants may also increase productivity if their skills are complementary to those of natives. Jaumotte, Koloskova, and Saxena (2016) find that both high- and low-skilled migrants have a positive impact on productivity of a similar magnitude (Figure 4.21, panel 3). They attribute this finding to the "over-qualification of migrants"—as noted above, some countries show a higher proportion of highly educated migrants employed in lower-skill occupations—and to the complementarities mentioned previously. Low-skilled workers allow higher-skilled natives to move into different labor market segments, encouraging them to take higher-skill jobs and obtain additional education. They also promote female labor force participation by taking housekeeping and childcare jobs. This interpretation is supported by evidence on the relationship between low-skilled migrants and female labor participation presented earlier in this chapter. Farré, González, and Ortega (2011) come to a similar conclusion in the case of Spain.

Source Countries: Costs and Mitigating Factors

Migration may impose significant costs in source countries, although there are some mitigating factors. Although push factors for migration can differ—from conflicts (for example, in the Middle East; see Box 4.2) to differences in the economic outlook, such as in eastern Europe during the past decade—the repercussions for source countries are similar. Migration can take a toll on population growth, which is especially costly when migrants are young and educated—usually referred as brain drain—damaging prospects for long-term growth. It may also affect the fiscal accounts and increase the challenges posed by population aging. These costs, though, could be mitigated by migrants' remittances, which can increase household income and potentially foster investment. And migrants may facilitate knowledge transfer between host and source countries, which ultimately could promote trade, investment, and growth.

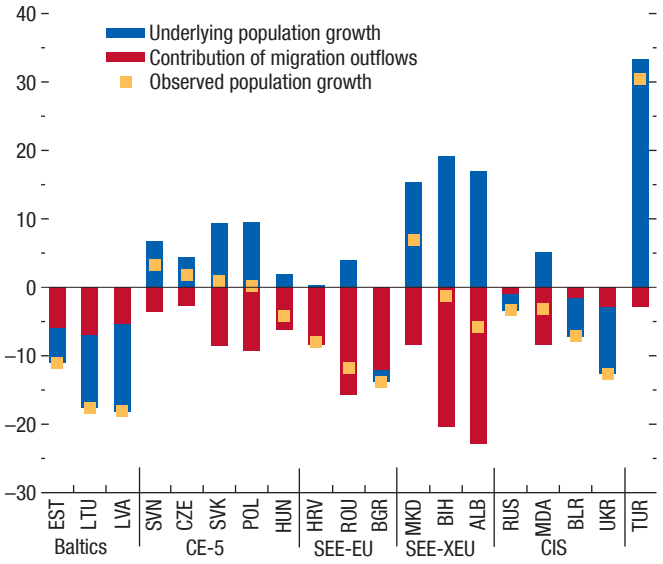
[42]While these results apply to the panel estimation, labor markets issues and the skill composition of the migrant population vis-à-vis the natives can play a role. For instance, a sudden large increase in the employment of low-skilled immigrants in low productivity sectors—as, for example, during the pre-crisis boom in Spain—can have a negative impact on aggregate labor productivity (see Kangasniemi and others 2012).

Costs of Brain Drain

While a natural response to demographic trends in some countries, migration may dent population growth in others. Some examples can illustrate these differences:

- Rapid emigration from sub-Saharan Africa has been associated with an ongoing demographic transition involving strong growth in the working-age population. This migration—which is set to continue in coming years—represents a shift in the labor force from countries with young populations to those with aging ones, and should help smooth asynchronous demographic patterns across economies (see Box 4.3).
- However, migration has taken a toll on demographic trends in other regions. For example, Caribbean countries lost between 7 percent and 27 percent of their labor force to the United States in 1965–2000 (Mishra 2006). Since the collapse of the Soviet Union Georgia's and Armenia's populations have contracted by 15 and 27 percent, respectively. In central, eastern, and southeastern Europe, about 5.5 percent of the population left the region during the past 25 years—southeastern European countries have witnessed cumulative outward migration of more than 8 percentage points between 1990 and 2012. Local populations in most countries in the central, eastern, and southeastern Europe have been stagnant or shrinking; the Baltics and Commonwealth of Independent States countries show similar trends (Figure 4.22).

Figure 4.22. Contributions of Outward Migration to Population Growth
(Percent change from 1993 to 2012)



Sources: Organisation for Economic Co-operation and Development, International Migration database; World Bank, *World Development Indicators;* and IMF staff calculations.
Note: Baltics = EST, LTU, LVA; CE-5 = CZE, HUN, POL, SVK, SVN; SEE-EU = Southeast Europe EU members; SEE-XEU = Southeast Europe Non-EU members; CIS = Commonwealth of Independent States.
Data labels in the figure use International Organization for Standardization (ISO) country codes.

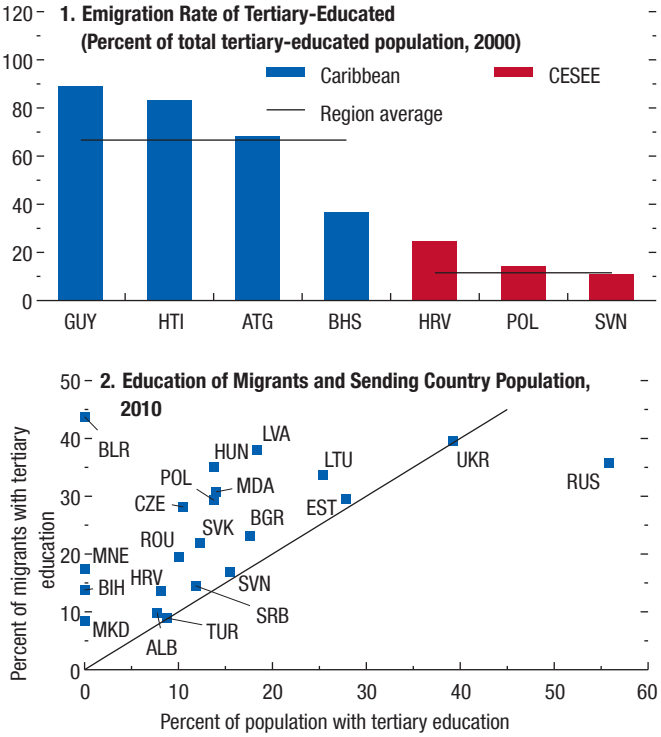
The migration of young and high-skilled people, known as brain drain, can result in significant losses of human capital. High-skilled people are more likely to migrate than others—they tend to have more resources to relocate and find more favorable conditions in recipient countries.[43] As a result, migration has had a substantial impact on the high-skilled labor force for some countries and regions (Figure 4.23, panel 1). For instance, Caribbean countries lost more than 50 percent of their high-skilled workers between 1965 and 2000 (see Mishra, 2006). Atoyan and others (2016) find that, for central, eastern, and southeastern European countries, several decades of migration have exacerbated the shortage of skilled labor. They show that the share of migrants with tertiary education in such countries as the Czech Republic, Hungary, Latvia, and Poland was well above the equivalent ratio in the general population (Figure 4.23, panel 2).

Brain drain can have profound effects on labor markets and growth prospects in sending countries. Migration dampens working-age population growth and can put upward pressure on wages, as documented in Mishra (2014) in a number of national case studies.[44] At the same time, it can have a negative impact on productivity. Low substitutability between skilled migrants and natives reduces labor productivity, which is compounded by the fact that more educated people usually transfer know-how to others. Atoyan and others (2016) conduct a counterfactual analysis suggesting that cumulative real labor productivity growth in central, eastern, and southeastern European countries between 1995 and 2012 might have been about 5 per-

[43]For instance, Atoyan and others (2016) show that in 2010, about three-quarters of migrants in central, eastern, and southeastern European countries were of working age and younger and better educated that the population at large.

[44]Depending on the skill level of migrants, migration can also change relative wages—if migrants are more educated, a decrease in the supply of high-skilled labor can increase the wage gap between high-and low-skill workers. Mishra (2007) finds some evidence of this in the case of Mexico, where emigration has the greatest impact on wages of workers with 12–15 years of schooling.

Figure 4.23. Migration of Population with Tertiary Education



Sources: Organisation for Economic Co-operation and Development, Database on Immigrants in OECD Countries 2010; World Bank, *World Development Indicators;* and IMF staff calculations.
Note: CESEE = central and southeastern Europe. Data labels in the figure use International Organization for Standardization (ISO) country codes.

centage points higher in the absence of migration. As a consequence, these countries witnessed lower GDP growth not only on account of migration-induced loss of labor but also because of worsening skill composition. Arguably, this has lessened the prospects for income convergence in emerging Europe.

Finally, migration can also affect fiscal accounts. Atoyan and others (2016) argue that emigration has no significant impact on public debt but has led to larger government relative to GDP in central, eastern, and southeastern European countries. This is because labor outflows tend to dampen tax revenue more than they reduce spending. Because migrants are mostly young, health care and pension spending tend to be little affected, which forces governments to increase tax rates or find additional revenue sources.[45] Some case studies have documented that emigration has a negative impact on fiscal accounts, to a great extent associated with lower revenue.[46]

Remittances and Diasporas

Remittances provide a source of income for a number of small migration source countries, notably for poor households. Remittances to developing countries reached $450 billion in 2015, more than half of foreign direct investment inflows (Figure 4.24, panel 1). For some small countries, remittances can reach over 25 percent of GDP (for example, Tajikistan, Nepal, and Moldova). Caribbean countries provide a clear example of the importance of remittances: after losing a significant portion of their labor force over the past decades, they are now the world's largest recipient of remittances as a percent of GDP as a region—about 7½ percent of the region's GDP in 2015. This can make a significant contribution to poor households' income. A cross-country study of 71 emerging market and developing economies by Adams and Page (2005) has found that a 10 percent increase in remittances per capita leads to a 3.5 percent decline in the share of people living in poverty. Remittances have been shown to increase education and health care spending relative to consumption as well (Ratha 2014).[47]

Remittances may also have macroeconomic effects. As a source of financing, remittances can contribute to investment, financial development, and growth by increasing domestic savings and easing credit constraints. For eastern Europe, Atoyan and others (2016) find a positive impact on private investment, suggesting that remittances ease collateral constraints and lending costs for entrepreneurs. Goschin (2013) also finds a positive impact on growth in central and eastern Europe in 1995–2011. But remittances may have adverse effects on labor markets and exchange rates as well. Atoyan and others (2016) argue that remittances reduce incentives to work due to a relaxation of the budget constraint and an increase in the reservation wage.[48] Remittance flows can also lead to real appre-

[45]See Gibson and McKenzie 2012 on revenue issues, and Clements and others 2015 on pension and health care spending.

[46]See Campos-Vazquez and Sobarzo 2012 for the case of Mexico; Desai, Kapur, and Rogers 2009 for India; and Gibson and McKenzie 2012 for Ghana, Micronesia, New Zealand, Papua New Guinea, and Tonga.

[47]In light of de-risking—the withdrawal of correspondent banking relationships and the closing of bank accounts of remittance service providers—the benefits of remittances are possibly lower in the current environment. See Alwazir and others (forthcoming) for small states in the Pacific.

[48]An increase of 1 percentage point of GDP in remittances is associated with a 2–3 percent increase in the economy-wide inactivity rate in Balkan and central European countries.

ciations and a contraction of the tradable sector, as documented in Magud and Sosa (2013) and Atoyan and others (2016) for Eastern Europe.

Finally, diaspora networks of emigrants may convey knowledge and expertise back to the source country, potentially raising productivity (Figure 4.24, panel 2). Mitra and others (2016) suggest that, by contributing to the curriculum design, diaspora networks can raise the quality of education in their home countries. They can also provide rigorous professional development and leadership training programs. Combining their skills, contacts, and know-how with their insight into global opportunities and local customs, diaspora networks of emigrants may help strengthen the home-country business environment, raise efficiency, and expand into new markets.[49] In the same vein, they can also advise governments and help to improve the quality of public institutions.[50]

Policy: The Importance of Integration

Migration has significant spillovers for recipient and source countries alike, and policy plays an important role in shaping their economic impact. In recipient countries, the degree to which migration increases labor supply and productivity, and contributes to the public finances over the long term, depends on the speed with which migrants integrate into labor markets. For source countries, the right policy response depends on the underlying drivers of migration—that is, whether it is driven by domestic or foreign developments.

Fast integration of migrants is key for recipient economies. Well-designed integration policies are essential for harnessing the benefits of migration and should, in particular,

- *Improve labor market policies.* Simple, affordable, and transparent procedures for hiring foreign workers and recognition of foreign qualifications and work experience can help smooth labor market integration. Proactive job placement and other incentives can reduce entry costs. Any fiscal incentives, such as wage and employment subsidies, should be temporary and targeted.
- *Provide access to education and financing.* Access to education and language and job training can help achieve a good skill-balance among migrants and minimize the potential for social tension. Ensuring access to financial services—for example, bank accounts and financial transactions—can broaden opportunities.
- *Support migrant entrepreneurs.* Encouraging migrant entrepreneurship could help foster competitiveness and innovation.

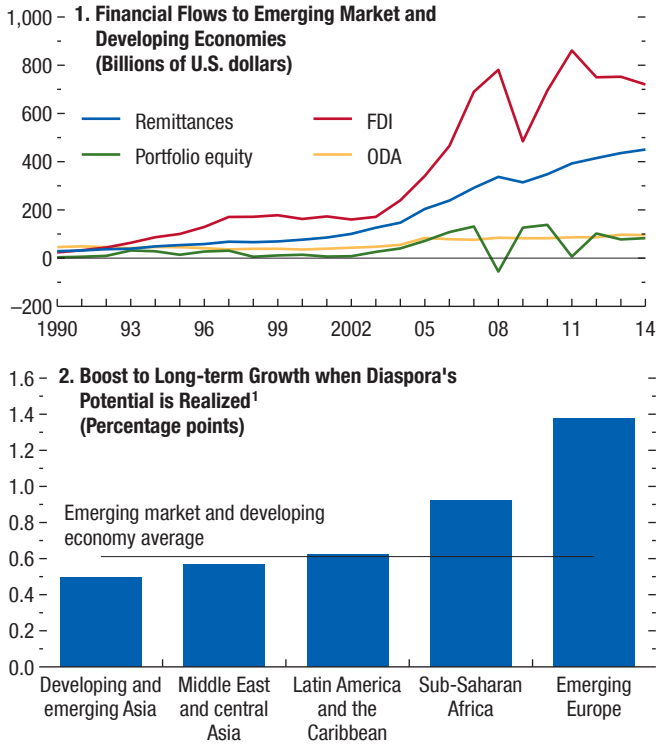
Refugees require special attention. A key issue is reducing the time asylum seekers must wait before they are allowed to work. Targeted support can reduce language and skill gaps, and such measures as temporary wage subsidies can create incentives for employers to hire. Improving geographic mobility, including through the availability of affordable housing, will help refugees move where labor demand is high.[51] Where

[49]Migrants could also foster trade (see Cohen, Gurun, and Malloy (forthcoming) and Parsons and Vezina 2014); and foreign direct investment (see Burchardi, Chaney, and Hassan 2016).

[50]For example, Indian-born executives working in US-based technology companies played a critical role in giving the latter confidence to outsource work to India.

[51]In the European Union, flexibility built into the Stability and Growth Pact should be allowed for a marginal loosening of fiscal targets to accommodate refugee-related short-term costs.

Figure 4.24. Remittances and Diasporas



Sources: Mitra and others 2015, 2016; World Bank, *World Development Indicators*; and IMF staff calculations.
[1]Potential growth if diaspora rises to best performers' benchmark. For simulation details see Mitra and others 2016.

countries receive refugees from neighboring conflict zones, international support remains crucial—including from donors—to ensure that refugees are appropriately cared for, including through complementary central government assistance

Source countries should strive to tilt the balance between positive and negative effects of emigration in their favor. If home-grown policy distortions are driving emigration, correcting them is a natural way to avoid brain drain. If emigration is driven by pull factors, the response should stress adjustment and policies to

- *Retain and re-attract migrants.* Strong institutions and growth-enhancing reforms will foster income convergence and make emigration less attractive—for instance, improvements to the business environment, governance, and the quality of institutions would create greater incentives for people to stay or emigrants to return. Recognition of skills acquired abroad, targeted tax benefits, and portable social security benefits could also persuade migrants to return.
- *Leverage diaspora networks and make remittances count.* This could include, for example, the issuance of diaspora bonds (as, for example, in India, Israel, Nigeria, the Philippines) and outreach to diaspora communities. Reducing the cost of remittances and enhancing incentives for their financial intermediation can also make a difference.
- *Mitigate the effects of migration.* Policies that boost labor supply, including raising female labor force participation, can overcome the labor shrinking effects of migration. Improving the efficiency of social and health care spending can ease possible fiscal pressure, and if there is a need to raise tax revenue, greater reliance on consumption instead of labor taxes will protect growth.

An effective policy response in postconflict source countries should protect economic institutions, prioritize budget allocations that serve basic needs of the population, and use monetary and exchange rate policies to shore up confidence. Once conflicts subside, successful rebuilding requires well-functioning institutions and robust yet flexible macroeconomic frameworks to absorb capital inflows and maintain debt sustainability. To prevent future violence, postconflict countries should accelerate inclusive growth reforms aimed at reducing inequality.

An enhanced multilateral framework is warranted to better govern international migration. Global efforts should focus on encouraging cooperation between source and recipient countries, including by facilitating remittance flows, protecting labor rights, and promoting a safe and secure working environment for migrants. Cooperation is also vital to address challenges from humanitarian migration, including through enhanced global development diplomacy—aimed at preventing, containing, and responding to humanitarian crises—and more flexible and innovative financing instruments to ensure effective assistance and resources for refugees wishing to return home. Given the increasing flows of refugees over the past years, and the impact that they have on neighboring countries that are shouldering a large share of the cost of receiving them, high-income donor countries (including international institutions, the Group of Seven, the Gulf Cooperation Council, and the European Union) need to coordinate their approach to provide more financial support to improve conditions for refugees.

Box 4.1. China's Ties with Low-Income and Developing Countries

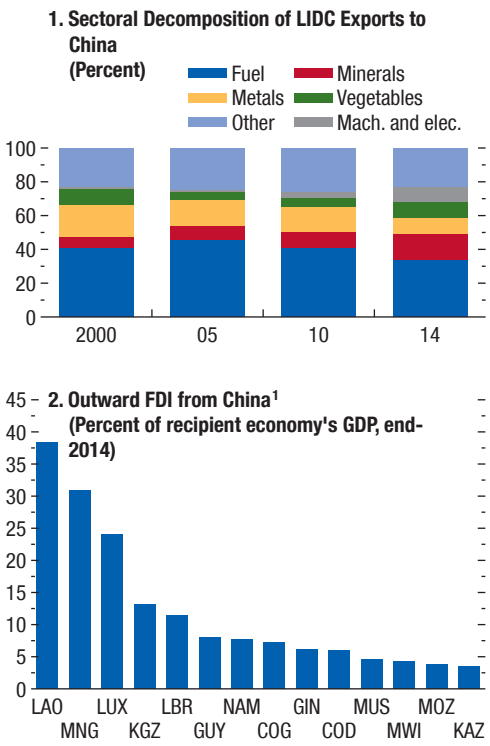
Trade linkages between China and low-income and developing countries have risen markedly in recent years. Exports to China as a share of these countries' total exports have more than doubled, from less than 5 percent before 2000. Although China's share of low-income and developing country exports appears modest, at 13 percent in 2015, it was among the three largest export destination markets for about half of these countries, which tend to trade across a large number of trading partners. As discussed in this chapter, countries with significant trade exposure to China have faced downward pressure on demand for their exports in recent years, and export volume growth in low-income and developing countries has slowed accordingly.

The sectoral composition of trade with China is dominated by fuel, minerals, and metals, which accounted for about 60 percent of total exports in 2014 (Figure 4.1.1, panel 1). The share of commodities, although still high, shows a slight decline relative to the early 2000s, when exports of raw materials represented about 70 percent of the total. Some of the share once occupied by these exports has recently given way to capital-goods exports, which now represent about 10 percent of total exports.

China is a major source of foreign direct investment inflows into low income and developing countries (Figure 4.1.1, panel 2). Although the two largest beneficiaries of Chinese direct investment (Lao P.D.R. and Mongolia) are geographically close to China, China is also a major source of foreign direct investment for several countries in sub-Saharan Africa. As China continues its transition and allows firms to seek new investment opportunities abroad, there may be positive spillovers for these countries. Lower demand for commodities may, however, get in the way somewhat, since foreign direct investment has usually been associated with commodity production. In addition, as discussed in IMF 2016j, the recent 'One Belt One Road' initiative will involve a further strengthening of foreign direct investment flows from China to the Caucasus and Central Asia, south Asia, and southeast Asia.

The author of this box is Nkunde Mwase.

Figure 4.1.1. China's Ties with Low-Income and Developing Countries



Sources: CEIC; and IMF staff calculations.
Note: FDI = foreign direct investment; LIDC = low-income and developing country; Mach. and elec. = machinery and electrical equipment. Data labels in the figure use International Organization for Standardization (ISO) country codes.
[1]Excludes Hong Kong SAR.

Box 4.2. Conflicts Driving Migration: Middle East and North Africa

The Middle East and North Africa is facing a new wave of conflict with significant economic costs and spillovers within the region. Since the end of World War II countries in this region have suffered more conflict than those in any other region in the world. Conflicts are more protracted and violent as well—between 1946 and 2014, 12 out of 53 episodes of conflict in the region lasted more than eight years, and a significant number of former conflict countries relapsed into violence within 10 years. The economic costs of conflict are massive for some countries and the spillovers large. GDP in Syria has fallen by half, and growth in Jordan and Lebanon has slowed significantly over recent years.

Based on Rother and others 2016.

The humanitarian and economic costs of conflict are massive. An estimated 10 million refugees from conflict countries have mostly stayed within countries in the region—for example, since 2010, refugees from Iraq and Syria have boosted the populations of Lebanon and Jordan by one-quarter and one-fifth, respectively. More than 1.7 million refugees have reached Europe since July 2014, and Turkey hosts about 3 million. Countries hosting refugees face difficult decisions about access to labor markets and social programs. This highlights the importance both of humanitarian aid aimed at addressing the immediate needs of refugees and those displaced within their own countries, and of scaled-up development assistance to the region as a whole.

Box 4.3. Migration in Sub-Saharan Africa

In the coming decades sub-Saharan African migration will be shaped by a profound demographic transition that has already begun. The working-age population is growing more rapidly than the population overall, which means migration outside the region is set to continue to expand.

Key Trends

Amid rapid population growth, sub-Saharan Africa migration has increased rapidly over the past 20 years. Although the migration rate—migration-to-total population—has remained stable at about 2 percent, the population has doubled over the past 25 years. Until the 1990s intraregional migration dominated and early in that decade represented 75 percent of the total. Over the past 15 years, though, migration outside the region—mainly to Organisation for Economic Co-operation and Development (OECD) countries—has picked up sharply, and represented one-third of the total stock of migrants by 2013 (Figure 4.3.1, panel 1).

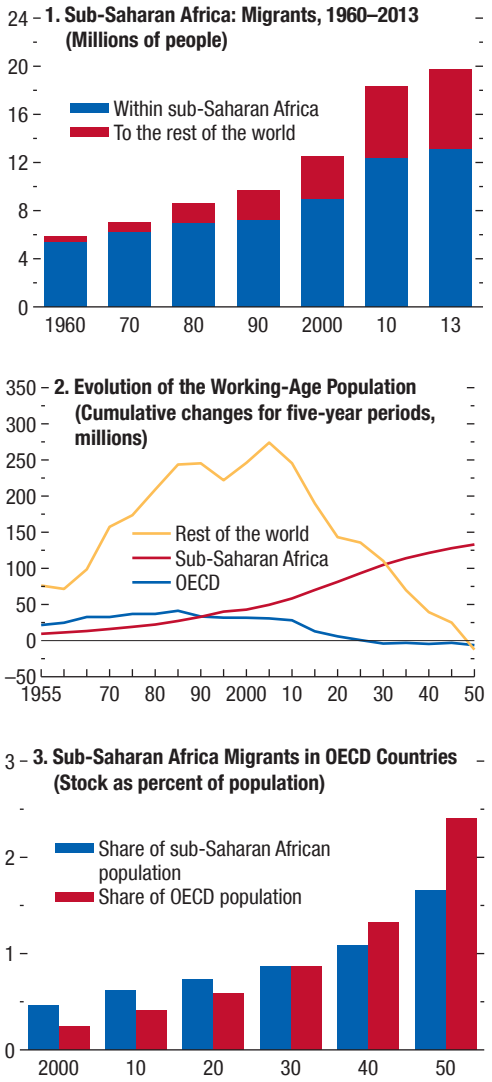
Migration from sub-Saharan Africa is set to continue to increase very rapidly. The region is undergoing a demographic transition as a result of strong population growth combined with reduced infant and maternal mortality. The latter implies that the working-age population—which typically feeds migration—is set to increase even more rapidly (Figure 4.3.1, panel 2). IMF staff projections using a gravity model of sub-Saharan African migration to OECD countries indicate that population growth will continue to shape migration. They suggest that the region's migrants in OECD countries could increase from about 7 million in 2013 to about 34 million by 2050. Given the relatively slow population growth expected for OECD countries, the ratio of sub-Saharan African migration as a share of OECD population could increase sixfold, from just 0.4 percent in 2010 to 2.4 percent by 2050 (Figure 4.3.1, panel 3).[1]

Migration is increasingly driven by economic considerations. The flow of refugees—about half of sub-Saharan African migration within and outside the region in 1990—had decreased to only one-tenth of the total in 2013. By 2013 most migrants outside the region—about 85 percent—were in OECD countries.

Based on Gonzalez-Garcia and others (2016).

[1]The determinants of migration to OECD countries are relative per capita income and working-age population, the existing diaspora in OECD countries, distance between countries, public health spending in OECD countries, and indicators of common language, previous colonial relationship, wars in sub-Saharan Africa, and landlocked countries.

Figure 4.3.1. Migration in Sub-Saharan Africa



Sources: United Nations *World Population Prospects;* World Bank, Migration and Remittances database; and IMF staff calculations.
Note: OECD = Organisation for Economic Co-operation and Development.

France, the United Kingdom, and the United States host about half of the total diaspora outside the region. Although a few sub-Saharan African countries—for example, Ethiopia, Nigeria, and South Africa, with close to 0.7 million people each—have a large number of migrants, they represent only a small share of their population. With a relatively small number of migrants, these are proportionately more important for some

Box 4.3 *(continued)*

small economies—such as Cabo Verde (about one-third of its population) and Mauritius, São Tomé and Príncipe, and Seychelles (about 10 percent).

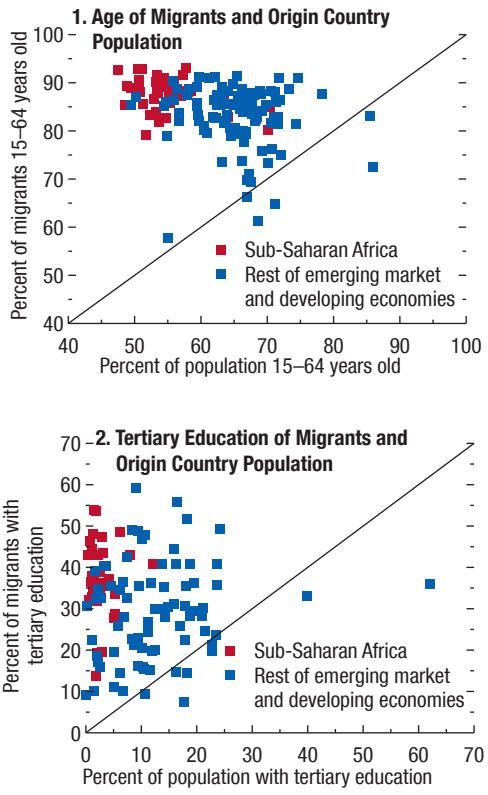
Economic Impact

Brain drain is particularly acute in sub-Saharan Africa. The migration of young and educated workers takes a large toll on a region whose human capital is already scarce. The concentration of migrants among those who are educated is higher than in other developing economies (Figure 4.3.2). The migration of highly-skilled workers entails a high social cost, as is evidenced by the departure of doctors and nurses from Malawi and Zimbabwe, which may mean welfare losses beyond those that are purely economic. Nevertheless, recent studies suggest some positive effects: returning migrants bring back new skills, and prospects for migration motivate human capital accumulation, which may be supported by large remittances from current migrants and returning migrants bringing knowledge and experience.[2]

Remittance inflows represent an important source of foreign exchange and income in several countries in the region. After the global financial crisis, while foreign direct investment entered a clear downward trend, remittances became one of the largest sources of external inflows, currently at a level similar to foreign investment. Remittances represented 25 percent of Liberia's GDP in 2013–15; about 20 percent in Comoros, the Gambia, and Lesotho; and roughly 10 percent in Cabo Verde, São Tomé and Príncipe, Senegal, and Togo (Figure 4.3.3). Remittances provide a relatively stable source of income that helps smooth consumption and support growth in sub-Saharan Africa. They also help alleviate poverty and promote access to financial services—many receiving families develop a relationship with a financial institution, usually a wire transfer company or bank, to receive their funds easily.

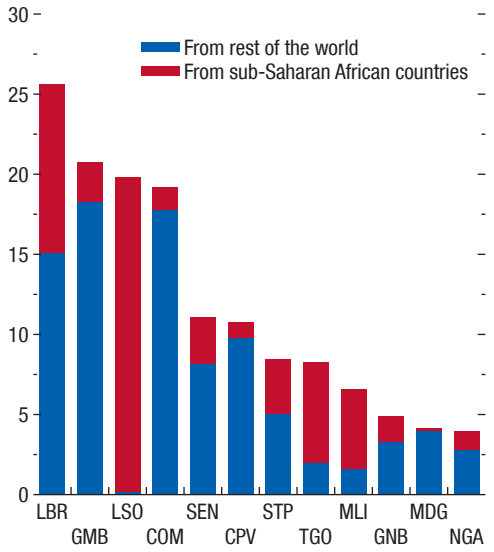
[2]For literature on brain gain in sub-Saharan Africa see Nyarko 2011; Easterly and Nyarko 2008; and Batista, Lacuesta, and Vicente 2007.

Figure 4.3.2. Age and Education of Migrants and Origin Country Population
(Percent)



Sources: Organisation for Economic Co-operation and Development, International Migration Database; World Bank, *World Development Indicators*; and IMF staff calculations.

Figure 4.3.3. Top Receivers of Remittances in Sub-Saharan Africa, 2013–15
(Percent of GDP)



Source: World Bank, Migration and Remittances database.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

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