HOW HAS GLOBALIZATION AFFECTED INFLATION?

Inflation in advanced and many emerging market economies has remained remarkably subdued over the past two years despite a significant rise in commodity prices, strong growth, and a broadly accommodating monetary policy stance in the major currency areas. Is this situation sustainable or does it foreshadow unwelcome inflation surprises in the near future? Some analysts have argued that low and stable inflation reflects more intense global competition, which prevents firms from raising prices and puts downward pressures on wages in many sectors.[1] If so, and given that lower-cost producers in emerging markets and developing countries will continue to integrate into the global trading system, these forces are likely to ensure low inflation in the foreseeable future, reminiscent of the secular deflation associated with broad productivity increases during the classical gold standard in the late nineteenth century. However, such views are not universally shared. Other analysts have offered alternative explanations for the recent inflation performance, including improved monetary policy credibility, broad productivity gains of uncertain duration, or cyclical conditions.[2]

Looking forward, the issue of whether or not globalization has indeed been a factor driving recent inflation behavior has important implications for the conduct of monetary policy. For example, if it could be established that the tailwind from declining prices of many internationally traded goods matters for inflation and is likely to continue, monetary policy would likely have to be less restrictive to meet a certain infla-

tion target than it would have to be otherwise. If the magnitudes and duration of the tailwind were overestimated, however, monetary policy may risk being too expansionary.

Against this background, this chapter explores the relationship between globalization and inflation, using both aggregate and sectoral analysis. The chapter seeks to address the following questions.

- How has globalization affected inflation over the past 15 years or so?
- How has globalization affected prices and costs at the sectoral level?
- Will globalization put downward pressure on inflation in the future, and, if so, what are the implications for monetary policy?

Two points should be noted at the outset.

- The chapter will take the now firmly entrenched goals of low and stable inflation as given.
- As usual, one needs to be specific in delineating the scope of globalization. For the purposes of the chapter, globalization is defined broadly as the acceleration in the pace of growth of international trade in goods, services, and financial assets relative to the rate of growth in domestic trade.[3] At the global level, this encompasses the growth spurts in key emerging market economies—notably China and, to a lesser extent, India. Globalization has also overlapped with economic and financial deregulation in many countries and with the information technology revolution. While an attempt is made to distinguish between these phenomena, this is often difficult to accomplish in practice.

[1]See, among others, BIS (2005); Greenspan (2005); or Fisher (2006).
[2]See, among others, Ball and Moffitt (2001); Kamin, Marazzi, and Schindler (2004); or Buiter (2000).
[3]See Chapter III of the April 2005 *World Economic Outlook*.

Figure 3.1. Inflation
(Distribution of five-year averages of year-on-year CPI inflation across countries)

Inflation declined significantly during the 1980s and 1990s in industrial countries and, with a lag, major emerging markets.
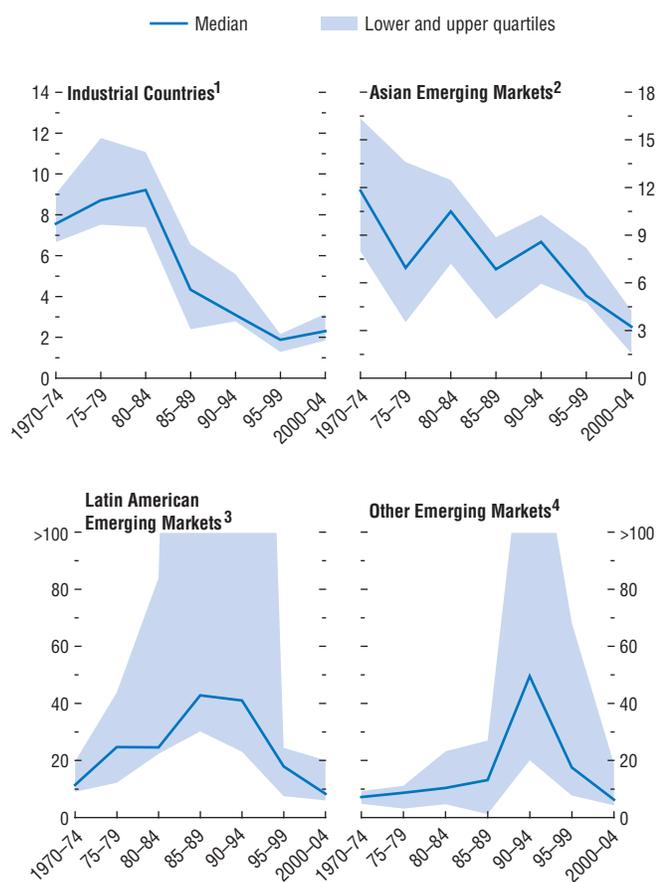
Source: IMF staff calculations.
[1]Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.
[2]China, India, Indonesia, Korea, Malaysia, the Philippines, and Thailand.
[3]Argentina, Brazil, Chile, Colombia, Dominican Republic, Ecuador, Mexico, Peru, and Venezuela.
[4]Czech Republic, Egypt, Hungary, Poland, Romania, Russia, South Africa, and Turkey.

The chapter is organized as follows. The next section provides an overview of salient features of recent inflation developments. The chapter then discusses the broad channels through which globalization affects inflation. The fourth section looks at the relationship between inflation and globalization at the aggregate level. The focus is on how globalization affects inflation variability over the cycle and how large declines in relative import prices influence aggregate inflation. The ensuing section then analyzes the relationship at the sectoral level, focusing on the impact of globalization on domestic (relative) producer prices. The last section provides a summary and policy conclusions.

Recent Inflation Developments

For a meaningful analysis of globalization and inflation in recent years, the relationship needs to be seen against the background of recent inflation developments. Following current central bank practice, aggregate inflation is measured by changes in consumer price indices. The picture would be broadly similar if other aggregate price measures were used.

- *Average inflation in industrial countries has been low since the early 1990s,* reflecting success in stabilizing inflation after the 1970s and early 1980s (Figure 3.1). Specifically, inflation rates have fluctuated around an average of 2–3 percent, with very little dispersion across countries. In contrast, the average was about 9 percent in the early 1980s and dispersion was wider. The low, roughly constant average inflation rates since the early 1990s closely match the central banks' explicit or implicit inflation targets.
- *Inflation in industrial countries has also become less volatile.* Magnitudes of inflation fluctuations around the average are thus smaller, reflecting in part the determined policy efforts in keeping inflation close to targets (Figure 3.2). As a result, expected deviations from an inflation target will now be smaller, everything else being equal.

- *The relationship between current and past inflation in industrial countries has weakened.* This decline in the so-called persistence means that deviations of actual inflation from its average are shorter-lived, and that the impact of disturbances to inflation has declined.[4]

- *The declines in inflation and inflation volatility in the major emerging market economies have lagged the declines in industrial countries.* High inflation remained a problem in many major emerging market economies, notably in Latin America, until the early 1990s. Since then, however, progress in stabilizing inflation at single-digit levels has been remarkable. In the emerging market economies of Asia, inflation typically was close to levels observed in the industrial countries.

- *Prices of services in industrial countries have typically increased faster than those for goods.* This has reflected generally faster productivity growth and higher trade openness in goods production but also the increasing expenditure shares on services associated with rising per capita incomes (Figure 3.3).[5] That said, the differential between services and goods price inflation has recently narrowed in a number of countries and for a number services that have been subject to increased competition, especially in business services (see below).

Understanding Globalization and Inflation: A Broad Framework

There is widespread agreement that globalization has accelerated since the early 1990s. In particular, cross-border trade in financial instruments has skyrocketed, both in advanced and

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[4]The extent of the decline remains subject to debate and partly depends on the underlying methodology and data. See, among others, Pivetta and Reis (2004); O'Reilly and Whelan (2005); or Stock (2002).

[5]This trend is documented for the major industrial countries in Clark (2004) and Gagnon, Sabourin, and Lavoie (2004). For similar reasons, broad indices of domestically produced goods and services have usually risen faster than broad price indices for imports, which remain determined mainly by goods price developments.

Figure 3.2. Inflation Volatility
(Standard deviations of rolling five-year windows of year-on-year CPI inflation; distribution across countries)

With declining average rates, inflation volatility has also declined significantly.
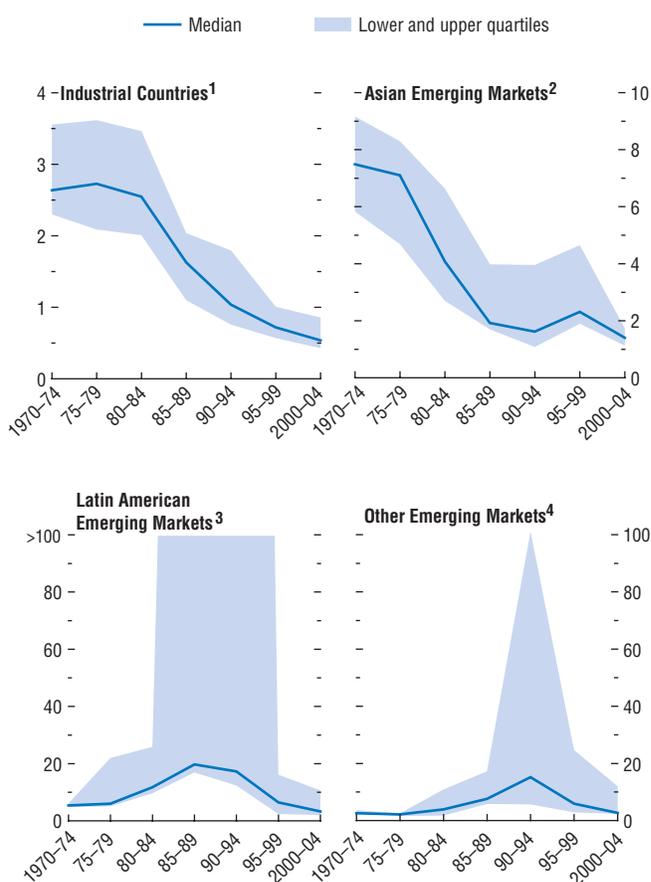
Source: IMF staff calculations.
[1]Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.
[2]China, India, Indonesia, Korea, Malaysia, the Philippines, and Thailand.
[3]Argentina, Brazil, Chile, Colombia, Dominican Republic, Ecuador, Mexico, Peru, and Venezuela.
[4]Czech Republic, Egypt, Hungary, Poland, Romania, Russia, South Africa, and Turkey.

Figure 3.3. Prices of Goods and Services

Price increases in services have typically exceeded those in goods prices, reflecting both supply and demand factors.
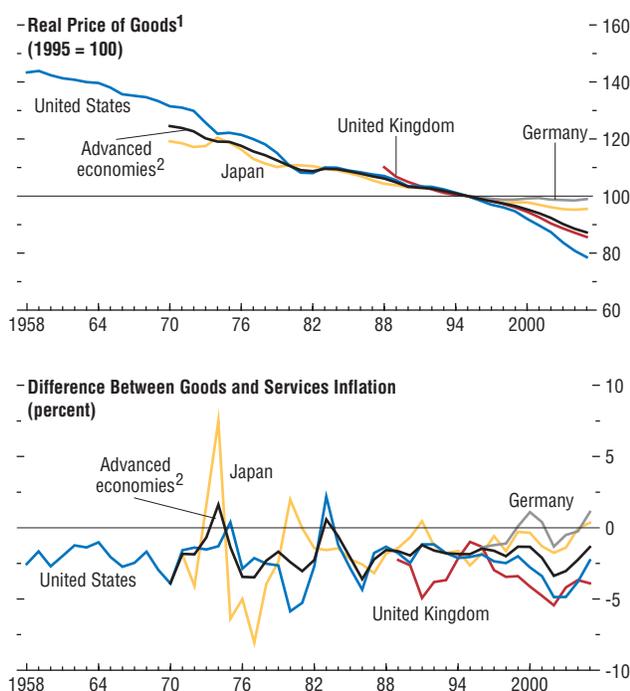
Sources: Eurostat; Haver Analytics; national authorities; and IMF staff calculations.
[1]Ratio of consumer prices of goods to overall CPI.
[2]The group of advanced economies includes Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

major emerging market economies (Figure 3.4). In international trade, the locational fragmentation in the production of manufactured goods and the growing importance of emerging market economies in world trade have reshaped many markets and industries. Measures of trade and financial integration obviously are highly correlated, and in the subsequent analysis, trade openness is used to quantify the exposure to globalization.

How have such globalization-related changes affected inflation? As a first step toward answering this question, it is useful to review the main broad channels through which globalization affects national inflation.

• *Policy incentives.* Determined monetary policy efforts aimed at reaching and maintaining low inflation have been a major factor in the global decline in inflation and inflation volatility during the 1980s and 1990s documented earlier. These efforts have reflected a number of factors. Policymakers have learned from the mistakes of the 1970s. Financial deepening, improved fiscal policies, and smaller disturbances have also played a role.[6] Globalization may have played a subtle role in the strengthened conduct of monetary policy by changing the incentives of policymakers (e.g., Rogoff, 2003). In particular, globalization may reduce their ability to temporarily stimulate output (e.g., Romer, 1993) and/or may increase the costs of imprudent macroeconomic policies through the adverse response of international capital flows (e.g., Fischer, 1997; or Tytell and Wei, 2004). Central banks in industrial countries are unlikely to lower their inflation targets further despite continued globalization. This is because of concerns about the adverse consequences of targets that are too close to zero at times of weak aggregate demand conditions. However, in many developing and emerging market countries, globalization is

[6]See, among, others Sims (1999); Romer and Romer (2002); Sargent (1999); Cogley and Sargent (2002 and 2005); Stock (2002); Goodfriend and King (2005); and Sargent, Williams, and Zha (2005).

likely to continue to affect inflation through its impact on central banks' inflation objectives (Box 3.1, "Globalization and Inflation in Emerging Markets").

- *Trade integration and price level declines.* Globalization and the associated rise in trade integration have reduced the barriers to market access by foreign producers. This tends to bolster price competition in domestic markets and increase imports. It has also led to the relocation of production of many internationally traded goods and, to a much smaller extent, of services to the most cost-efficient firms in the countries with a comparative advantage. As a result, the prices of affected goods or services typically decline compared to the general price level—in other words, their relative price declines. A case in point is the observed fall in the relative prices of many manufactured goods, such as textiles, that has accompanied the rapid integration of emerging market economies into the world trade system. Because such goods prices are a component of consumer prices (and other aggregate prices), their fall has, to some extent, contributed to low overall inflation. In addition to such direct effects, increased competition may also have indirect effects by moderating domestic producer prices, input prices, and markups in some industries more generally, given the availability of close substitutes produced abroad.

- *Productivity growth, aggregate supply, and relative prices.* Globalization can raise productivity growth, reflecting increased pressures to innovate and other forms of nonprice competition. By increasing aggregate supply, such productivity gains typically lower prices, which may affect aggregate inflation, along the lines discussed above, with the effects possibly amplified by positive feedback from low inflation to productivity growth. Clearly, globalization-related productivity increases have overlapped with increases due to other factors, including the information technology revolution.
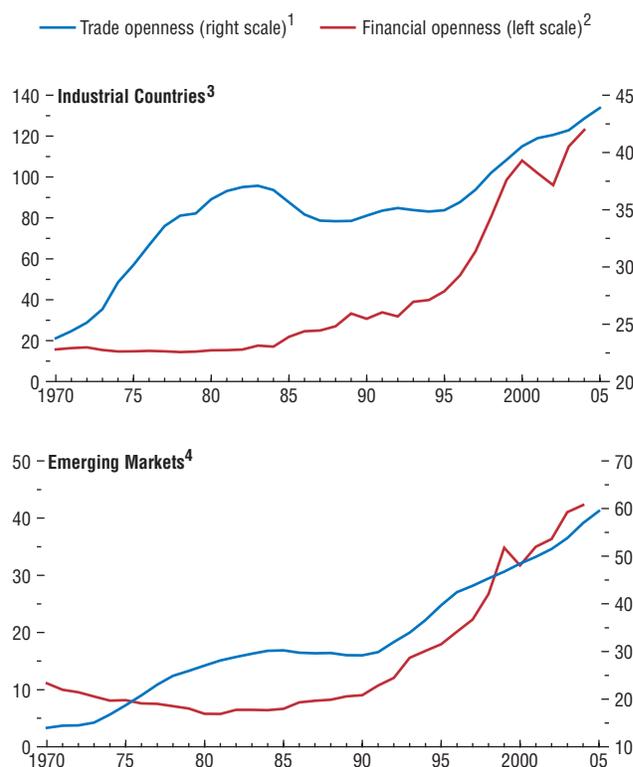
- *Inflation response to domestic output fluctuations.* Globalization may have affected the strength

Figure 3.4. Trade and Financial Openness
(Percent of GDP)

In the early 1990s, international trade and financial openness increased for both industrial and emerging market economies, reflecting an acceleration in globalization.

Sources: Lane and Milesi-Ferretti (2006); and IMF staff calculations.
[1]Measured as the sum of exports and imports in percent of GDP (five-year moving average).
[2]Measured as the sum of the stocks of external assets and liabilities of foreign direct investment and portfolio investment in percent of GDP.
[3]Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.
[4]Argentina, Brazil, Chile, China, Colombia, Czech Republic, Dominican Republic, Ecuador, Egypt, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, and Venezuela.

Box 3.1. Globalization and Inflation in Emerging Markets

Average inflation in emerging market economies has declined dramatically since the early 1990s—in many cases from double- and triple-digit levels—to about 5 percent at the present time. This decline in inflation, which has now been sustained for more than half a decade, is impressive compared with the experience from the mid-1970s to the mid-1990s when recurring episodes of loose fiscal and monetary policies, combined with commodity price shocks, kept inflation high (see figure).[1]

The inflation performance has reflected policymakers' increasing preference for low and stable inflation. This policy shift in part resulted from the earlier experience with high and variable inflation in both emerging markets and advanced economies. In the early 1980s, the perceived costs of double-digit inflation increased, as high inflation coincided with low growth and rising unemployment.[2] Governments in the advanced economies responded first by strengthening institutional and policy frameworks to foster monetary stability.[3] The combination of falling external inflation, learning from successful policies elsewhere, and public dissatisfaction with inflation explain much of the subsequent shift to low-inflation policies in emerging markets. Moreover, the gradual deepening of domestic financial markets and greater central bank independence have made inflationary financing of fiscal deficits less common.

Aside from these factors, globalization may also have strengthened policymakers' incentives to conduct prudent monetary policy. Rogoff (1985 and 2003) and Romer (1993) noted that in open economies, policymakers benefit less
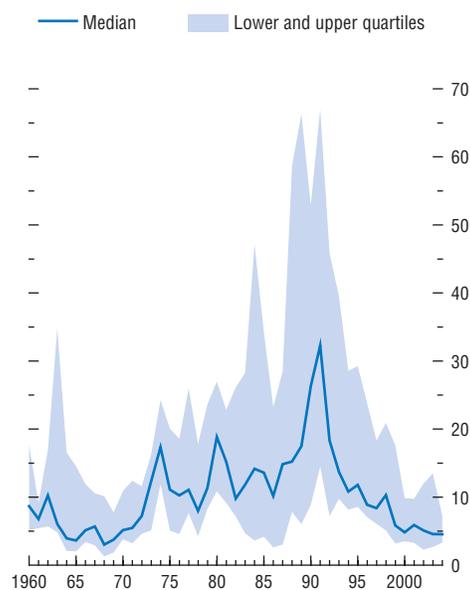
Inflation in Emerging Markets[1]
(Annual percent change)

Source: IMF staff calculations.
[1]Includes Argentina, Brazil, Chile, China, Colombia, Czech Republic, Dominican Republic, Ecuador, Egypt, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, and Venezuela.

from accommodative policies because monetary expansion has a smaller impact on domestic output than in closed economies.[4] In addition, rising trade and financial integration tends to weaken the co-movement between domestic consumption and production, which increases the welfare costs of inflation variability (Razin and Loungani, 2005). Finally, international capital markets may have a disciplining effect on monetary policy, including through the risk of a reduction in foreign investment (see, for example, Tytell and Wei, 2004).

Note: The main author of this box is Martin Sommer.
[1]In the Central and Eastern European countries, inflation spikes were associated with the initial stage of economic transformation.
[2]See the May 2001 issue of the *World Economic Outlook* for a detailed review of inflation developments in emerging markets.
[3]For example, by boosting the central bank transparency and independence and—in some countries— adopting an explicit inflation target (see the September 2005 issue of the *World Economic Outlook*).

[4]For the recent empirical analysis of links between trade openness and inflation, see Gruben and McLeod (2004). The early research includes Triffin and Grubel (1962) and Iyoha (1977).

Inflation in Emerging Markets: Probit Estimates

	Dependent Variable: Probability of Achieving Low Inflation[1]			
	(1)	(2)	(3)	(4)
Openness[2]	0.39***	0.76***	0.45**	0.30**
Fiscal balance[3]	1.17***	2.48***	1.36***	2.55***
Inflation in advanced economies[4]	−2.95***	−6.12***	. . .	−4.42***
Depth of financial sector[5]	0.94***	1.04**	1.05**	−0.35
Pegged exchange rate regime[6]	. . .	36.46***	. . .	. . .
Central bank independence[7]	. . .	−10.30**	. . .	. . .
Other	. . .	. . .	Time dummies	Country dummies
Sample	1960–2004	1975–2004	1960–2004	1960–2004
Number of observations	815	484	815	804

Sources: IMF, *International Financial Statistics*; Reinhart and Rogoff (2002); World Bank, *World Development Indicators*; *World Economic Outlook;* and IMF staff calculations.
   [1]Low inflation is defined as annual inflation below 10 percent. The probability is scaled between 0 and 100. All explanatory variables are lagged by one year. *** denotes statistical significance at the 1 percent level; and ** at the 5 percent level.
   [2]Trade in percent of GDP.
   [3]Central government balance in percent of GDP.
   [4]Expressed as a percentage. The group of advanced economies consists of Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.
   [5]Money in percent of GDP.
   [6]The dummy takes value of 1 (peg) or 0 (otherwise) and is calculated from the Reinhart-Rogoff (2002) data set.
   [7]Proxied by the central bank governor's turnover. Higher turnover may be associated with lower central bank independence.

How much has globalization contributed to the decline of inflation in emerging market economies? To answer this question, IMF staff estimated an econometric model that links the likelihood of good inflation performance—defined as annual inflation below 10 percent—to the factors discussed above.[5] Specifically, the model specification includes trade openness, inflation in advanced economies, the depth of the domestic financial sector, and the fiscal balance. In addition, the model also controls for monetary policy credibility and conduct—as measured by central bank independence—and the exchange rate regime (see table).[6] The results suggest that more open economies tend to experience lower inflation rates, even after accounting for the other inflation determinants. Coefficient estimates vary across specifications, but, on average, a country whose trade-to-GDP ratio is 25 percentage points higher than in another country[7] is over 10 percentage points more likely to achieve single-digit inflation. Moreover, since average openness in the sample increased from approximately 30 to 60 percent over the past four decades, globalization has increased the probability of low inflation by about 10 percent in the whole group of emerging markets.[8]

While growing openness may have boosted incentives for the prudent conduct of monetary policy and thus helped to reduce inflation, the model confirms that the other policy determinants discussed above have played a key role. The model attributes a significant weight to

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   [5]The probit model is estimated for 24 emerging market economies over 1960–2004 (see figure footnote for the complete list).
   [6]See Catão and Terrones (2005) and the May 2001 *World Economic Outlook* for analysis of the relationship between fiscal deficits and inflation. Alesina and Summers (1993) document the broad correlation between measures of central bank independence and average inflation. Boschen and Weise (2003) find that U.S. inflation is a useful predictor of inflation spurts in the OECD countries. Ghosh and others (1997) provide evidence that the fixed exchange rate regime can

help reduce inflation, although in the long term, the currency peg may incur large output and inflation costs if it is not supported by appropriate policies and breaks down (Mishkin, 1999).
   [7]This figure roughly corresponds to 1 standard deviation of trade openness across countries in the sample.
   [8]These calculations are based on specifications (3) and (4) in the table.

Box 3.1 *(concluded)*

the inflation performance in advanced economies. The disinflation that took place there in the early 1980s is estimated to have increased the likelihood of low inflation in emerging markets by 30 percentage points or more. Fiscal policy—a traditional source of inflation pressure—is also identified as an important determinant of inflation. In general, a 10 percent budget deficit relative to GDP increases the likelihood of high inflation by up to 25 percentage points. Moreover, countries that had a high turnover of central bank governors—which tends to be associated with low central bank independence—were less likely to achieve low inflation. Finally, a fixed exchange rate regime on average improved chances of attaining low inflation, although sustaining currency pegs in emerging markets have proven difficult in the long term.[9]

Will low inflation in emerging markets prove to be durable? With price stability abroad and domestic budget positions strengthened, the risk of a sustained increase in inflation rates at present appears small. Should fiscal deficits rise significantly in the future, they could again put pressure on the monetary authorities to inflate, especially in the countries with shallow financial markets. However, the ability of governments to obtain inflationary financing from the central bank and reduce the real value of their debts has increasingly been constrained by greater central bank independence. More generally, the stronger institutional and policy frameworks for monetary policy,[10] deepening financial systems, and policy incentives provided by globalization are all important factors that may help to prevent inflation in emerging markets from returning to high levels.

[9]See the September 2004 issue of the *World Economic Outlook* for a discussion of recent developments in exchange rate regimes in emerging markets.

[10]The September 2005 issue of the *World Economic Outlook* analyzes the benefits and costs of adopting inflation targeting in emerging markets.

of the cyclical response of inflation to output fluctuations for a number of reasons. For example, prices of many items that are produced or consumed at home are increasingly determined by foreign demand and supply factors rather than local factors. This is reinforced by the effects of financial integration, which allows for larger trade balance deficits or surpluses and, thereby, weakens the relationship between domestic output and demand. While it is widely thought that globalization has reduced the sensitivity to fluctuations in domestic production, some aspects of globalization may actually have increased it, as elaborated below.

An important question that naturally arises is that of whether the effects of globalization on aggregate inflation are likely to be lasting or only temporary. There is broad agreement among macroeconomists that in the long run inflation is determined by the nominal anchor, the nominal target variable for monetary policy. If credibly and effectively pursued, this anchor will determine expected and actual inflation in the medium term. Accordingly, to the extent that globalization has contributed to changing nominal anchors through its impact on policy incentives, it may have had permanent effects—most recently primarily in emerging market economies, as noted above.[7] In contrast, to the

[7]On empirical grounds, it would be difficult to argue that globalization has had an impact on the medium-term level of inflation targeted by central banks in advanced economies over the past decade or so. During the 1990s, formal inflation targets were introduced in many advanced economies and have been held largely unchanged since. That said, greater openness may have further strengthened policymakers' resolve to keep inflation close to the targets over the cycle or over their forward-looking policy horizon.

extent that it may have primarily affected relative prices or the cyclical behavior of inflation, the effects may have been substantial over short- to medium-term horizons, but are unlikely to be lasting in the sense of affecting long-run average inflation.

Globalization and Inflation: An Aggregate Perspective

This section analyzes the relationship between inflation and globalization at the aggregate level, focusing on two of the broad channels discussed earlier. The first issue of interest is whether globalization and the associated increase in trade flows have reduced the sensitivity of prices to domestic economic conditions. The second issue is the impact of large declines in the relative import prices of some goods on aggregate inflation.

Inflation over the Business Cycle

How might globalization influence the sensitivity of prices to domestic economic conditions? With the growing share of international trade, prices of many items that are produced or consumed at home are increasingly determined by foreign demand and supply factors. Similarly, stronger foreign competition may reduce the pricing power of domestic corporations, limiting their ability to raise prices during booms.[8] Consequently, prices become less sensitive to the domestic cycle, and the business-cycle volatility of inflation decreases.

Of course, openness is not the only factor that could have weakened the co-movement of output and inflation. The strengthened conduct of monetary policy over the past two decades is

likely to have contributed as well for at least two reasons. First, in a low-inflation environment, firms re-price their production less often (Ball, Mankiw, and Romer, 1988). Second, increasing policy credibility increases the weight that price setters put on expected inflation or inflation targets when they set their prices (Bayoumi and Sgherri, 2004).

However, certain factors related to globalization and the associated push for structural reforms may have acted in the opposite direction, effectively raising the sensitivity of inflation to output. In highly competitive markets with very low margins, producers respond faster to changes in their cost structure and may become more sensitive to demand fluctuations if production costs vary with volumes over the cycle. Co-movements between output and inflation could therefore increase when economies become less regulated, more competitive, and more flexible.[9] Which of the competing factors have so far been most important for the output-inflation relationship needs to be determined empirically.

Figure 3.5 illustrates the behavior of headline and core inflation in selected countries over past business cycles. While the figure can be no substitute for a model that takes into account various determinants of inflation, it seems that over the past two decades, inflation has become less responsive to output gap fluctuations. This has occurred against the background of rising trade openness, greater monetary policy credibility, and more flexible wage-setting mechanisms in some countries (see Figure 3.6).

To examine the issue in more detail, IMF staff constructed a model of inflation for selected advanced economies (see Appendix 3.1 for details).[10] The model is an extension of the tra-

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[8]See, for example, Kohn (2005). Razin and Loungani (2005) point out that financial integration weakens the link between output and domestic demand by allowing for greater variation in net exports. This can also reduce the consumer price response to domestic output fluctuations.

[9]Cournède, Janovskaia, and van den Noord (2005) find that inflation responds more weakly to economic downturns in economies with greater labor and product market rigidities. Nunziata and Bowdler (2005) present evidence that a high degree of labor market coordination dampens the effect of unemployment movements and other shocks on inflation. By contrast, high unionization rates amplify the inflation response to shocks.

[10]The sample consists of Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States, and spans 1960–2004.

Figure 3.5. Inflation over the Business Cycle, 1961–2003[1]

(Annual percent change for inflation; percentage points for output gap)

In many countries, the sensitivity of headline and core inflation to the business cycle seems to have diminished.
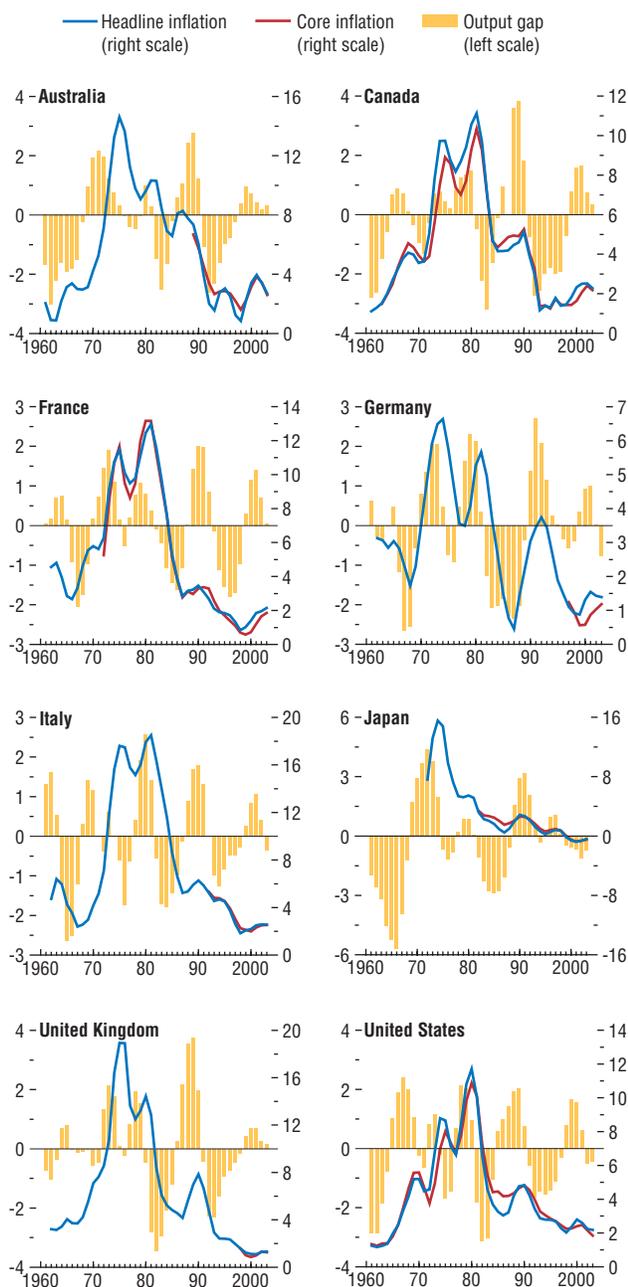
Sources: Eurostat; Haver Analytics; national authorities; and IMF staff calculations.
[1]Output gap is defined as the percent deviation of real GDP from its long-term trend. Core inflation refers to headline CPI excluding food and energy. All variables are expressed as three-year centered moving averages. See Appendix 3.1 for details.

ditional Phillips curve framework, which relates wage inflation to the rate of unemployment or, alternatively, the inflation rate to the degree of spare capacity in the economy. For each country in the panel data set, annual inflation is related to its own lag (to capture the persistence in inflation outcomes, which can reflect policies, structural rigidities, and the importance of past inflation in the formation of expectations) and a measure of spare capacity in the economy. The inflation response to output is allowed to vary across countries and over time, as it is interacted with the various factors discussed above. The basic version of the model also contains oil price changes to account for one particularly important source of large relative price changes with a potentially broad price impact. To control for shifts in policymakers' inflation objectives and expectations about monetary policy behavior, the regressions include either time dummies or a measure of monetary policy credibility.[11] The econometric analysis suggests that the sensitivity of prices to domestic economic conditions has indeed been falling over the past couple of decades (Table 3.1). Currently, the estimated average inflation-output elasticity implies that if a country's output rises above its long-term trend by 2 percentage points for a year,[12] inflation would be higher by 0.4 percentage points in the first year, instead of 0.6 percentage points a couple of decades ago.

Trade openness appears to be the key factor behind the reduced sensitivity of prices to output. The coefficient on openness remains negative (therefore reducing the inflation sensitivity) and statistically significant in most modifications of the basic model. Reduction in labor market rigidities (as measured by an index of centraliza-

[11]One additional point is worth mentioning here. Since the model residuals include, in addition to the modeling error, also the impact of external environment on domestic prices—which is to some extent shared across countries—the panel model is estimated using the Seemingly Unrelated Regression method. This method exploits correlation in the residuals across countries to obtain more precise estimates of the model parameters (Zellner, 1962).

[12]This figure roughly corresponds to 1 standard deviation of output gaps in the sample over 1983–2004.

Table 3.1. Estimates of Output-Inflation Sensitivity and Inflation Persistence in Advanced Economies[1]

Inflation-output elasticity	
1960	0.3
1983	0.3
2004	0.2
Inflation persistence	
1960	0.6
1983	0.7
2004	0.6

Source: IMF staff calculations.

[1]The underlying inflation model relates current inflation to past inflation, a measure of cyclical slack in the economy and other variables. The model coefficients vary across countries and time, and depend on the various factors discussed in the main text. Inflation persistence refers to the effective coefficient on past inflation, and inflation-output elasticity refers to the effective coefficient on the measure of business cycle. The reported coefficients are PPP-weighted average of estimates for Australia, Canada, Germany, France, Italy, Japan, the United Kingdom, and the United States. See Appendix 3.1 for a detailed specification of the inflation model and its variants.

tion and coordination in wage bargaining) in some countries has partly offset the effects of openness by raising the price sensitivity, but this effect tends to be small.[13]

The estimation results also confirm that the strengthened conduct of monetary policy over the past two decades has reduced inflation persistence, as measured by the effective coefficient on the inflation lag, which partly depends on a measure of monetary policy credibility.[14] As policy credibility has improved, the estimated coefficient on the first lag of inflation has declined from over 0.7 in the early 1980s to less than 0.6

[13]For example, the fall in the extent of economy-wide wage bargaining centralization and coordination is estimated to have raised the sensitivity of inflation to output by about 0.025 in Australia and 0.05 in the United Kingdom. It needs to be noted, however, that due to their qualitative nature, the available measures of wage bargaining may be imprecise.

[14]It should be noted that the credibility measure, which was developed by Laxton and N'Diaye (2002), is based on government bonds yields (see Appendix 3.1). It encompasses many of the factors underlying the credibility of monetary policy. While one would expect the measure to reflect primarily expectations about future inflation, such expectations partly depend on the record of previous macroeconomic policies, including past fiscal policies, and institutional arrangements governing these policies, including central bank independence, transparency, and any specific commitment mechanisms to low budget deficits or public debt.

Figure 3.6. Selected Structural Indicators

Trade openness has been rising in most advanced economies. Credibility of monetary policy strengthened substantially during the past two decades, and recovered from the earlier period of monetary instability. Wage-setting mechanisms vary widely across countries but tend to be highly persistent over time.
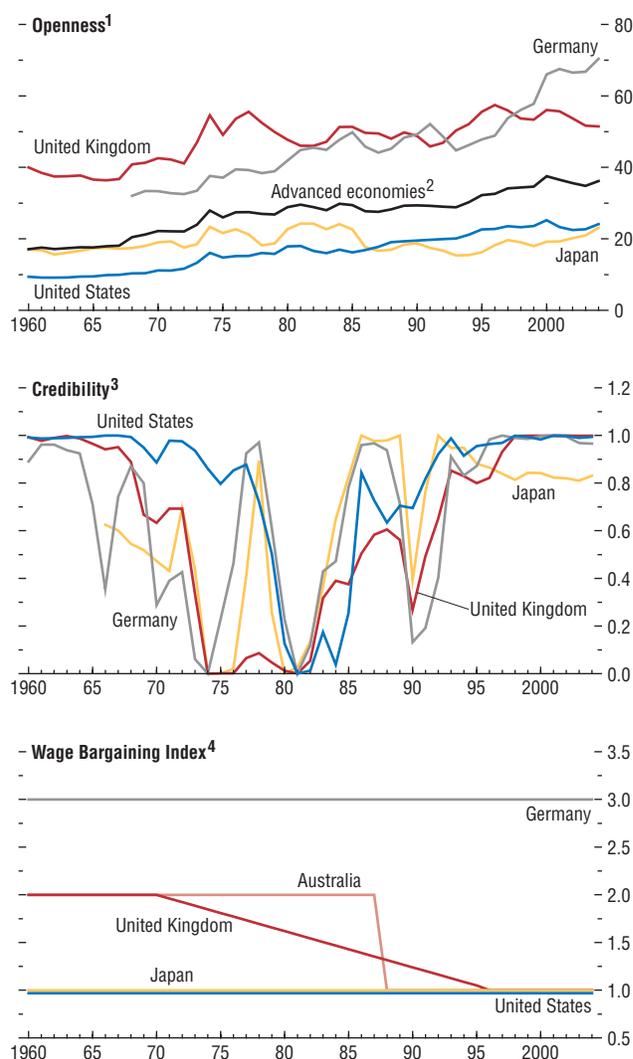
Sources: Elmeskov, Martin, and Scarpetta (1998); Laxton and N'Diaye (2002); Nicoletti and others (2001); and IMF staff calculations.
[1]Share of non-oil trade in GDP.
[2]The group of advanced economies includes Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.
[3]Measure of Laxton and N'Diaye (2002). The minimum score for the indicator is zero, the maximum is one. See Appendix 3.1 for details.
[4]Summary index of wage-setting centralization and coordination by Elmeskov, Martin, and Scarpetta (1998), as updated by Nicoletti and others (2001). The wage bargaining index ranges from one (low) to three (high). See Appendix 3.1 for details.

Figure 3.7. Import Prices

Real prices of internationally traded commodities have been on a trend decline. However, import prices are highly volatile, reflecting various factors such as oil price fluctuations and exchange rate movements. In the United States, relative prices of imported consumer and capital goods continue to fall, though on the whole, import prices are now contributing to inflation.

Real Price of Imports in Advanced Economies
(1995 = 100)

Real Import Price Changes
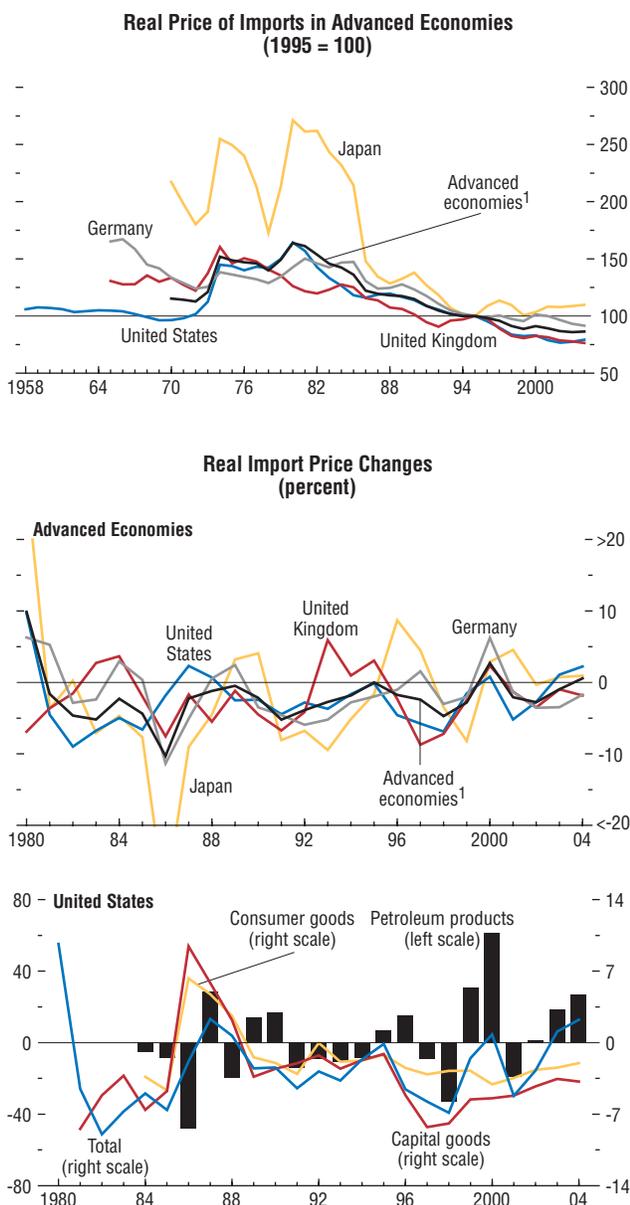**(percent)**

Sources: Haver Analytics; and IMF staff calculations.
[1]The group of advanced economies includes Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

for the last observation.[15] This lowers the extent to which disturbances propagate over time. Continuing with the earlier example, the second-year impact of a temporary 2 percentage point output increase would now almost be to raise inflation in that year by 0.22 percentage points, instead of 0.45 percentage points some 20 years ago. By the third year, that same output disturbance would now almost cease to affect inflation, while earlier, half of its cumulative effect would still be forthcoming. Overall, the analysis suggests that openness contributed over half of the decline in the sensitivity of prices to domestic output, while improved monetary policy credibility and the low inflation environment account for the remainder.[16]

The Impact of Import Price Changes

Trade integration, notably with developing countries and emerging markets, has been accompanied by a rapid decline in the prices of certain goods and services. From the aggregate perspective, this has been reflected in falling real import prices (that is, import prices relative to broad price indices that include prices of domestically produced goods and services) in the advanced economies over the past two decades (Figure 3.7) and was supportive of the declines in the real prices of goods noted earlier.[17] The question of interest is whether the various relative price changes associated with globalization have had a significant impact on inflation in advanced economies and how persistent these effects have been. Clearly, if recent inflation developments in the advanced econo-

[15]The estimation results indicate that together with persistence, the implied average annual inflation declined as well—from a peak of about 10 percent in 1981 to roughly 2 percent in 2004.
[16]Loungani, Razin, and Yuen (2001) examined the impact of financial integration on the output–inflation sensitivity and made a similar finding. In their empirical specification, countries with stricter capital controls had a steeper Phillips curve.
[17]Real goods prices would generally be falling on average even in a closed economy because productivity in the goods-producing sectors tends to grow faster than in the services sectors.

mies had reflected tailwinds from globalization, import prices would need to have played a significant role in the process.

A brief look at Figure 3.7 suggests that, in general, the role of import prices in keeping inflation low has likely been limited. The downward trend in relative import prices started before the acceleration in globalization, and the recent fluctuations in these prices do not appear unusual in either magnitude or persistence. On the contrary, they appear to broadly reflect fluctuations in global economic activity, as before. Specifically, during the past decade, relative import prices in advanced economies declined during 1997–98 (in parallel with the Asian crisis when currencies of advanced economies appreciated and prices of many manufactures and commodities fell), increased during the ensuing recovery in Asia and with strong global growth, and then declined again during the 2001–02 downturn. To give a sense of the magnitudes, in the sample of eight advanced economies analyzed in this section, real import prices fell on average by 3.8 percent a year during 1997–98, compared to an average decline of 1 percent a year during 1960–2004.[18] With import shares in the sample ranging from 10 to 35 percent, the immediate direct impact on inflation of import price movements of a few percentage points is likely small.

To examine the impact of relative import prices on inflation more formally, one of the model specifications from the previous subsection explicitly includes import prices (Appendix 3.1 provides details).[19] The estimation results corroborate the intuition—on average, only about one-tenth of an import price decline relative to the long-term trend passes through into inflation during the first year (Table 3.2). Moreover, the effects of an import price decline almost disappear from headline inflation after two years in all countries in the sample.

Table 3.2. The Cumulative Impact of a 1 Percent Decrease in Real Import Prices on Inflation
(Percentage points)

| | Impact on Inflation | | | |
	First year	Second year	Third year	Import Share[1]
Australia	−0.10	−0.07	−0.03	0.21
Canada	0.08	−0.07	−0.03	0.34
France	−0.07	−0.01	0.01	0.26
Germany	−0.07	−0.01	—	0.33
Italy	−0.01	−0.05	−0.02	0.26
Japan	−0.08	—	—	0.11
United Kingdom	0.19	−0.07	−0.03	0.28
United States	−0.15	−0.12	−0.06	0.15
Advanced economies[2]	−0.08	−0.07	−0.03	0.20

Source: IMF staff calculations.
[1]Share of imports in GDP.
[2]PPP-weighted average of the sample countries.

What do the estimates above mean in practice? Figure 3.8 presents simulations of the path of inflation under the assumption that real import prices during 1997–2005 were evolving in line with their historical trend. In the first simulation, real import prices during 1997–2005 fall on average at the rate of one percent a year (Scenario A in the figure). The results suggest that the large fall in real import prices in recent years has contributed importantly to inflation developments in the short term. On average, import prices contributed about ½ percentage point to the reduction in inflation in both 1998 and 1999, and over ¼ percentage point in 2002. For some countries, the calculations point to a stronger impact—especially in those cases where the broad decline in prices of internationally traded commodities were accompanied by real appreciation. In the United States, for example, the contribution of import prices to disinflation was 1¼ percentage point in 1998 and over ¾ percentage point in 2002. Excluding the direct impact of oil prices (Scenario B), these magnitudes are reduced by up to ¼–½ percent-

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[18]The cross-country differences in the broad trend of real import prices are not large and can often be related to the real exchange rate movements. See Clark (2004) for a detailed analysis of country-specific fluctuations in the real goods prices.

[19]The specification includes real import price changes weighted by the import share. The model therefore allows for a time-varying response of inflation to import price changes. The persistence of the effects of import price changes also varies over time because of their dependence on the coefficient on lagged inflation, which evolves in line with monetary policy credibility, as described earlier.

Figure 3.8. The Impact of Import Prices on CPI Inflation
(Annual percent change)

Had import prices evolved during 1997–2005 in line with historical trends, inflation in the advanced economies would—until recently—have been higher. Import prices contributed to disinflation, especially in the late 1990s after the Asian currency crisis (½ percentage point on average in advanced economies and more than 1 percentage point in the United States). Import prices also helped temporarily reduce inflation during the global slowdown in 2001–02.
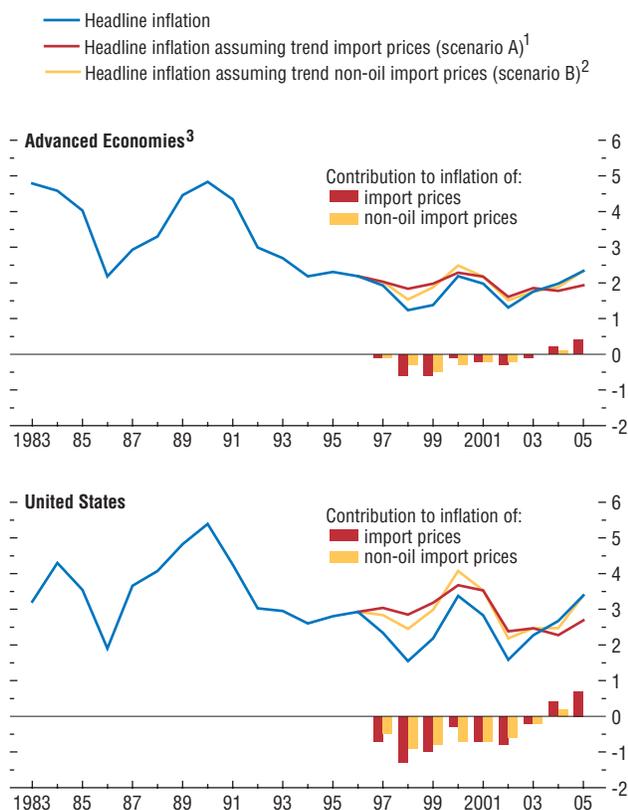
Sources: Eurostat; Haver Analytics; national authorities; and IMF staff calculations.
[1]Scenario A assumes that during 1997–2005, real import prices fell at the historical average rate of about 1 percent a year.
[2]To capture the impact of globalization on inflation more precisely, scenario B removes the impact of oil prices from scenario A. Real import price changes are first decomposed into the contribution of oil prices and non-oil commodities. The scenario then assumes that the contribution of oil prices to import price changes was the same as the actual values during 1997–2005 but the contribution of non-oil commodities was at the historical average rate of about 1.6 percent a year.
[3]The group of advanced economies includes Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

age point, which suggests that the disinflation pressures that can be directly associated with globalization in the production of goods may have been somewhat less.

The simulations also show that during 2003–05, there was almost no globalization-related impact on inflation. The differences between actual and simulated inflation were almost entirely due to oil price increases. Overall, the results suggest that while the initial effects of substantial import price changes can be sizable in times of low inflation—up to the order of 40–60 percent of average inflation—the cumulative effects tend to be small. In both episodes with above-average import price declines, inflation tended to return to its average level within a period of two years in all countries.

When interpreting this finding, it is useful to realize that the effects of price declines generated by foreign competition—such as the falling prices of textiles and other consumer goods—are very similar in their nature to the effects of other, perhaps more "traditional," kinds of so-called price shocks, such as swings in the prices of food or energy. These reflect fluctuations in the equilibrium price of specific products or commodities (relative to prices of other products) because of changes in demand or supply conditions. If policymakers do not change their monetary policy objectives (such as the inflation or monetary target) in the aftermath of the shock and keep policy rates at levels consistent with those objectives, the impact of the disturbances will only be temporary and inflation will return to the range desired by policymakers.[20] In such an environment, the falling prices in the sectors most affected by globalization will simply be offset by rising prices elsewhere, partly because consumers will use the related increase in purchasing power to boost their spending on other goods, including on other imports. Hence, large changes in the import price of some goods need not result in large increases or decreases in broad price indices.

[20]See Hooker (2002) for a recent study on the inflation impact of oil price shocks.

A number of conclusions emerge from this analysis.

- Concerns about the risks of ongoing deflation due to globalization clearly need to be reconsidered. The main reason for the secular deflation in the last era of accelerated globalization—the period 1880–96 under the classical gold standard—was that a roughly constant gold stock did not allow the accommodation of the increased demand for money due to high, productivity-driven growth (Box 3.2, "Globalization and Low Inflation in a Historical Perspective"). In today's environment, with a determined monetary policy response to downward deviations of inflation from the medium-term target at times of large declines in import prices, such risks generally seem small, especially at the current juncture.

- While the results do not suggest a strong persistent effect of falling import prices on aggregate inflation in the advanced economies,[21] the sizable effects found for one- to two-year periods may offer opportunities for disinflation. Under such circumstances, policymakers may permanently lower their target for average inflation while avoiding the output losses that would have been incurred in the absence of such favorable external conditions.[22]

- At the current juncture, with the global economy expanding strongly, there is no noticeable impact of globalization on inflation in the advanced economies. This highlights that in the short term, there are both upside and downside risks to the inflation impact of globalization. The possible upside risks are reinforced by the recent increases in commodity prices, which have been associated with the very same force that has put pressure on prices of manufactures, namely the rising integration of major emerging market economies into the world trade system.[23]

- Since import prices are partly determined by exchange rate fluctuations, the evidence of low persistence in imported inflation is also consistent with the literature on diminishing pass-through of exchange rate changes to inflation (see Box 3.3, "Exchange Rate Pass-Through to Import Prices").

A Sectoral Perspective on Globalization and Prices

This section examines differences in producer price changes across sectors and investigates how they might be related to globalization. The sectoral perspective complements the aggregate perspective and can deepen the understanding of the relationship between globalization and changes in relative prices. In particular, since the extent of globalization differs across sectors, a sectoral approach might help in better identifying the indirect effects of globalization on domestic relative prices—through the competitive effects associated with the increased availability of close substitutes produced abroad—in addition to the direct effect through relative import prices.

Globalization in the sense of more market access for foreign producers fosters competition by increasing the price elasticity of demand, which may force producers to lower margins while rents in factors of production may decrease (Chen, Imbs, and Scott, 2004). In addition, the exit of inefficient firms may lower the average costs of production. The predicted negative relationship between globalization and sectoral inflation, which will be

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[21]This is consistent with other studies. Kamin, Marazzi, and Schindler (2004) find that China's exports to the United States have only had a marginal impact on import and producer prices in the United States. Similarly, Feyzioglu and Willard (2006) suggest that prices in China have a fairly small and temporary impact on inflation in the U.S. and Japan, although they find evidence of stronger price linkages in some sectors.

[22]See Orphanides and Wilcox (2002) for a discussion of such an "opportunistic approach to disinflation." It should be noted that the role of globalization in disinflation in this case differs from that discussed earlier, as it affects decisions through its impact on the policy environment rather than policy incentives.

[23]See, for example, Chapter IV of the April 2005 *World Economic Outlook* on the long-run oil market outlook.

Box. 3.2. Globalization and Low Inflation in a Historical Perspective

The present era of globalization and low inflation has an important precedent: 1880–1914, the era of the classical gold standard. In the context of this chapter, the most noteworthy feature of this precedent is the coincidence of globalization with secular deflation from 1880–96. Given current views that lower cost producers are "exporting deflation," a reexamination of the deflation experience under the classical gold standard clearly is of interest. This box documents the extent of deflation, examines the underlying forces, assesses the impact of deflation on economic activity, and discusses implications for today.

Today, it is widely believed that the deflation of 1880–96 reflected the interaction of favorable supply disturbances—productivity growth shifted the aggregate supply curve to the right—and the nominal anchor, the classical gold standard. The latter prevailed from 1880 to 1914, when the majority of countries adhered to the rule of fixing the prices of their currencies in terms of gold (Bordo, 1999). The world price level was determined by the demand and supply of monetary gold, which depended on gold production on the one hand and the relative demands on gold for monetary and nonmonetary (e.g., jewelry, industrial use) purposes on the other (Barro, 1979). In the long run, global prices were anchored by the (roughly constant) marginal cost of producing gold.

In this setup, disturbances to the demand and supply of gold could lead to persistent, but not necessarily permanent, changes in the price level because the stock of monetary gold was exogenous in the short to medium term. In the case of global disturbances, the global price level would change. For example, the increased global income associated with a global productivity boom would boost the demand for monetary gold, which, with an unchanged stock of monetary gold, would lead to deflation initially. Over time, however, the stock of monetary gold would adjust because of the implied changes in

Note: The main author of this box is Michael Bordo.

the real price of gold (the nominal price of gold divided by the price level). Under deflation, the rise in the real price would encourage gold production and the search for new sources, as well as the conversion of nonmonetary gold into monetary gold (see, among others, Rockoff, 1984). The resulting increase in the world monetary gold stock would generate inflation and thereby offset the price level effects of the earlier deflation.
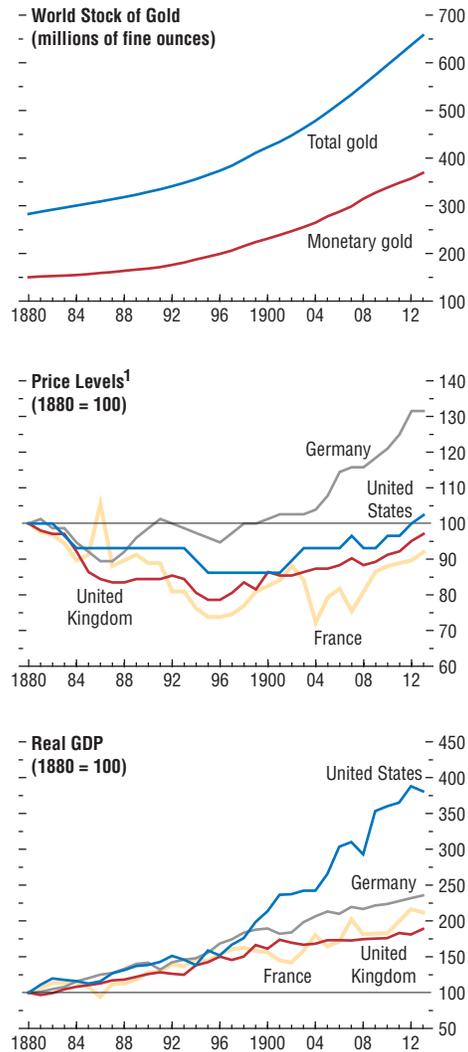
Reflecting this mechanism, the gold standard era was characterized by alternating episodes of inflation and deflation. The top panel of the figure shows the movements in the world gold stock and the world monetary gold stock. Gold production remained fairly stable until the 1890s. Then the combination of the development of the cyanide process for extracting gold from low-grade ore and the discovery of low-grade deposits in South Africa led to a dramatic expansion in world gold production.

The middle panel of the figure documents the price level behavior during 1880–1914 era in the four core countries of the era—the United Kingdom, France, Germany, and the United States. The broad picture is one of deflation followed by inflation. Prices fell in all countries between 1880 and 1896 but rose subsequently. The lower panel shows growth in the four countries. While somewhat slower during the deflation phase, the sustained growth during the era does not seem consistent with the proposition that this was the period of the "great depression" in the United Kingdom or the "longue stagnation" in France, as economic historians used to classify the years 1880–96 (e.g., Craig and Fisher, 2000).

What were the effects of the secular deflation on economic activity during the first era of globalization? Bordo, Landon Lane, and Redish (2004 and 2005) addressed this issue for the 1880–1914 experience of the four core countries using a structural vector-autoregressive model. Specifically, they decompose fluctuations in prices, output, and the money stock in each country into the effects of a gold stock shock, a domestic aggregate supply shock, and a domestic

Gold, Prices, and Growth Under the Classical Gold Standard

World Stock of Gold
(millions of fine ounces)

Total gold

Monetary gold

Price Levels[1]
(1880 = 100)

Germany

United States

United Kingdom

France

Real GDP
(1880 = 100)

United States

Germany

United Kingdom

France

Sources: Bordo and others (2005); and IMF staff calculations.
[1]Implicit GDP deflator.

aggregate demand shock. The key presumption underlying the analysis is that the impact of deflation depends on the underlying disturbance. Deflation owing to shocks to aggregate supply is likely to be different in its interaction with economic activity than deflation due to, say, stagnant gold production or a banking panic.

The results show that in European economies, output movements were mainly driven by supply shocks, while price level fluctuations were dominated by gold stock shocks. In the United States, deflation was driven by positive supply shocks, but also by adverse gold stock shocks (which helped induce serious banking panics) in the mid-1890s, which had real effects. Overall, the evidence suggests that the deflation experience in the nineteenth century was benign, reflecting the prevalence of favorable supply shocks—for example, the second industrial revolution—that were rapidly reflected in real income gains, as there were virtually no nominal rigidities. The latter may not be the case today. Moreover, while pre-1914 deflation seemed benign in its impact, contemporaries did not feel good about it. The common perception was that deflation was depressing. This may have reflected the fact that deflation was largely unanticipated by certain groups affected by its redistribution effects or money illusion.

Overall, the experience with the classical gold standard suggests that the risks of deflation are clearly different today, given that positive inflation targets allow for the more immediate accommodation of increased money demand with strong growth. However, with regard to the credibility of the nominal anchor, the experience of the gold standard still seems relevant. If the nominal anchor is credible, and if agents expect inflation to be anchored at a low level, then temporary disturbances (business cycles)—including, as discussed in the chapter, a large fall in import prices—will lead to temporary departures of inflation from the long-run average. Indeed, under the gold standard, the expected inflation rate hovered around zero and long-run price level uncertainty was low, which is consistent with the observed mean-reversion in price levels (Klein, 1975; Borio and Filardo, 2004; and Bordo and Filardo, 2005). Moreover, the persistence of price level changes was low and symmetric. These features are akin to key characteristics of today's inflation behavior.

Box 3.3. Exchange Rate Pass-Through to Import Prices

Exchange rate pass-through measures the extent to which movements in the nominal exchange rate affect either domestic import prices (first stage) or the consumer price level (second stage). Empirical evidence suggests that the rate of exchange rate pass-through (first and second) varies widely across countries, reflecting their ability to influence import prices in an increasingly global setting, but in general tends to be less than complete.[1] Moreover, the degree of exchange rate pass-through in advanced economies appears to have declined significantly since the 1980s (see the figure). Lower exchange rate pass-through implies that larger movements in the exchange rate are necessary to reduce current account imbalances or influence growth via the import/exchange rate channel. On the other hand, lower exchange rate pass-through may also enhance the performance of monetary policy by limiting the impact of exogenous exchange rate fluctuations on the domestic price level and output.

A number of competing arguments have been offered for the decline in exchange rate pass-through, a subset of which includes:

• *Lower headline inflation.* Exchange rate pass-through is linked explicitly to the level of inflation and, indirectly, to domestic monetary conditions (positive association). In contrast to the standard literature on the determinants of exchange rate pass-through, which emphasizes market structure and the elasticity of demand, Taylor (2000) argues that in a stable, low inflation environment supported by a credible inflation-targeting regime, firms reduce the extent to which they pass on exchange-related cost increases because the

Note: The authors of this box are Kornélia Krajnyák and Sam Ouliaris.

[1]See Goldberg and Knetter (1997) for an extensive review of the empirical literature on exchange rate pass-through. In the case of the United States, they conclude that the median estimate of exchange rate pass-through is approximately 0.5. More recent studies (e.g., Marazzi, Sheets, and Vigfusson, 2005) suggest that the first stage exchange rate pass-through coefficient has declined to 0.2.

Response of Import Prices to Nominal Effective Exchange Rate Movements
(Percentage decline: 1990–2002 over 1975–89)
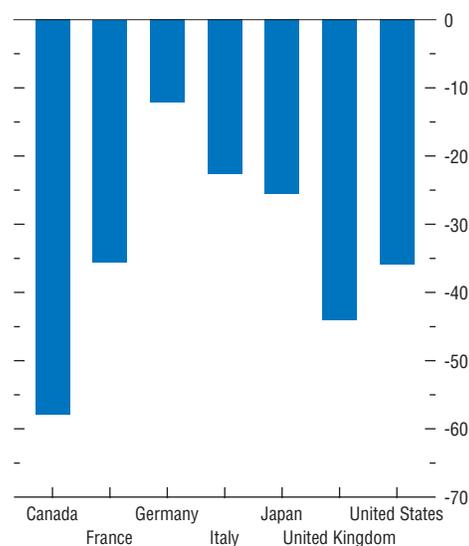
Source: IMF staff calculations.

latter are likely to be perceived as temporary in such an environment. Others link exchange rate pass-through to inflation by arguing that the costs of maintaining fixed prices (namely, forgone profits) are much greater than the costs of changing prices. Numerous empirical papers have obtained support for Taylor's (2000) hypothesis by including the level and variability of inflation in standard empirical models of exchange rate pass-through (e.g., Choudhri and Hakura, 2001).

• *Changes in import composition.* Campa and Goldberg (2002) question the macroeconomic/monetary explanation for the decline in exchange rate pass-through exposited in Taylor (2000). In particular, they argue that the decline in exchange rate pass-through is better explained in terms of a shift in the import bundle away from energy and raw

materials toward manufactured goods, which have lower estimated pass-through rates. While Campa and Goldberg (2002) confirm that countries with lower inflation have lower exchange rate pass-through coefficients, they conclude that the decline in exchange rate pass-through is due more to a change in the composition of imports rather than lower inflation. This view is largely endorsed by Marazzi, Sheets, and Vigfusson (2005) for the United States, but the authors also emphasize the role of China's increasing presence in the U.S. market.

• *Structural reforms.* Since the early 1980s, a number of industrial countries have implemented structural reforms that have resulted in substantial gains in multifactor productivity, lower unit costs, and greater choice to consumers (see Rogoff, 2003; and Chen, Imbs, and Scott, 2004). As a result, firms now operate in a more competitive environment relative to the 1980s, thereby reducing their ability to pass on cost increases. Moreover, by lowering unit costs of production, multifactor productivity gains increase the capacity of firms to absorb exchange rate losses, possibly lowering exchange rate pass-through. Of course, the validity of the structural reform argument relies on the presence of imperfect competition and excessive "quasi-rents" (or "abnormal" markups) to monopolistic firms prior to the introduction of the reforms. Exchange rate pass-through could rise once these

markups decline to more normal levels— for instance, as the level of competition approaches what is prevalent in energy and commodity markets. Evidence in favor of the "structural reform" hypothesis is reported in Ouliaris (2006), who finds that the decline in exchange rate pass-through can be better explained using structural reform indicators rather than the average rate of inflation or other proxies for monetary conditions. Moreover, the decline in pass-through is evident only in the short-run/business cycle components of the data, and is therefore likely to be *temporary* in nature.

Has exchange rate pass-through declined permanently? If structural reforms or the changing composition of international trade are the main driving factors, then the decline is likely to be temporary. Rationalizing lower pass-through by appealing to "lower cost producers" or "decreasing importer's willingness to increase domestic prices" relies on the existence of significant markups over costs or "quasi-rents" that are likely to be eventually eroded in a heightened competitive environment. The tighter margins will naturally limit the ability of competitive firms to absorb nominal exchange rate movements, placing upward pressure on the degree of exchange rate pass-through to import prices. However, the eventual impact on final goods prices will be influenced by the conduct and credibility of monetary policy, particularly in an inflation-targeting setting.

referred to as the "global competition hypothesis," has several implications at the sectoral level. For example, if increased exposure to foreign competition has helped to contain inflation, one would expect smaller price increases in manufacturing than in services, as the former

sector has long been, and continues to be, more open than the latter.

Patterns in overall producer price inflation are very similar to those for consumer price inflation discussed earlier.[24] After declining in the late 1980s and early 1990s, producer price

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[24]The analysis is based on sectoral producer prices and their components from the OECD's Structural Analysis (STAN) Database. For consistency, much of the analysis is performed for the advanced economies, with the most complete data coverage for the period 1987–2003 (Austria, Denmark, Finland, France, Germany, Italy, Japan, Korea, Luxembourg, Norway, and the United States). Unless mentioned otherwise, sectoral averages are simple averages of the country data. See Appendix 3.2 for a description of the data.

Figure 3.9. Inflation in Manufacturing and Business Services in Selected Industrial Countries[1]
(Annual percent change)

While inflation in manufacturing has been consistently below overall inflation, business services have also significantly contributed to the decline in inflation.

Producer Prices[2]

Median   Lower and upper quartiles

Relative Producer Prices[3]
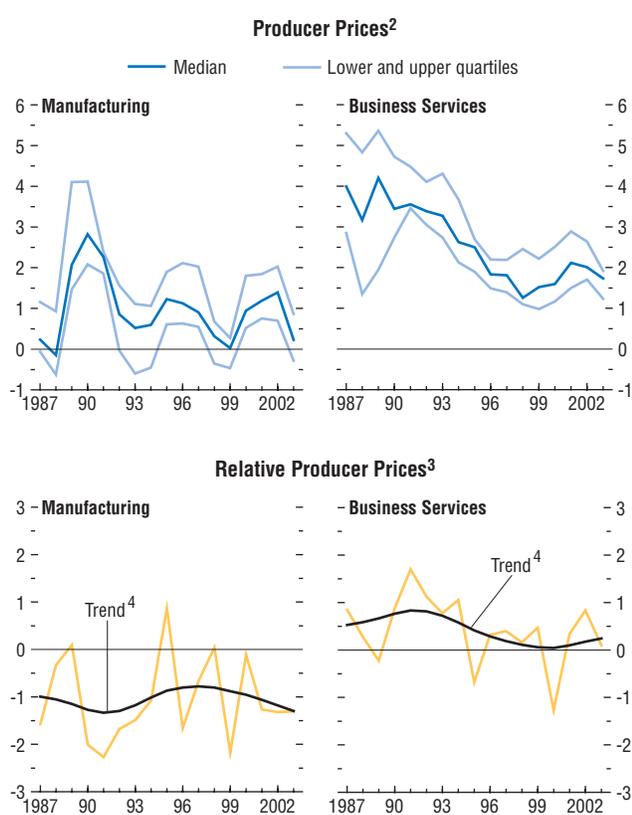
Sources: OECD, STAN database; and IMF staff calculations.
[1]Sample includes Austria, Denmark, Finland, France, Germany, Italy, Japan, Korea, Luxembourg, Norway, and the United States.
[2]Three-year moving average.
[3]Difference between sectoral producer price inflation and producer price inflation in all sectors.
[4]Trend derived using Hodrick-Prescott filter.

inflation has been about stable from the mid-1990s. Comparing manufacturing and business services—the two largest sectors that have been most exposed to globalization-related changes over the past decade or so—shows that in the former, producer price increases have consistently been below those registered in overall prices (Figure 3.9).[25]

In contrast, while changes in producer prices in business services used to exceed overall producer price inflation, they have fallen at a faster rate than overall inflation since the mid-1990s, thereby contributing at least as much as manufacturing to the decline in overall producer price inflation.[26] A possible explanation for this finding could be the substantial extent of deregulation in important business services sectors, including, for example, telecommunications, although improvements in the measurement of prices of services may also have played a role.[27]

Within manufacturing, relative prices have, on average, declined less in low-tech sectors than in high-tech sectors (the distinction is based on a measure of spending on research and development). Since the mid-1990s, however, both low- and high-tech sectors have experienced a similar trend of disinflation (Figure 3.10).[28] Likewise,

[25]Together, manufacturing and business services sectors account for some 70 percent of a typical industrial country economy in the sample. The other sectors are agriculture, mining, construction, utilities, and community, social and personal services (including government). Details on the sectors and the subsectors therein are provided in Appendix 3.2.
[26]Other sectors' contributions are smaller in part because their weights in the overall economy are smaller.
[27]Output volumes (and hence prices) are notoriously difficult to measure in services due to the complexity of the products. As a result, part of the productivity increases or quality enhancements are recorded as price increases instead of volume increases. To the extent that measurement may have improved over the last 15 years, this could partly explain a decrease in measured business services inflation.
[28]It should be noted that sectoral price changes are often expressed relative to the aggregate rate of producer price inflation in order to eliminate fluctuations in inflation that are common to all sectors. An example would be fluctuations due to monetary policy, which in itself tends to affect all sectoral prices equally in the longer run.

price increases in high-skill sectors (based on average education levels of the labor force) have, on average, been lower than in low-skill sectors, both in manufacturing and in the overall economy.[29]

Overall, the most important recent changes in broad patterns of sectoral producer price developments appear to have occurred in some services and high-skill, high-tech manufacturing sectors. At first glance, these results are difficult to reconcile with a narrow version of the global competition hypothesis that views most of the competitive pressure arising from the integration of developing and emerging market countries into the world trade system as being in low-tech and low-skill sectors. The results are, however, consistent with a broader notion of the hypothesis that views trade integration more generally, including in high-end manufacturing, as the driving force behind increasing global competition. China, for example, exports a large and increasing set of products that may be classified as high-tech or high-skill.[30] The findings may also reflect the impact of the information technology revolution, which has led to sharp declines in the relative prices of high-tech and high-skill electronics goods. Finally, it is worth noting that the data also suggest that increased competition may have begun to affect price developments in the business services sectors.

How Has Globalization Affected Prices in Different Sectors of the Economy?

How do these sectoral patterns in inflation relate to globalization? To analyze this, changes in relative producer prices in a sector were related to changes in the sector's exposure to globalization, as measured by its import-to-production ratio (Chen, Imbs, and Scott, 2004).

Figure 3.10. Relative Producer Price Inflation by Technological and Skill Intensity[1]
(Annual percent change)

Interestingly, inflation has been higher in low-tech sectors than in high-tech sectors. In the overall economy, low-skill sectors also have had higher inflation than sectors classified as high-skill.
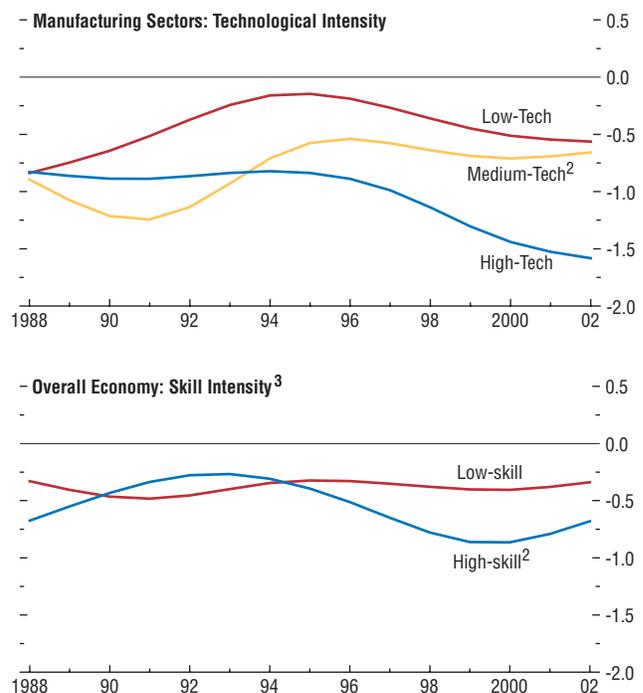
Sources: OECD, STAN database; and IMF staff calculations.
[1]Growth in the ratio of sectoral producer price indices and the producer price index in all sectors. See Appendix 3.2 for the list of sectors included within each grouping.
[2]Excludes refined petroleum products.
[3]Excludes agriculture, mining, and community, social, and personal services sectors.

[29]Agriculture, mining, refined petroleum, and community, social, and personal services are excluded from both the low-skill and high-skill aggregates.
[30]According to Rodrik (2006), the implied income level in China's export basket is much higher than its actual (PPP-adjusted) income.

Figure 3.11. Producer Price Inflation and Openness
(1987–2003; annual percent change)

Changes in trade openness and relative producer prices are negatively correlated.

Sources: OECD, STAN database; and IMF staff calculations.
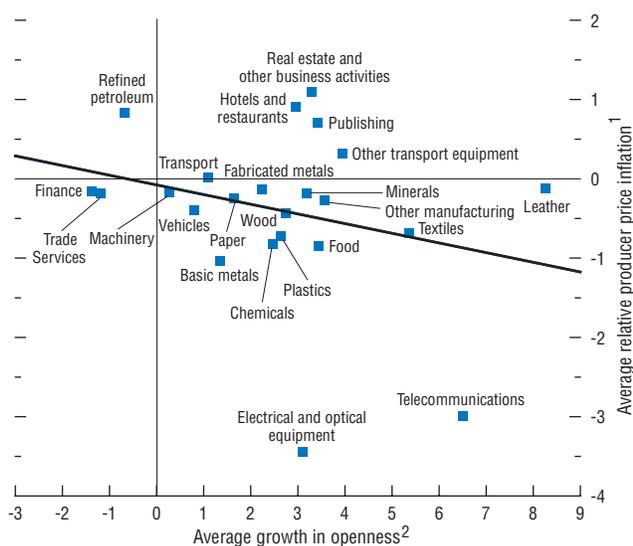[1]Growth in the ratio of sectoral producer price indices and the producer price index in all sectors.
[2]Growth in a sector's import-to-production ratio.

The expectation is that the relationship is negative; faster increases in trade openness in a sector would be associated with smaller producer price increases. Simple correlations confirm this expectation, as the relationship between changes in the relative producer price and changes in the import ratio is indeed negative (Figure 3.11). In particular, in textiles, telecoms, and electrical and optical equipment, the strong increases in openness are clearly associated with negative changes in relative prices.[31]

Econometric analysis supports this broad finding (details of the econometric analysis can be found in Appendix 3.2). The analysis is performed both for the manufacturing sectors, for which trade data are more readily available and are of better quality, and for the manufacturing and business services sectors together.

The results show that changes in the import ratio and changes in relative producer prices are negatively and significantly related (Table 3.3). According to the central estimates for the manufacturing sector, a 1 percent increase in the import ratio reduces the relative producer price by about 0.1 percent. The results also suggest that the effect tends to be the same for manufacturing and business services sectors, as simple tests for a differential impact yield insignificant results. Changes in labor productivity also have a significant impact on changes in relative producer prices, with a 1 percent increase in labor productivity also reducing relative producer prices by about 0.l percent.[32] As shown in Appendix 3.2, the impact of globalization on producer prices is robust and does not depend on a specific model or a specific variable to measure globalization, even when allowing for reverse causality (including for productivity growth).

[31]A similar picture emerges for the simple correlation between the relative unit labor cost growth and the import ratio growth.
[32]Increased productivity growth does, to some extent, result from increased competitive pressures due to globalization, but this indirect effect of globalization on inflation is very small, as detailed in the next subsection.

Table 3.3. Impact of Trade Openness on Relative Producer Price Inflation[1]

Explanatory Variables	Dependent Variable: Changes in Relative Producer Prices		
	Manufacturing[2] (16 sectors)		Manufacturing and business services[2] (22 sectors)
	1977–2003 (all countries available)	1988–2003 (core countries)[3]	1977–2003 (all countries available)
Change in import share	−0.11**	−0.12***	−0.12**
Difference for services[4]	. . .	. . .	−0.01
Change in labor productivity	−0.10***	−0.09***	−0.10***
Difference for services[4]	. . .	. . .	−0.08

Source: IMF staff calculations.

[1]All variables are in natural logarithms. The equations are estimated by two-step feasible generalized method of moments treating changes in import shares as an endogenous variable. Control variables include the dollar exchange rate interacted with sectoral dummies (effect through cost of intermediates), and sectoral and country dummies. *** denotes statistical significance at the 1 percent level; ** at the 5 percent level.

[2]The refined petroleum sector is excluded from the regressions because its behavior is strongly affected by oil price developments.

[3]Restricted to countries used in the descriptive analysis of sectoral inflation patterns.

[4]Variables interacted with a dummy variable indicating a business services sector.

Put another way, the increase in openness explains about 30 percent of the 1 percent inflation differential between manufacturing and the overall economy during 1987–2003 while labor productivity growth accounts for about 40 percent of this differential (Figure 3.12). Increased openness has played a particularly important role in Japan and the United States, where the manufacturing sectors appear to have opened relatively more during the past 15 years than in other countries.

Within manufacturing, increased openness contributed about twice as much to lower inflation in low-tech sectors than in high-tech sectors, in line with what conventional wisdom would have predicted.[33] Interestingly, changes in openness were roughly similar between high-skill and low-skill manufacturing sectors, and the differ-

[33]Part of the difference in relative price changes between high-tech and low-tech sectors remains unexplained: the model underpredicts the fall in relative prices of high-tech sectors while it overpredicts the fall in low-tech sector prices.

Figure 3.12. Contributions to Declines in Relative Producer Prices[1]

(Percent; annual average)

Increased openness contributed approximately 0.3 percentage point to the average decline in relative producer prices in manufacturing.
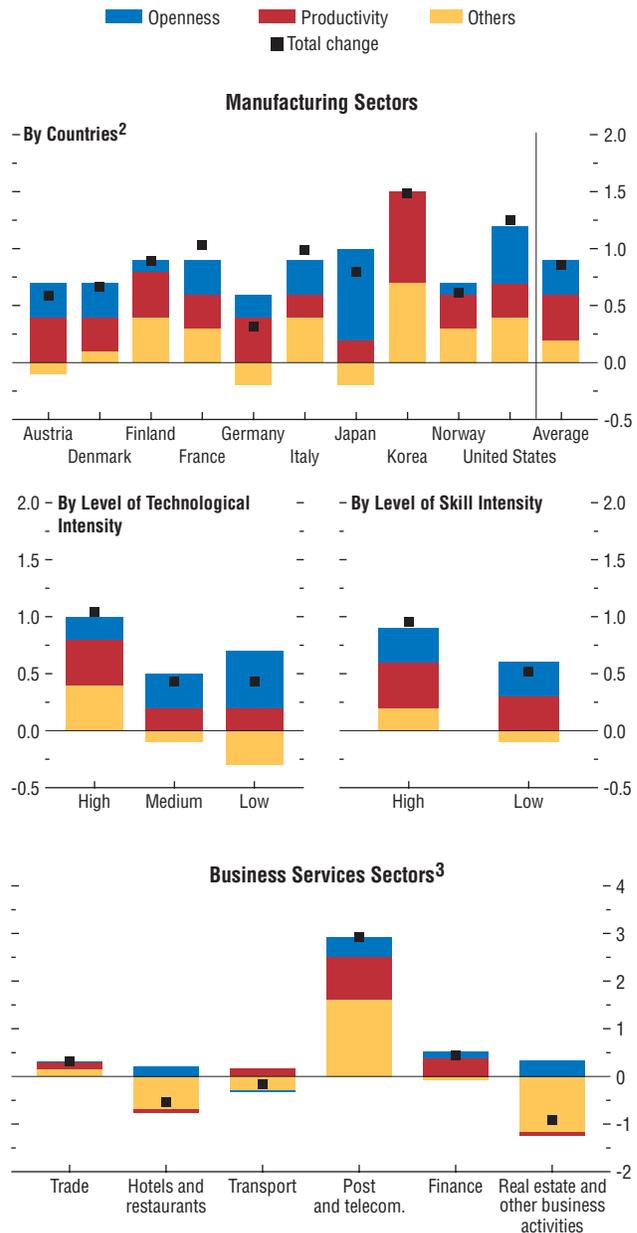
Sources: OECD, STAN database; and IMF staff calculations.

[1]Based on estimates of the global competition hypothesis reported in column two of Table 3.3. Positive values reflect contributions to decreases in relative producer prices while negative values reflect contributions to increases in relative producer prices.

[2]Averages are for the period 1987–2003 except for France (1987–2002), Germany (1991–2003), and Korea (1995–2003).

[3]Averages are for the period 1992–2002.

Figure 3.13. Producer Price Inflation by Cost Components
(Annual percent change)

The decline in unit labor cost increases appears to be greater than the decline in producer price inflation (PPI). On the other hand, changes in other cost components, such as unit gross operating surplus, have been moving relatively closely with PPI.

Unit gross operating surplus

PPI

Unit labor cost

1988   91   94   97   2000   03
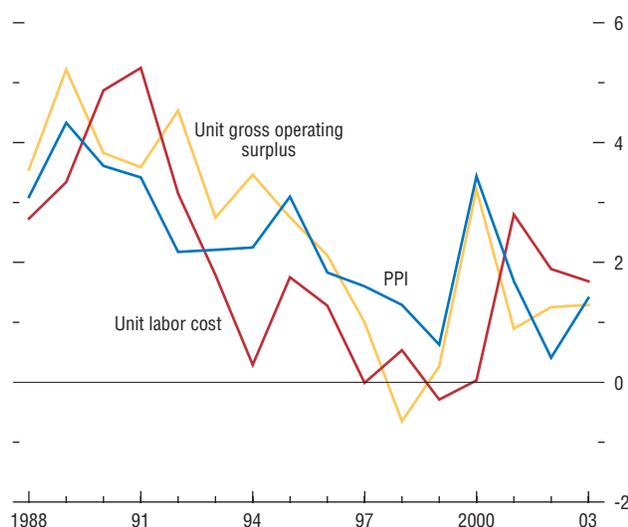
Sources: OECD, STAN database; and IMF staff calculations.

ences in relative inflation rates between these two types of sectors appear to be primarily due to higher labor productivity growth in high-skill sectors. Looking at business services, the contribution of globalization to lower inflation was as strong as in manufacturing in a number of sub-sectors, especially telecoms, other business activities, and hotels and restaurants (the latter category includes some tourism services). In finance and telecoms, sizable productivity increases also had a moderating effect on sectoral producer prices.

The impact of globalization in the manufacturing sectors in most countries has increased in recent years. While openness explained only one-quarter of the decline in relative prices of manufacturing over the period 1987–94, it accounted for about 40 percent of the decline over the more recent period. This acceleration of globalization was visible at all levels of technological intensity, but more so in low-skill than high-skill activities.

Finally, if trade integration in business services sectors were to reach the levels currently seen in manufacturing—which would mean that the average import ratio in business services would quadruple[34]—the relative producer prices for these services would, on average, decline by slightly less than 20 percent. This clearly illustrates the substantial impact that further trade integration in services could have. Clearly, such an increase in openness would occur gradually, and the year-on-year declines in relative prices of business services would thus be smaller.

Overall, therefore, the analysis provides robust support for the global competition hypothesis, with differences in the openness explaining about one-third of the differences in relative producer prices. That said, in terms of the actual

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[34]This illustrates how despite strong opening in some services sectors in recent years, levels of openness in business services remain low on average compared to manufacturing, even when the provision of services through foreign affiliates is taken into account (considered to be imports).

Table 3.4. Producer Price Inflation by Cost Components[1]
(Average deviations from changes in the overall economy in percent)

	Manufacturing and Business Services		Manufacturing				
	Manufacturing	Business services	High-tech	Medium-tech[2]	Low-tech	High-skill[2]	Low-skill
Changes in producer prices and costs[3]							
Producer prices	**–1.0*****	0.4	**–0.9****	–0.6	–0.4	**–0.9****	–0.6
Unit labor costs	**–1.2*****	–0.1	**–1.5****	–0.7	–0.6	**–1.4****	–0.7
Nominal labor compensation	**0.6*****	–0.2	**0.7****	0.2	0.3	**0.7****	0.3
Real productivity	**1.8*****	–0.1	**2.7*****	1.1	1.0	**2.6*****	1.2
Unit intermediate costs	**–1.0*****	1.1	–0.8	–0.6	–0.5	–0.9	–0.6
Unit gross operating surplus[4]	–0.8	–0.2	2.7	–0.7	1.2	4.0	0.2
Contribution to producer price inflation by cost components[5]							
Unit labor costs	**–0.4*****	—	**–0.5****	–0.2	–0.3	**–0.4***	–0.3
Unit intermediate costs	**–0.2*****	0.2	–0.2	–0.1	0.1	**–0.3+**	0.0
Unit gross operating surplus[4]	**–0.4*****	0.2	–0.3	–0.3	–0.2	–0.2	–0.3

Source: IMF staff calculations.

[1]A bold entry indicates that the deviation from the country average is significant at the 5 percent level. Significant differences between sectors (e.g., high-tech versus medium-tech and low-tech) are marked by *** (1 percent confidence level); ** (5 percent confidence level); * (10 percent confidence level); or + (15 percent confidence level).

[2]The refined petroleum sector is excluded from medium-tech and high-skill because its behavior is strongly impacted by oil price changes.

[3]The entry "–1.0" for changes in producer prices in manufacturing means that annual inflation in manufacturing was on average (across countries and years) 1 percentage point lower than inflation in the overall economy.

[4]The sample size is somewhat smaller for the unit gross operating surplus.

[5]A contribution of unit labor costs to producer price inflation in manufacturing of –0.4 means that changes in unit labor costs imply that annual producer price inflation should be on average –0.4 percentage points below overall producer price inflation.

moderation of domestic producer prices, the estimated magnitudes of the globalization effects are relatively small. On average, the increased trade openness has reduced relative producer prices in manufacturing by about 0.3 percentage point a year over the past 15 years.

A Cost Perspective on the Moderation in Sectoral Producer Prices

How has the moderation in sectoral producer prices been mirrored in producer's cost components, especially unit labor costs? By definition, changes in producer prices must be reflected in changes in at least one of the following components: unit labor cost, unit intermediate cost, unit gross operating surplus (or loss), and unit net taxes. As discussed in Appendix 3.2, the change in producer prices is just the weighted average of changes in its components, with weights given by the cost shares.

At the economy-wide level, the most noticeable feature of cost developments is the greater decline in unit labor cost increases compared to producer price inflation during the mid- to late 1990s (Figure 3.13). In contrast, changes in other cost components appear to have closely followed changes in overall producer prices. As a result, the labor share declined during the 1990s.[35]

Differences in unit labor costs also appear to explain most of the differences in cost developments between manufacturing and business services and within manufacturing (Table 3.4). Labor compensation in manufacturing increased in nominal terms at a faster rate and in business services at a slower rate than in the overall economy. However, in manufacturing, the faster rise in nominal compensation was more than offset by strong labor productivity growth, so that unit labor costs increased at a rate below that in the overall economy. Similarly, within manufactur-

[35]The labor share is the ratio of the unit labor cost over the unit producer price.

Table 3.5. Impact of Trade Openness on Productivity, Labor Compensation, and Unit Labor Costs[1]
(Manufacturing subsectors relative to the overall economy)[2]

	Dependent Variable		
Explanatory Variables	Change in relative productivity	Change in relative labor compensation	Change in relative unit labor cost
Change in import share	0.12**	−0.10***	−0.09***
Change in relative labor productivity	. . .	0.63***	−0.71***
Interacted with import share	. . .	−0.18*	. . .

Source: IMF staff calculations.

[1]All variables are in natural logarithms. The equations are estimated by two-step feasible generalized method of moments treating changes in import shares and changes in relative labor productivity as endogenous variables. Other control variables include sectoral and country dummy variables. *** denotes statistical significance at the 1 percent level; ** at the 5 percent level; and * at the 10 percent level.

[2]The sample covers the period 1977–2003, the maximum number of countries, and 16 manufacturing subsectors. The refined petroleum sector is excluded from the regressions because its behavior is strongly affected by oil price developments.

ing, much stronger productivity growth, not fully compensated by stronger increases in nominal labor compensation, accounted for the smaller increase in unit labor costs in high-tech sectors compared to the medium- or low-tech sectors, and in high-skill sectors compared to low-skill sectors.

Regarding other costs, relative declines in unit intermediate costs appear to have contributed to lower relative producer price inflation in manufacturing, but not in business services, where these costs actually rose faster than in the overall economy. Finally, the rate of change in the gross operating surplus—which includes both the cost of capital and profits—has declined broadly in line with overall producer price inflation. While there is some evidence that the surplus has increased relatively less in manufacturing than in business services, the difference appears not to be significant.

Econometric analysis confirms that sectoral differences in openness partly explain these pat-

terns in unit labor costs and labor compensation. An increase in openness is found to reduce the response of nominal labor compensation to productivity changes, both directly, as a 1 percent increase in the import ratio of a sector reduces its relative compensation by about 0.1 percent for a given level of productivity growth, and indirectly through a reduction in the response of compensation to productivity growth (Table 3.5). The effects of openness on labor compensation remain negative even if the significant, small positive relationship between openness and productivity (and, therefore, labor compensation) is considered; a 1 percent increase in sectoral openness raises sectoral productivity by 0.1 percent, after controlling for the overall level of productivity in the economy.[36] Unit labor costs are affected in a similar way by openness.[37]

Overall, therefore, the empirical evidence appears to support the proposition that the moderating effects of globalization on domestic producer prices are restraining unit labor costs and labor compensation. In addition, a fall in relative unit intermediate costs appears to have played some role in explaining the faster decline in relative prices in manufacturing. This could reflect outsourcing, which, in turn, could in part explain the behavior of unit labor costs. Evidence for the gross operating surplus is less conclusive. Finally, the analysis also highlights the important role that productivity differentials play in explaining differences in unit labor cost and wage behavior across sectors.

Summary and Policy Conclusions

This chapter has examined the proposition that globalization has been an important factor behind low and steady inflation in recent years. The main points arising from the chapter are as follows.

[36]The relationship between openness and productivity might actually be stronger but data limitations prevent obtaining better estimates by controlling for more determinants of sectoral productivity (such as spending on research and development).

[37]The effect of labor productivity on unit labor costs is negative but smaller than minus one (about –0.7) because productivity increases are partly absorbed by compensation gains.

- Over the medium term, the prevailing nominal anchor—such as the central bank's inflation target—determines inflation. Therefore, the impact of globalization on inflation will be temporary unless it changes the overarching objectives of monetary policy. This is unlikely in industrial countries given the already low single-digit inflation targets (explicit or implicit). In emerging market and developing countries, however, greater openness appears to have been—and is likely to remain—an important factor behind the sustained improvement in inflation.

- The direct effect of globalization on inflation through import prices has in general been small in the industrial economies. That said, when global spare capacity increases—such as during the 1997–98 Asian financial crises and the 2001–02 global slowdown—import price declines have had sizable effects on inflation over one- to two-year periods, shaving more than 1 percentage point off actual inflation in some advanced economies. With low average inflation, such effects are economically significant. This lends support to the view that inflation targets should not be set too close to zero—otherwise shocks of this size could result in periods of deflation.

- Globalization has contributed to reducing the sensitivity of inflation to domestic capacity constraints in advanced economies over the past couple of decades—for example, through the impact on the labor markets and wages. As global economic developments have become increasingly important for domestic inflation, they will require closer monitoring by monetary policymakers in the years ahead.

- Globalization has had a significant effect on relative prices in industrial economies. Sectors that have become more exposed to foreign competition have seen the largest relative price declines in recent years. Nevertheless, globalization is not the only factor driving rel-

ative price changes. While openness has been important, particularly in low-tech and low-skill sectors, productivity growth has also contributed significantly to relative price changes, particularly in the high-tech manufacturing and services sectors. Indeed, while price increases in the manufacturing sector have consistently been below those in services, the decline in inflation in some services sectors since the mid-1990s has been more pronounced, contributing as much to the decline in overall producer price inflation as the manufacturing sector.

Against this background, the immediate policy concern is judging how globalization may impact inflation in the future. Globalization has undoubtedly provided some break on inflation in the industrial economies in recent years and has allowed for a more measured monetary policy tightening to date. Ongoing trade integration will continue to put downward pressure on prices in many industries in the foreseeable future, although the extent of these pressures will vary with the economic cycle. The experience with earlier episodes of rapid integration, such as those of Japan from the mid-1950s, suggests that China's share in world trade may double over the next 10 years or so.[38] Moreover, international trade in services is also likely to accelerate, leading to declining relative prices in the concerned sectors.

Notwithstanding these developments, however, globalization cannot be relied upon to keep a lid on inflationary pressures in present circumstances. Strong global growth and diminishing economic slack have reduced the restraining impact of declining import prices on inflation, and with strong global growth expected to continue, the primary risk is that a further upturn in import prices could result in stronger inflationary pressures going forward, particularly in countries that are well advanced in the economic cycle. The possibility of further, partly globalization-related, commodity price increases

[38]See Chapter II in the April 2004 *World Economic Outlook.*

Table 3.6. Inflation in Advanced Economies: SUR Estimates

Estimated Equation: $\pi_{it} = c_i(1 + \phi Credib_{it}) + \alpha_i(1 + \theta Credib_{it})\pi_{it-1} + \beta_i(1 + \gamma Open_{it}^{DV} + \lambda Credib_{it}^{DV} + \delta\overline{\pi}_{it}^{DV} + \chi Bargain_{it}^{DV})y_{it} + \varepsilon_{it}$

Model	(1)	(2)	(3)	(4)	(5)
c_i (average)	0.010***	0.013***	0.011***	0.010***	0.012***
ϕ	−0.091	. . .	−0.309*	−0.105	−0.098
α_i (average)	0.768***	0.641***	0.774***	0.763***	0.748***
θ	−0.243***	. . .	−0.232***	−0.241***	−0.275***
β_i (average)	0.223***	0.312***	0.217***	0.237***	0.201***
γ	−2.711***	−1.719*	−1.915*	−2.517***	−1.737+
λ	−0.309	−0.154	. . .	−0.225	. . .
δ	. . .	. . .	0.481	. . .	. . .
χ	. . .	. . .	. . .	−0.233	. . .
Oil price					
Current (average)	0.032***	. . .	0.026***	0.032***	. . .
Lagged (average)	0.020***	. . .	0.021***	0.020***	. . .
Import prices × import share					
Current (average)	. . .	. . .	. . .	. . .	0.224***
Lagged (average)	. . .	. . .	. . .	. . .	0.122*
Time dummies	No	Yes	No	No	No
Memorandum:					
Inflation-output elasticity[1]					
1960	0.26	0.31	0.35	0.27	. . .
1983	0.27	0.31	0.24	0.27	0.19
2004	0.17	0.24	0.19	0.17	0.16
Adjusted R^2 (average)	0.823	. . .	0.812	0.817	0.726
Sample	1960–2004	1960–2004	1960–2004	1960–2004	1970–2004
Number of observations	333	333	284	333	278

Source: IMF staff calculations.

Notes: The inflation model was estimated for Australia, Canada, Germany, France, Italy, Japan, the United Kingdom, and the United States using the Seemingly Unrelated Regressions estimator. *Credib* stands for the monetary policy credibility measure of Laxton and N'Diaye (2002); *Open* denotes a country's openness to trade; $\overline{\pi}$ is the average inflation level; and *Bargain* is the wage bargaining index of Elmeskov, Martin, and Scarpetta (1998) and Nicoletti and others (2001). The variables labeled *DV* are expressed as deviations from the sample mean. *Average* refers to the simple average of country-specific coefficients or regression statistics. *** denotes statistical significance at the 1 percent level; ** at the 5 percent level; * at the 10 percent level; and + at the 15 percent level.

[1]PPP-weighted average of the sample countries.

adds to these upside risks from the external sector. Monetary policymakers must therefore remain vigilant for any signs of a pickup in inflation in the period ahead.

Appendix 3.1. Sample Composition, Data Sources, and Methods

The main author of this appendix is Martin Sommer.

This appendix provides further details on the sample composition, the data and their sources, and the empirical strategies used in the analysis of inflation in the chapter.

Inflation Model

The inflation model presented in Table 3.6 consists of eight equations, one for each country in the sample: Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. Most parameters of the model are allowed to vary across countries (constant, average persistence, and average slope of the output-inflation relationship). However, it is assumed that changes in openness, credibility, average inflation, and wage-bargaining index influence these country-specific parameters similarly, through multiplicative terms.[39] To capture changes in inflation persistence over time, the

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[39]Variables labeled *DV* denote deviations from the sample mean. The equation also contains contemporaneous and lagged oil price changes to control for large inflation shocks or, alternatively, import prices.

constant term and the coefficient on past infla-tion depends on a measure of monetary policy credibility detailed below.

$$\pi_{it} = c_i (1 + \phi Credib_{it}) + \alpha_i (1 + \theta Credib_{it}) \pi_{it-1}$$
$$+ \beta_i (1 + \gamma Open_{it}^{DV} + \lambda Credib_{it}^{DV} + \delta \overline{\pi_{it}^{DV}}$$
$$+ \chi Bargain_{it}^{DV}) y_{it} + \varepsilon_{it}.$$

The model is estimated over 1960–2004 using an iterative Seemingly Unrelated Regressions estimator. The starting values for the iterative estimation are Least-Squares estimates of the sys-tem.[40] The inflation-output elasticity and infla-tion persistence in Table 3.1 were calculated for each country separately from specification (4) in Table 3.6, using the country-specific coefficient estimates and actual values of openness, credibil-ity, and other relevant variables. The advanced country average is computed on the basis of pur-chasing-power-parity (PPP) weights.

The counterfactual simulations in Figure 3.8 indicate what inflation might have been in the advanced economies if import prices evolved over 1997–2005 in line with their historical trend. The counterfactual simulations have two versions. In Scenario A, real import prices are assumed to be falling during 1997–2005 at the sample average rate for each country—the advanced economy average rate would be about 1 percent a year. The simulated inflation paths are averaged into an advanced economy aggre-gate using PPP weights. In an attempt to capture the impact of globalization on inflation more precisely, Scenario B removes the impact of oil prices from Scenario A. Real import prices are first decomposed into the contribution of oil prices and non-oil commodities. The scenario then assumes that the contribution of oil prices to import price changes was the same as actual values over 1997–2005 but the contribution of non-oil commodities was at its historical average rate for each country—or about 1.6 percent a year for the advanced economy group average.

Variable Definitions and Data Sources

The variables of the inflation model are defined below. The data sources are listed in parentheses.

- Inflation, π, is defined as the change in the natural logarithm of annual consumer price index (Eurostat; Haver Analytics; national authorities, and *World Economic Outlook*).
- Output gap, *y*, is defined as the difference between the natural logarithm of annual GDP and the natural logarithm of its trend, calcu-lated by the Hodrick-Prescott filter with the smoothing parameter of 100 (Haver Analytics; *World Economic Outlook;* and IMF staff calcula-tions). These estimates of the output gap are similar to the data published by, for example, the OECD.
- Openness, *Open,* is defined as the share of nominal non-oil exports and non-oil imports in GDP (World Bank's *World Development Indicators*). The data on crude oil imports and exports are from the database of International Energy Agency.
- Monetary policy credibility, *Credib,* is calcu-lated using the formula of Laxton and N'Diaye (2002):

$$Credib_{it} = \frac{(R_{it} - R_i^{High})^2}{(R_{it} - R_i^{High})^2 + (R_{it} - R_i^{Low})^2},$$

where R_{it} denotes yield of long-term govern-ment bonds in country i at time t (Haver Analytics; IMF's *International Financial Statistics*; and IMF staff calculations); R_i^{High} denotes the maximum yield in country i over the sample period; and R_i^{Low} is calibrated at 5 percent in line with Laxton and N'Diaye (2002). Since the credibility measure is cal-culated from bond yields, it captures a variety of factors. First, the bond yields reflect expec-tations about future inflation, and therefore also the record of previous stabilization policies and various institutional arrange-

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[40]The estimation results are qualitatively similar when lagged output gap instead of its contemporaneous value is used as a regressor or when the measures of openness and credibility enter the model with a lag, or as a moving average of their historical values.

ments, including central bank independence, transparency, and accountability. Second, the risk premiums in the bond yields are related to the fiscal performance and any institutional commitment to low deficits or debt. In the sample of advanced economies analyzed here, it is likely that the credibility measure mostly reflects behavior of inflation expectations.

- Average inflation, $\bar{\pi}$, is calculated as the simple average of actual inflation rates over $t-2, \ldots, t-12$.
- Oil price is expressed as the change in the natural logarithm of the simple average of the spot prices of the Brent, Dubai, and West Texas Intermediate crude oil varieties (Source: IMF's *Commodity Price System* database).
- Import prices are measured using the import price deflator (*World Economic Outlook*). The inflation model incorporates this variable as the change in the natural logarithm of the real import price.[41] The change in the real import price is weighted by the import share (including oil) to allow for time-varying contemporaneous impact of import prices on inflation. Effectively, the persistence of import price shocks is also allowed to vary over time—to the extent that the coefficient on the inflation lag depends on the credibility of policymakers.
- Index of wage bargaining, *Bargain*, is a summary measure of wage-setting centralization and coordination by Elmeskov, Martin, and Scarpetta (1998). The index reflects the proportion of workers who are members of a trade union, the level at which wages are negotiated (aggregate, sectoral, or firm level), and the degree of coordination between employers and trade unions. The index ranges from one (low) to three (high). The original data set of Elmeskov, Martin, and Scarpetta was updated by Nicoletti and others (2001). Values of the index are assumed unchanged during 2001–04.

Appendix 3.2. A Sectoral Perspective on Globalization and Inflation

The main author of this appendix is Florence Jaumotte.

This appendix provides further details on the data and their sources and the empirical strategy used in the analysis of the relationship between globalization and sectoral prices.

Variables and Their Sources

Most data used in the section are from the OECD's Structural Analysis (STAN) database. The following are the main variables (from STAN unless otherwise noted).

- *Relative producer prices.* The relative producer price of a sector is the producer price of the sector scaled by the overall producer price. Producer prices are defined by the ratio of the value of production at current prices and the volume of production in a sector. The value of production includes the cost of intermediate inputs.
- *Import ratio.* This variable is the ratio of the import value to the value of production in a sector. The imports referred to are those produced by foreign producers in the same sector and not the imports of intermediates by domestic producers in the sector. For services, import data are from the OECD's *Statistics of International Trade in Services* and include, in addition to traditional measures of imports, the services performed by foreign affiliates established and temporary workers posted in the country when available.
- *Labor productivity.* This variable is defined as a ratio of the volume of production in a sector to the number of employees. When data on the number of employees were incomplete, they were spliced using growth rates from total employment (including self-employed and unpaid family workers).
- *Components of unit costs.* The nominal value of production by definition equals the sum of the

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[41]Using real rather than nominal changes is consistent with the theoretical literature (e.g., Ball and Mankiw, 1995). However, estimation results are similar when the nominal changes are used.

Table 3.7. Classification of Sectors by Technological and Skill Intensity

	High-Skill	Low-Skill	Not Classified
Manufacturing			
High-tech	Chemicals Electrical and optical equipment Other transport equipment	Machinery Motor vehicles	
Medium-tech	Refined petroleum	Plastics Minerals Basic metals Fabricated metals	
Low-tech	Publishing	Food Textile Leather Wood Paper	Other manufacturing
Business services	Trade Telecoms Finance Other business activities	Hotels and restaurants Transport	
Other sectors	Utilities	Construction	

Sources: OECD; and IMF staff estimates.

costs of intermediates, costs of labor, gross operating surplus and net taxes.[42]

$$PY = P_{IM}IM + P_L L + GOS + TAXN,$$

where P denotes the producer price and Y the production volume; P_{IM} is the price of intermediates and IM is the volume of intermediates; P_L is the nominal compensation per employee and L is the number of employees; and GOS is the gross operating surplus and $TAXN$ represents the net taxes. Accordingly, the producer price equals the sum of the unit intermediate cost, the unit labor cost, the unit gross operating surplus, and the unit net tax.

$$P = P_{IM}(IM/Y) + P_L(L/Y) + GOS/Y + TAXN/Y$$
$$= UIC + ULC + UGOS + UTAXN.$$

- *Changes in unit costs.* The change in producer prices is by definition a weighted average of the changes in the various cost components, where the weights are the shares of the respective unit cost components in the producer price.

$$dP/P = (dUIC/UIC)(UIC/P)$$
$$+ (dULC/ULC)(ULC/P)$$
$$+ (dUGOS/UGOS)(UGOS/P)$$
$$+ (dUTAXN/UTAXN)(UTAXN/P).$$

In Table 3.4, the contribution of unit cost components to producer price inflation is defined as the product of the change in the unit cost component and its share in total unit costs.

The *sectoral classification* is based on the *International Standard Industrial Classification* (ISIC), Revision 3. Most of the econometric analysis uses a disaggregation of the sectors at the two-digit level for manufacturing (depending on data availability) and at the single-digit level for business services. The descriptive analysis, on the other hand, distinguishes various broad aggregate sectors (Table 3.7).
- *Manufacturing* versus *business services.*
- *High-tech, medium-tech,* and *low-tech.* This distinction is based on the intensity of R&D in the sector and follows the OECD classification. For technical reasons, the definition of the

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[42]The net tax is a partial measure calculated as the difference between the value of production and the sum of the cost of intermediates, the cost of labor, and the gross operating surplus (which includes the consumption of fixed capital). When data for the gross operating surplus were not available, the variable was calculated using tax adjustment factors prepared by the OECD.

high-tech category used in this chapter includes both high-tech and medium high-tech sectors while medium-tech refers to medium low-tech sectors.

- *High-skill* and *low-skill*. This distinction is based on the fraction of skilled labor in the employment of a sector, where a person is considered skilled if he or she has at least upper secondary education. Data on the average fraction of skilled labor in each sector (across 16 OECD countries from 1994 to 1998) are taken from Jean and Nicoletti (2002). The threshold between high-skill and low-skill sectors was put at 20 percent of skilled employment in order to achieve a rough balance between the number of observations in high-skill and low-skill sectors in the overall economy (40 percent versus 60 percent).

Advanced economies with coverage from 1987 to 2003 include Austria, Denmark, Finland, France, Germany, Italy, Japan, Korea, Luxembourg, Norway, and the United States. Data are also available for shorter periods of time for Belgium and Greece. The descriptive analysis is based on the 11 countries for which coverage over time is similar.

Econometric Analysis

This part of the appendix provides details on the specification of the various equations reported in the main text and the econometric methodology. It also presents additional results on the relationship between sectoral inflation and sectoral import prices, as well as on the effect of trade openness on cost components other than unit labor costs.

Sectoral Inflation and Globalization

The econometric analysis of the relationship between inflation and globalization at the sec-

toral level is based on the following variant of Chen, Imbs, and Scott (2004),

$$p_{ijt} - p_{it} = \alpha(my)_{ijt} + \beta(yl)_{ijt} + \gamma_j(\$xr)_{it}$$
$$+ \eta_i + \mu_j + \zeta_i t + \xi_j t + \varepsilon_{ijt}, \qquad (1)$$

where the subscript j denotes the sector; the subscript i the country; and the subscript t the time period. The variables are defined as follows: p is the logarithm of the producer price; my represents the logarithm of the import-to-production ratio; yl is the logarithm of average real productivity per employee; $\$xr$ represents the nominal local currency to U.S. dollar exchange rate; η are the country fixed effects and μ are sector fixed effects. Sectoral price levels are scaled by the overall producer price to account for the influence of monetary policy and the fact that in the long-run price levels are determined by monetary policy. The relative price of a sector is allowed to depend on the sectoral import ratio, sectoral labor productivity, and an interaction term between a sectoral dummy and the local currency to U.S. dollar exchange rate. The latter captures the impact that exchange rate fluctuations exert on sectoral producer prices through the price of imported intermediates in the sector. This effect is allowed to vary across sectors because the share of imported intermediates differs across sectors. Finally, the specification controls for country and sector fixed effects and time trends. Among other things, sector fixed effects control for important sectoral differences in technological intensity, skill intensity, and degree of differentiation of products.

The equation is estimated in first differences using a two-step feasible generalized method of moments estimator instrumenting for the changes in the import ratio given concerns about their endogeneity.[43] The list of instruments used is as follows:

- A measure of how close (geographically) the country is from the large producers in a sector

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[43]There are two sources of possible bias in the estimates. On the one hand, high producer price inflation in a sector lowers competitiveness and increases the import ratio, inducing an upward bias in the estimates. On the other hand, high producer price inflation in a sector could trigger stronger protectionism, thereby reducing the import ratio and imparting a downward bias on the estimates.

at a point in time: for each country, this variable is constructed as a weighted sum of the shares of the other countries in the "world" production of a sector (excluding the country's production), where the weights are the inverse distances between the country and the other producers.

- The nominal effective exchange rate, which captures the countrywide evolution in import prices and competitiveness and affects directly each sector's import-to-production ratio.

A relevant and valid set of instruments comprising various lags of the difference and level of these two variables was identified based on the Anderson likelihood-ratio test of relevance of the instruments and the Hansen-Sargan test of validity of the instruments (as implemented in Stata, a data processing software).

Equation (1) is estimated first for 16 manufacturing subsectors and then for all 16 manufacturing sectors jointly with six business services sectors.[44] Two different samples of countries and years are used: one with the maximum number of countries and years available, and another one restricted to the countries and years included in the descriptive analysis of sectoral inflation patterns. The maximum sample covers the period 1977–2003 and the following 11 OECD countries: Austria, Belgium, Denmark, Finland, France, Greece, Italy, Japan, Norway, the United Kingdom, and the United States (Germany does not report production volumes and Korea does not provide labor productivity data for most of the two-digit level subsectors of manufacturing).[45] The results are robust when the sample excludes Belgium and Greece and is restricted to the period 1988–2003 to match the

sample used in the descriptive analysis. Results are reported in Table 3.3. Variables have the expected sign and are significant, generally at the 5 percent level.[46] The magnitude of the coefficients is also broadly similar to that found by comparable studies.[47]

IMF staff also explored the relationship between changes in relative producer prices and changes in the price of imported goods in that sector. This relationship is the price dual of the relationship between sectoral relative prices and quantities of imported goods in the sector (Gamber and Hung, 2001). Sectoral import prices, which are only available for manufacturing sectors, are based on unit values of imports of products classified under the sector.[48] The specification is the same as equation (1) except that changes in the sectoral import ratio are replaced by changes in sectoral import prices. An equation including both changes in the sectoral import ratio and changes in sectoral import prices is also estimated. The estimation method and the samples are the same as before and the instrumental variables are again chosen based on validity and relevance. Results reported in Table 3.8 show that changes in relative producer prices are positively and significantly related to import price inflation, confirming that import price developments constrain the ability of domestic producers to raise prices. Specifically, a 1 percent change in import prices is associated with a 0.15 percent change in producer prices. These estimates are close to those found by Gamber and Hung (2001) for the United States. Finally, the model that includes both changes in the import ratio and import price inflation lead to coefficients that are similar in

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[44]As in the descriptive analysis, the refined petroleum sector is excluded because its behavior is strongly influenced by oil price developments.

[45]The period covered varies across sectors and countries depending on data availability, and the panel data set is thus not balanced.

[46]Although not reported, the results are also robust when IT sectors such as electrical and optical equipment and telecommunication services are excluded. Allowing for endogenous labor productivity growth in the estimation yields similar results, although the negative effect of productivity growth on sectoral price changes becomes somewhat larger in magnitude.

[47]See, for example, Chen, Imbs, and Scott (2004) for the effect of the import ratio and labor productivity on sectoral inflation in a sample of European countries.

[48]This measure does not control for composition changes within lines of products and quality improvements, but it is a widely used proxy measure. The main source is the United Nations' Comtrade database.

Table 3.8. Impact of Changes in Import Prices on Relative Producer Price Inflation[1]

	Dependent Variable: Changes in Relative Producer Prices in Manufacturing Sectors (16)[2]			
	Price version		Price and quantity version	
	1981–2003 (all countries available)	1988–2003 (core countries)[3]	1981–2003 (all countries available)	1988–2003 (core countries)[3]
Change in import prices	0.16***	0.15***	0.12***	0.25***
Change in import share	. . .	. . .	−0.12**	−0.19**
Change in labor productivity	−0.08***	−0.09***	−0.11***	−0.13***

Source: IMF staff calculations.

[1]All variables are in natural logarithms. The equations are estimated by two-step feasible generalized method of moments instrumenting for changes in import prices and changes in the import share. Other control variables include the dollar exchange rate interacted with sectoral dummies (effect through cost of intermediates), and sectoral and country dummies. *** denotes statistical significance at the 1 percent level; ** at the 5 percent level.

[2]The refined petroleum sector is excluded from the regressions because its behavior is strongly affected by oil price developments.

[3]Restricted to countries used in the descriptive analysis of sectoral inflation patterns.

magnitudes and significance. Overall, therefore, the impact of globalization on producer price does not depend on a specific model or a specific variable to measure globalization.

Sectoral Unit Labor Cost Changes and Globalization

The econometric analysis of the relationship between globalization and unit labor cost (denoted as *ulc* below) changes at the sectoral level is based on a similar specification as equation (1), except for the exchange rate term, which is not needed:

$$dulc_{ijt} - dulc_{it} = \alpha(dmy)_{ijt} + \beta(dyl_{ijt} - dyl_{it}) + \zeta_i + \xi_j + \varepsilon_{ijt} - \varepsilon_{ijt-1}. \quad (2)$$

In order to gain a better understanding of the effects at work, similar equations are estimated for the two components of unit labor cost changes, namely changes in labor compensation per employee (*plab*) and changes in productivity per employee (labor productivity, denoted as *yl*),

$$dplab_{ijt} - dplab_{it} = \alpha(dmy)_{ijt} + (\beta + \gamma M_{ijt})(dyl_{ijt} - dyl_{it}) + \zeta_i + \xi_j + \varepsilon_{ijt} - \varepsilon_{ijt-1} \quad (3)$$

$$dyl_{ijt} - dyl_{it} = \alpha(dmy)_{ijt} + \zeta_i + \xi_j + \varepsilon_{ijt} - \varepsilon_{ijt-1}. \quad (4)$$

These equations allow one to estimate separately the direct effect of the import ratio on labor compensation (or unit labor costs)—controlling for labor productivity—and its indirect effect through labor productivity. Equation (3) also allows the elasticity of the relative price of labor to the relative productivity to depend on the level of the import ratio (denoted as M_{ijt}) in order to test whether globalization affects the extent to which productivity changes are translated into labor compensation changes.

Equations (2), (3), and (4) are estimated using a two-step feasible generalized method of moments estimator instrumenting for the changes in the import ratio and, in equations (2) and (3), for the changes in relative productivity. The instrumental variables used are the same as before and the specific lags included were selected using tests of the relevance and validity of the instruments.[49] Results of the estimation are reported in Table 3.5 and are robust to restricting the sample to countries covered in the descriptive analysis and reducing the period covered to 1987 onwards.

Finally, it is also of interest to examine the effect of globalization, as measured by increases in the import ratio, on changes in unit intermediate costs (*uic*) and changes in the unit gross operating surplus (*ugos*). The following two

[49]For equation (3), the lagged relative productivity growth was used as an additional instrument.

Table 3.9. Impact of Trade Openness on Cost Components[1]
(Manufacturing subsectors relative to the overall economy)[2]

	Dependent Variable[2]					
	Change in relative unit labor cost		Change in relative unit intermediate cost		Change in relative unit gross operating surplus	
	1977–2003 (all available countries)	1988–2003 (core countries)[3]	1977–2003 (all available countries)	1988–2003 (core countries)[3]	1977–2003 (all available countries)	1988–2003 (core countries)[3]
Change in import share	−0.13***	−0.16***	−0.12***	−0.19***	—	0.30

Source: IMF staff calculations.

[1]All variables are in natural logarithms. The equations are estimated by two-step feasible generalized method of moments instrumenting for changes in import prices and changes in the import share. Other control variables include the dollar exchange rate interacted with sectoral dummies (effect through cost of intermediates), and sectoral and country dummies. *** denotes statistical significance at the 1 percent level.

[2]The refined petroleum sector is excluded from the regressions because its behavior is strongly affected by oil price developments.

[3]Restricted to countries used in the descriptive analysis of sectoral inflation patterns.

equations are estimated using the same estimation and instrumentation methods as above:

$$duic_{ijt} - duic_{it} = \alpha(dmy)_{ijt} + \gamma_j(d\$xr)_{it}$$
$$+ \zeta_i + \xi_j + \varepsilon_{ijt} - \varepsilon_{ijt-1}$$

$$dugos_{ijt} - dugos_{it} = \alpha(dmy)_{ijt} + \zeta_i + \xi_j + \varepsilon_{ijt} - \varepsilon_{ijt-1}.$$

The results reported in Table 3.9 suggest that increases in trade openness also contributed to reduce increases in unit intermediate costs, while the effect on changes in the unit gross operating surplus is not significantly estimated.

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