CHAPTER 3

EXCHANGE RATES AND THE ADJUSTMENT OF EXTERNAL IMBALANCES

In recent years, few subjects have attracted more attention from the research, financial, and policy communities than the causes of the large U.S. current account deficit—which now absorbs about three-fourths of available world surpluses—and its implications for the global economy. Yet, there is still little consensus on either how long current imbalances may be sustained or the channels through which adjustment could take place, and in particular on the role of exchange rates in the unwinding of the imbalances.

Some argue that the current imbalances can be sustained for a relatively long period, as they are a reflection of secular changes in the global economy, including the integration into world markets of countries with a large and underutilized labor force, such as China and India; the comparative advantage of the United States in producing marketable securities in the context of increasing financial integration across countries; and relatively benign U.S. demographic trends compared with those of many surplus economies.[1] This view of global imbalances often assumes that their eventual narrowing will depend on a rebalancing of the differential saving and investment behavior between the United States and the surplus economies, with only a minor role for a realignment of exchange rates.

Others have emphasized that the narrowing of external imbalances is unlikely to occur exclusively through a rebalancing of demand between the United States and the surplus economies. Given the imperfect global integration of markets for goods and services and the rigidities that constrain the reallocation of resources to tradables sectors, the redistribution of world spending is likely to require considerable movements in real exchange rates to avoid a prolonged U.S. recession. The experience of the late 1980s—when the U.S. external deficit narrowed by about 3½ percentage points of GDP over a three-year period—suggests that these changes could be large. During that episode, the real effective value of the U.S. dollar depreciated by about 40 percent, despite a substantial decline in the U.S. GDP growth differential with trading partners. A number of recent studies also conclude that the U.S. current account deficit cannot be reduced without a major real exchange rate depreciation.[2]

Previous issues of the *World Economic Outlook* have looked at saving and investment behaviors underlying global imbalances and described alternative scenarios for their unwinding, using the IMF's Global Economy Model.[3] This chapter complements this analysis by looking more directly at the role of real exchange rates in the process of adjusting external imbalances, with the aim of answering the following questions:

- Looking at the past 40 years and across a broad range of countries, how many episodes of large external imbalances can be identified? How long have these episodes lasted and, when the adjustment occurred, what were the relative contributions of changes in growth differentials and changes in real exchange rates?

Note: The main authors of this chapter are Roberto Cardarelli and Alessandro Rebucci, with support from Angela Espiritu and Olga Akcadag. Caroline Freund, Jaime Marquez, Jean Imbs, and George Kapetanios provided consultancy support.

[1]See Dooley, Folkerts-Landau, and Garber (2005); Greenspan (2004); and Cooper (2006).

[2]Typical econometric estimates suggest that a real U.S. dollar depreciation of between 10 and 20 percent is required to achieve a 1 percent improvement in the ratio of current account to GDP in the United States (see Krugman, 2006; and Mussa, 2004). See Edwards (2005) for a survey of selected studies on U.S. current account adjustment.

[3]See the April 2005, September 2005, and September 2006 issues of the *World Economic Outlook*.

- Are there reasons to believe that U.S. trade volumes may be more reactive to changes in relative international prices than generally assumed, so that a trade balance correction in the United States could be achieved with smaller real movements in the U.S. dollar exchange rate than sometimes considered necessary?

The main findings are twofold. First, a clear lesson from cross-country experience is that movements of real exchange rates can play an important supportive role in facilitating the smooth unwinding of external imbalances. Real depreciation helps contain the costs in terms of slower GDP growth that are associated with large reversals of current account deficits. Fiscal consolidation and a significant increase in national savings are also typical of episodes where adjustment has been achieved without serious damage in terms of growth. The likelihood of such a benign adjustment decreases with the size of the external deficit and increases with the degree to which a country is open to trade. As for surplus countries, periods in which current account surpluses have narrowed have often involved real exchange rate appreciation, though an increase in domestic demand has usually also played a key role in these cases.

Second, the chapter finds that external adjustment in the United States may involve a smaller real depreciation of the U.S. dollar than sometimes claimed in the recent policy and academic debates. To start, standard empirical trade models may underestimate U.S. trade volume responses to relative prices if they fail to account for large differences in response across sectors (aggregation bias) and for the degree to which imports embody domestically produced intermediate products (vertical integration bias). Correcting for these biases significantly increases the estimated impact of real depreciation on the U.S. trade balance. Further, trade volumes seem to have become more reactive to changes in relative international prices over the past two decades, reflecting greater competition among firms in an increasingly globalized economy, and seem to react more strongly to larger changes in relative international prices.

The chapter also shows that the more flexible the economy, that is, the smaller the obstacles to the reallocation of resources, the more responsive trade will be to changes in real exchange rates. An important corollary is that changes in real exchange rates that are consistent with a given amount of external adjustment will be larger for economies where it is more difficult for firms to enter and exit trade—either because of rigidities in product and labor markets or because of trade protectionism.

What do these results suggest for the present constellation of global imbalances? A consistent theme that emerges from this chapter is that a market-led real depreciation of the U.S. dollar and a real appreciation of the currencies of surplus countries could potentially play a helpful role in narrowing global imbalances. At the same time, the adjustment process will involve a rebalancing of domestic demand toward surplus economies, including a rising private saving rate and further fiscal consolidation in the United States. Policies that remove obstacles to the reallocation of resources and to international trade would help lower the dislocation in economic activity that might accompany this adjustment process.

Past Episodes of Large External Imbalances: An Event Analysis

Several explanations have been advanced that rationalize the large U.S. external deficit as the consequence of economic characteristics specific to the United States in the context of an increasingly globalized economy and greater international capital mobility (Greenspan, 2004). While these factors could make the current constellation of imbalances sustainable for a long period, standard sustainability analysis—which looks at the implications of large and persistent current account deficits for the ratio of net foreign assets to GDP—suggests that this position cannot be sustained forever without a trade balance correction (Box 3.1).

Against this background, it is helpful to revisit the experience of past episodes of large external imbalances. Although several papers have analyzed episodes of external adjustment in advanced economies and emerging markets, they have focused only on current account deficit reversals.[4] The main innovations of this chapter are in expanding the range of reversals to cover those that are most relevant for the current conjuncture—namely, the deficits of advanced economies and surpluses of advanced, emerging market, and oil-exporting economies—and in analyzing episodes of large imbalances that have persisted for a long period.

Large and sustained reversals are defined as swings in the current account balance of at least 2.5 percent of GDP and at least 50 percent of the initial current account imbalance that are sustained for at least five years.[5] Large and persistent imbalances are defined as episodes where the current account balance remained above 2 percent of GDP (in absolute value) for at least five years.[6]

Deficit Reversals in Advanced Economies: Do Real Exchange Rates Matter?

Based on these criteria, the chapter identifies 42 episodes of large and sustained external deficit reversals over the past 40 years in advanced economies (Figure 3.1). The magnitude of the reversals ranges from the 2.7 percent of GDP adjustment in Italy beginning in 1981 to the

[4]The literature on advanced economies includes Freund (2000); Freund and Warnock (2005); Croke, Kamin, and Leduc (2005); Goldman Sachs (2005); Debelle and Galati (2005); and de Haan, Schokker, and Tcherneva (2006). Papers on emerging market countries include Milesi-Ferretti and Razin (1998); Edwards (2005); and the September 2002 *World Economic Outlook*.

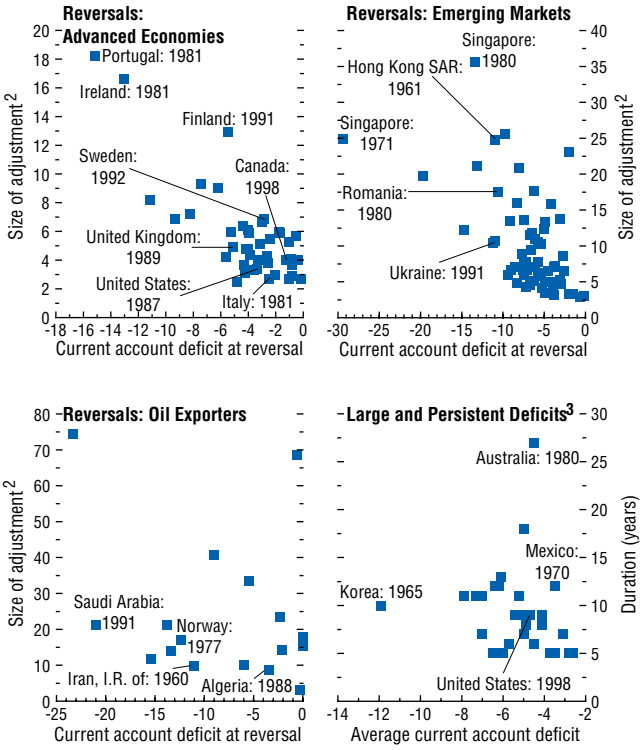
[5]The size of the adjustment is the difference between the trough of the current account balance and its value at the end of the reversal. In contrast with previous studies, this chapter also considers reversals that start from small initial levels (less than 2 percent of GDP) and explicitly estimates the duration of the episodes, rather than looking at adjustment over a fixed (e.g., two-year) period.

[6]See Appendix 3.1 for a detailed description of the data and methodology used in this section.

Figure 3.1. Episodes of Deficit Reversals and Large and Persistent Deficits[1]

(1960–2006; current account deficit in percent of GDP)

The chapter identifies 42 episodes of large and sustained deficit reversals in advanced economies, 60 episodes in emerging markets, and 17 episodes in oil-exporting countries. Moreover, 29 cases of large and persistent deficits were identified in the entire sample.



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

[1]See Appendix 3.1 for the definition of deficit reversals and large and persistent deficit episodes, and information on country group composition.

[2]Change in current account deficit, in percent of GDP, from the trough to the end of the reversal episode.

[3]The x-axis refers to the average current account deficit, in percent of GDP, during the episode. The y-axis refers to the number of years the large current account deficit was sustained.

Box 3.1. External Sustainability and Financial Integration

Despite massive net external borrowing, U.S. net foreign assets have remained broadly stable for the past five years as a share of GDP. This, together with the ease with which the United States has financed its large trade and current account deficits, has led to suggestions that in an increasingly financially integrated world such deficits are sustainable without the need for exchange rate adjustment. In particular, some point to the U.S. dollar's role as a reserve currency and to the depth and liquidity of U.S. financial markets to explain high demand for U.S. assets, while others argue that intangible exports and assets make the U.S. external account much stronger than currently measured.[1]

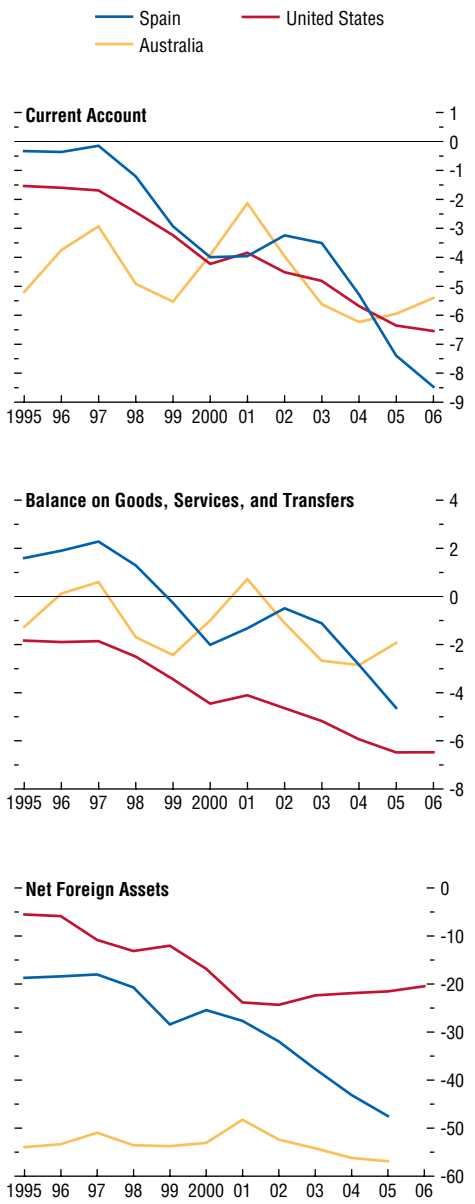
Over the medium term, external sustainability requires that a country's net external position not increase or decrease without bound, relative to the size of the economy. To highlight how financial integration influences this requirement for sustainability, this box considers the cases of three countries that have run large and protracted current account deficits over the past few years—Australia, Spain, and the United States—and investigates the implications of these deficits for their net foreign asset positions. As the figure shows, these deficits had very different implications for the path of net foreign assets of the three countries: Spain's net foreign liabilities increased substantially, relative to its GDP; the U.S. liabilities remained broadly stable despite its large current account deficit; and Australia's experience fell in between. What accounts for these striking differences?

The balance of payments identity says that changes in net foreign assets (*NFA*) can originate from net external lending or borrowing (*FL*)—which, abstracting from statistical discrepancies and other factors such as reclassifications of claims or liabilities, is broadly equal to the

Note: The authors of this box are Jaewoo Lee and Gian Maria Milesi-Ferretti.

[1]On the first point, see Caballero, Farhi, and Gourinchas (2006); on the latter, see Hausmann and Sturzenegger (2006).

External Imbalances: Australia, Spain, and United States
(Percent of GDP)



Sources: IMF, *Balance of Payments Statistics Yearbook;* and IMF staff calculations.

current account balance (CA)—and changes in the value of external assets and liabilities due to fluctuations in exchange rates or asset prices (KG).[2] In turn, the current account is equal to the balance on goods, nonfactor services, and transfers ($BGST$) plus the investment income earned on assets ($i_t^A A_{t-1}$) minus the income paid out on liabilities ($i_t^L L_{t-1}$):

$$NFA_t - NFA_{t-1} = FL_t + KG_t$$
$$FL_t \equiv CA_t = BGST_t + i_t^A A_{t-1} - i_t^L L_{t-1}. \quad (1)$$

Dividing both sides of the equation by GDP and rearranging terms, changes in a country's net foreign asset position can be described as follows:

$$nfa_t - nfa_{t-1} = bgst_t + \frac{r_t^L - g_t}{1+g_t} nfa_{t-1} + \frac{r_t^A - r_t^L}{1+g_t} a_{t-1}, \quad (2)$$

where lowercase letters denote ratios to GDP; r_t^A and r_t^L denote the nominal rate of return on foreign assets and liabilities, respectively—inclusive of the yields i_t^A and i_t^L and of capital gains; and g_t denotes the growth rate of nominal GDP. When the returns on external assets and liabilities are the same, equation (2) reduces to the standard debt accumulation equation. If this is the case, and if the rate of return is higher than the GDP growth rate, a debtor country will need to run a trade surplus to prevent its net external position from deteriorating. The equation also shows that in a world with much larger stocks of external assets and liabilities than a decade ago, differences in rates of return have potentially grown in importance as factors explaining the evolution of net foreign assets.

Equation (2) helps us understand the differential experiences of Australia, Spain, and the United States. The table illustrates the role played by the three factors driving changes in net foreign assets in equation (2) between end-2001 and end-2005 (2006 for the United States).[3]

- Australia ran a trade deficit during this period, averaging 2 percent of GDP. The rate of return on its liabilities and the GDP growth rate were similar for this period, as were returns on assets and on liabilities. Consequently, the external position deteriorated in proportion to the size of the trade deficit.
- Spain ran a similar trade deficit of just over 2 percent of GDP, but the return on its external liabilities was much higher than the return on its assets. As a consequence, and despite a high growth rate, its net external position deteriorated much more sharply than did Australia's position.
- The U.S. trade deficit averaged over 5 percent of GDP, more than twice as large as that of Australia or Spain. However, a very large

Evolution of Net External Position
(In percent of GDP unless otherwise noted)

	United States (2001–06)	Australia (2001–05)	Spain (2001–05)
Changes in net foreign assets	3.4	–8.7	–19.8
Cumulative effects of:			
Trade deficit	–28.2	–8.5	–8.7
Return–growth rate differential	1.5	1.0	3.1
Asset-liability return differential	30.0	–1.4	–14.2
Differential in returns on assets and liabilities average (in percent)	8.0	–0.5	–3.5
Correlation with change in the real effective exchange rate (over 1995–2005)	–0.74	–0.54	–0.34

Source: IMF staff estimates.

[2]There are differences across countries in the measurement of *NFA*—in particular, most countries (including Spain) estimate foreign direct investment (FDI) at book value, while others (including Australia and the United States) estimate it at market value. These differences will be reflected in the calculation of capital gains, and hence of rates of return.

[3]Data on *NFA* for the United States in 2006 are based on staff estimates. If *NFA* was scaled by exports of goods and services, to reflect the different degree of trade openness between the three countries, the trends within countries would be similar, but net external liabilities would be lower in Spain than in the United States and Australia.

Box 3.1 *(concluded)*

positive differential between returns on external assets and on liabilities kept the external position from deteriorating at all.

Which factors can help explain differences in rates of return between external assets and liabilities?

- *Relative currency and stock price movements* play an important role. For example, in a country with liabilities denominated in domestic currency and assets in foreign currency, an unexpected exchange rate depreciation will raise the domestic currency return on assets. In a country with high net liabilities denominated in foreign currency, an unexpected depreciation would instead have unfavorable balance sheet effects, by raising the return on liabilities measured in domestic currency. Obviously, higher price increases in foreign stock markets relative to the domestic market would generate a favorable return differential.
- The *composition of the external portfolio* also matters. For example, since returns have on average been higher on equity instruments than on debt instruments, countries with a larger share of equity-type assets (FDI and portfolio equity) in total assets than of equity-type liabilities in total liabilities could have a favorable return differential.

These factors played an important role in the countries under consideration:[4]

- *Exchange rate movements.* Australia, Spain, and the United States have significant net external liabilities denominated in domestic currency but positive net foreign currency holdings. As a result, a currency depreciation will, other things being equal, raise domestic currency returns on external assets by more than returns on liabilities. During the period under consideration, the U.S. dollar depreciated in real effective terms, while the euro appreciated, consistent with the observed return differentials.[5] The Australian dollar also appreciated, but its adverse effect on the domestic currency value of external assets was mitigated by widespread currency hedging.
- *Relative stock price movements.* Spain's stock prices increased faster than stock prices of its financial trading partners, raising the return on Spain's external liabilities, while the opposite happened for the United States. Australian stock prices also increased more rapidly than stock prices elsewhere, raising returns on Australian equity liabilities, but the effect on the overall return differential was muted by the higher weight of equity on the asset side of the balance sheet.
- *Portfolio composition.* During the sample period, the United States and Australia had a higher share of equity-type instruments (FDI and portfolio equity) in their asset portfolios (around 60 percent) than in their liability portfolios (around 40 percent), with Spain also showing a modest positive difference between the asset and liability share of equity instruments. In light of the higher returns on equity than on debt during the period under consideration, this composition effect helps explain the behavior of return differentials in Australia and especially the United States.

Of course the overall size of the net external position also matters—if overall returns rise, net external liabilities will increase faster in countries that start off with larger imbalances.

Should one extrapolate these trends for the future? Do the large favorable return differentials in the United States obviate the need for trade balance and exchange rate adjustment? Extrapolating these trends would be unwise—as

[4]Measured return differentials can also be affected by other factors, such as the method for estimating FDI (see footnote 2 in this box), the riskiness of assets, and incentives for transfer pricing driven by differences in corporate tax policy. Box 1.2 in the September 2005 *World Economic Outlook* discusses the role of these factors in explaining differences between returns on U.S. FDI assets and liabilities.

[5]The real effective depreciation of the U.S. dollar since early 2002 was much sharper vis-à-vis its "financial" trading partners than its commercial trading partners, thus increasing its effect on return differentials.

specified in investment prospectuses, "past performance is no guarantee of future returns." And return differentials would not indefinitely obviate the need for U.S. trade balance and exchange rate adjustment. More specifically:

- Return differentials induced by exchange rate movements require *unexpected* exchange rate depreciation period by period—hence, they are inconsistent with a stable exchange rate. The effect of exchange rate depreciation on return differentials in debtor countries with significant domestic currency liabilities can help the adjustment process, but it would disappear once the exchange rate stabilizes, or when investors require higher returns to compensate for exchange rate risk.
- Similarly, it is not realistic to project persisting differentials in stock returns (indeed, there is no evidence that the U.S. stock market has significantly underperformed world markets over the past three decades).
- Return differentials explained by differences in portfolio composition, risk, liquidity, and other factors may well persist, but they are likely to fall well short of those witnessed recently for the United States. For example, with the current differences in portfolio composition for the United States and Australia, a hefty 5 percent extra return on equity instruments relative to debt would imply a positive return differential between external assets and liabilities of about 1 percent. In addition, a return differential of 2 percent between U.S. FDI assets and liabilities would widen the overall return differential by about ½ percent. Under this illustrative scenario, the need for U.S. trade balance adjustment would be reduced by about 1½ percent of GDP, well short of the 6 percent adjustment that would be needed to stabilize the external position.

In sum, while international financial integration allows for a diversification of risk, with balance sheet effects cushioning external adjustment, it does not provide a permanent flow of "free lunches." Changes in asset prices and returns can generate large valuation effects on a year-to-year basis, but would likely play a more modest role over a longer period. Hence, in a debtor country running a large trade deficit, a correction in the trade balance is eventually inevitable to ensure external sustainability. Of course, the point in time at which this correction will actually take place, its size, and the means through which it would occur would depend on the specific circumstances of the country as well as international macroeconomic and financial market conditions more generally.

18 percent of GDP adjustment that began in Portugal in the same year. Moreover, 13 cases of large and persistent deficits were identified, including the most recent U.S. episode and Australia's two-decade-long period of current account deficit starting in 1980, and are described in detail in Box 3.2. The rest of this section focuses on the reversal episodes.

Examining the reversal episodes reveals the following common patterns:

- The current account deficit averaged 4 percent of GDP at the start of the adjustment, with an average correction of about 6 percent of GDP over a period of four to five years (Table 3.1).
- Consistent with the literature on deficit reversals, the process of current account adjustment was generally accompanied by both a real depreciation of the domestic currency (an average 12 percent total real depreciation)[7] and a slowdown of growth (an average 1½ percentage point decline in annual average GDP growth after the reversal compared with before the reversal). Figure 3.2 shows that the real currency depreciation has typically started in advance of the external adjustment.

[7]Defined as the maximum (peak-to-trough) change in the real effective exchange rate in the period surrounding the reversal.

Table 3.1. Summary Statistics of Episodes of Reversals[1]

	Number	Current Account at Year of Reversal (percent of GDP)	Size of Adjustment (percent of GDP)	GDP Growth		
				Duration of reversals (years)[2]	Average change (percent)[3]	REER: Total change (percent)[4]
			Deficit reversals			
Advanced economies	42	–4.1 (–3.5)	5.7 (4.9)	4.6 (4.0)	–1.4 (–1.0)	–12.2 (–12.5)
Preceded by large and persistent deficits	7	–6.9 (–6.2)	7.4 (6.9)	5.0 (4.0)	–0.2 (–0.9)	–10.2 (–6.2)
			Surplus reversals			
Advanced economies	36	2.4 (1.9)	5.0 (4.6)	4.7 (4.0)	0.6 (0.3)	15.6 (12.1)
Emerging markets	49	4.7 (3.2)	10.1 (9.1)	4.0 (4.0)	1.4 (1.2)	23.1 (16.6)
Oil exporters	15	18.9 (12.3)	20.7 (11.7)	4.4 (4.0)	–2.4 (–1.6)	71.6 (36.0)

Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

[1]Average values. Medians are in parentheses.

[2]Number of years between year 0, the trough (peak) year of the current account deficit (surplus), and year *T* (the end year of the episode). See Appendix 3.1 for further details.

[3]Average after the reversal (between year 1 and *T*, where 1 is the first year of the reversal and *T* is the year when the episode ends) less average before the reversal (between –*T* and –1).

[4]Maximum change in real effective exchange rate (REER) within the period surrounding the reversal (–*T*. . .*T*). An increase represents a real appreciation of a country's domestic currency relative to its trading partners.

- Deficit reversals tended to be preceded by a positive output gap, with the difference between actual and potential output peaking one year before the start of the adjustment and declining considerably afterward. This observation is consistent with the proposition that the slowdown in economic activity associated with deficit reversals is a consequence of the business cycle (Goldman Sachs, 2005). However, the size and persistence of the average swing in the output gap during a reversal episode suggests that while the business cycle may indeed have played a role in these episodes, it does not fully account for the output costs associated with the reversals (Edwards, 2005; and Freund and Warnock, 2005).

The magnitude of the exchange rate correction and of the GDP growth slowdown varies considerably across episodes. To shed light on this, the reversal episodes were ordered based on the average change in GDP growth after the reversal. Consistent with Croke, Kamin, and Leduc (2005), two groups of episodes were identified (Figure 3.3):

- A group of "contractionary" deficit reversals, characterized by a significant growth deterioration (a median 3½ percentage point slowdown). These episodes were also associated with a strong reduction in GDP growth relative to trading partners and a widening of the output gap, following a strong decline in investment rates.[8] Relatively large initial external deficits and low openness to trade were also observed. In these cases, the degree of real effective depreciation was modest (median of about 8 percent), often reflecting limited flexibility of the exchange rate regime.[9]

[8]A typical case in this group is Spain, whose external deficit increased to 3.5 percent of GDP in 1991 following an economic boom after its accession to the European Union (EU) in 1986, and then returned to zero as the Spanish economy fell into recession along with the economies of the other EU member states in the early 1990s.

[9]Indeed, in 9 of the 11 episodes in this group, the exchange rate was under a narrow peg at the time of reversals, according to the classification of exchange rate systems in Reinhart and Rogoff (2004).

- A group of "expansionary" reversals, in which growth did not slow down and in fact some pickup was generally observed (a median increase in GDP growth of about ¾ percentage point). These episodes were associated with both a larger-than-average total real depreciation (median of about 18 percent), which corrected a somewhat more overvalued currency and spurred export growth, and a strong increase in saving rates, associated with substantial fiscal consolidation, which allowed investment rates to be sustained much closer to their pre-reversal values.[10]

While the contractionary episodes conform to an adjustment occurring largely through a rebalancing of demand differentials with trading partners in the context of limited exchange rate flexibility, the expansionary episodes reflect a stronger role for relative price adjustment. In these cases, real depreciation played a key role by either offsetting an expenditure-reducing shock (e.g., fiscal consolidation) or correcting a competitiveness problem.

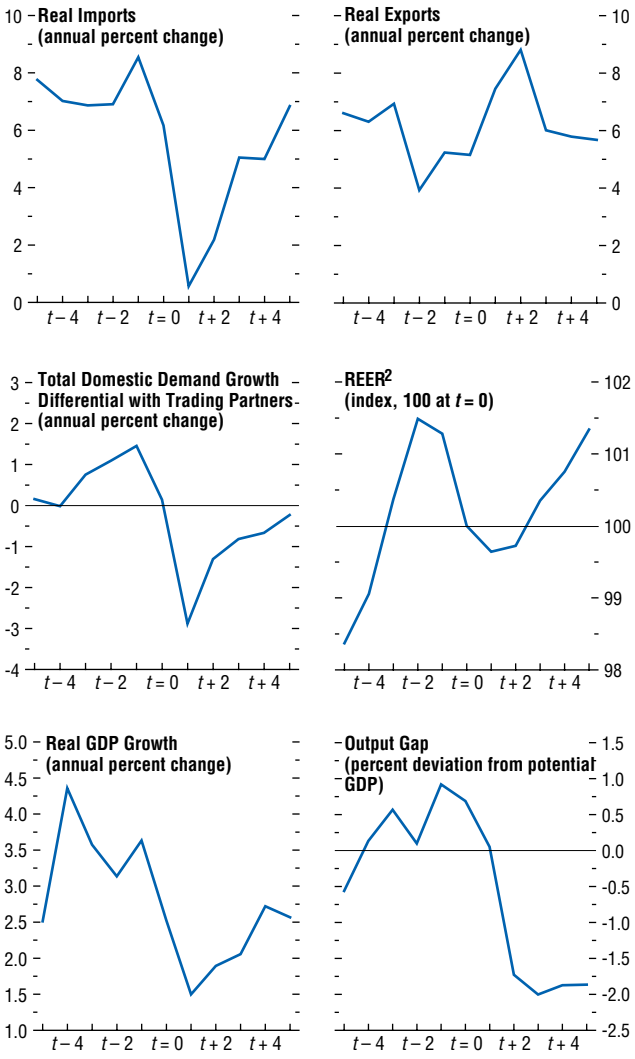
The main conclusions from this analysis of deficit reversals in advanced economies are that while changes in growth differentials clearly play a role in the adjustment, real depreciation can help smooth the impact of slowing domestic demand. Indeed, among historical episodes of deficit reversals in advanced economies over the past 40 years, there has been a clear trade-off between the growth slowdown after the reversal and total real effective exchange rate depreciation (Figure 3.4). Simple regression analysis suggests that a 10 percent total real effective depreciation has been associated with a ½ percentage point lower average decline in GDP growth after the reversal.

[10]Episodes in this group include Finland in 1991, Sweden in 1992, and Canada in 1998. For Finland and Sweden, the depreciation helped smooth the effect of negative external shocks (the decline of prices of key commodities such as pulp and paper, the vanishing of Russia as a major export market, and the world recession) and of the banking system crisis (Dornbusch, 1996). In Canada, both the reversal and the real exchange rate depreciation occurred in the context of a significant process of fiscal consolidation.

Figure 3.2. Advanced Economies: Key Indicators During Deficit Reversals[1]

(Medians across episodes; t = 0 is the trough year of the ratio of current account deficit to GDP; x-axis in years before and after t = 0)

The real effective exchange rate (REER) starts depreciating around two years before the trough of the current account deficit. Total domestic demand growth is above that of trading partners before the reversal but falls below after the reversal. Output is above potential before the trough but the output gap widens and remains low afterwards.



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

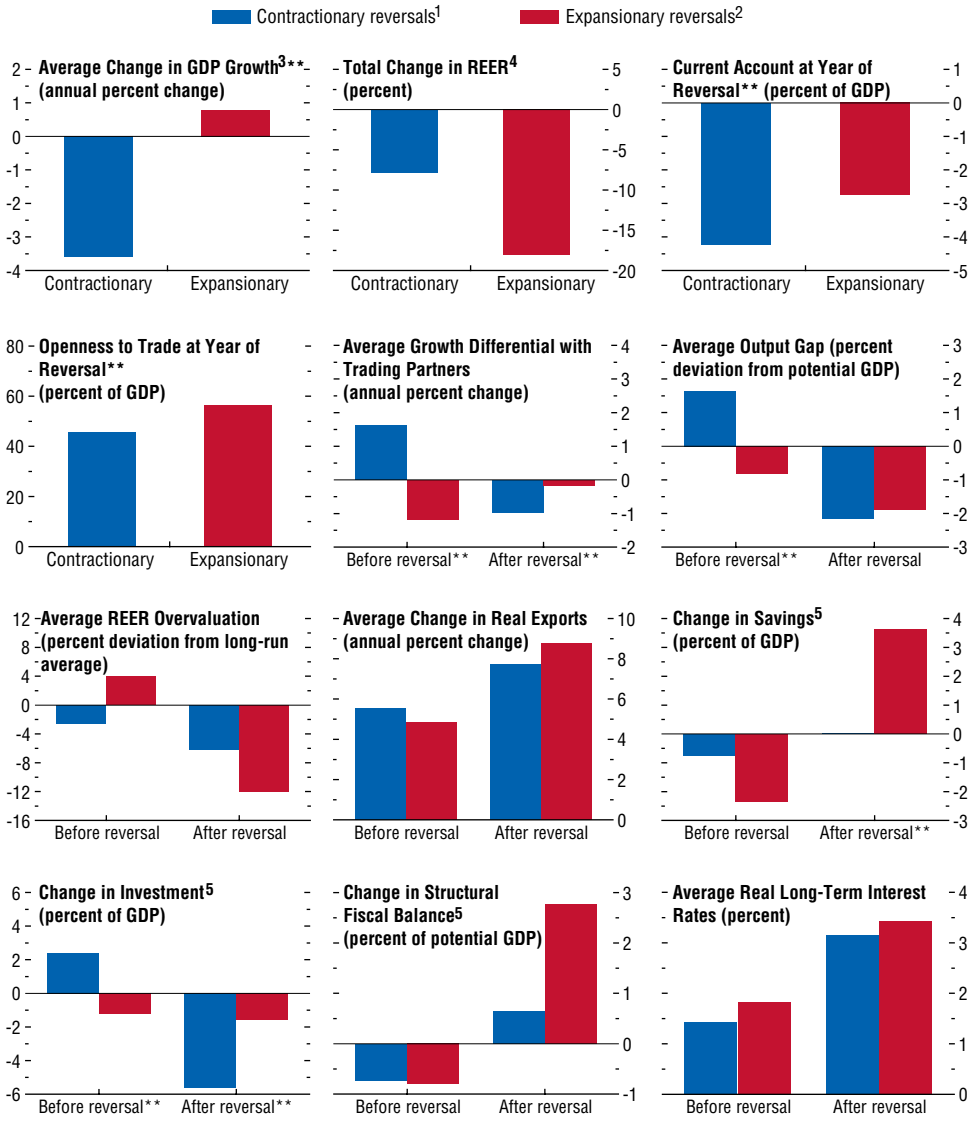
[1]See Appendix 3.1 for the definition of deficit reversals and information on country group composition.

[2]An increase in the index represents a real appreciation while a decrease represents a real depreciation of a country's currency relative to its trading partners.

Figure 3.3. Deficit Reversals in Advanced Economies: Episode Characteristics by Average Change in GDP Growth

(Medians across the two groups of episodes; asterisks show that the difference between the medians in the contractionary and expansionary deficit reversals is statistically significant at the 10 percent confidence level)

Total depreciation of real effective exchange rate (REER) is much higher in the expansionary reversals. These cases are also characterized by higher openness to trade and smaller current account deficits.



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

[1]Contractionary deficit reversals are the 11 deficit reversals with the largest average decline in GDP growth (the bottom quartile in the sample ordered by the change in growth).

[2]Expansionary deficit reversals are the 10 deficit reversals with the smallest average decline in GDP growth (the top quartile in the sample ordered by the change in growth).

[3]Average of GDP annual growth rates in the period after the reversal (1 . . . *T*) less average annual growth rates in the period before the reversal (–*T* . . . –1).

[4]Maximum change in REER within the period surrounding the reversal (–*T* . . . *T*). A decrease represents a real depreciation of a country's currency relative to its trading partners.

[5]"Before reversal" is the change in the variable between –*T* and 0. "After reversal" is the change in the variable between 0 and *T*.

Surplus Reversals: What Is the Role of Real Exchange Rate Appreciation?

This chapter identifies 36 episodes of large and sustained reversals of external surpluses in advanced economies, 49 episodes in emerging markets, and 15 episodes among oil exporters (Figure 3.5). Moreover, 20 cases of large and persistent surpluses were identified for all countries, including the two-decade-long current account surplus of Switzerland (see Box 3.2).

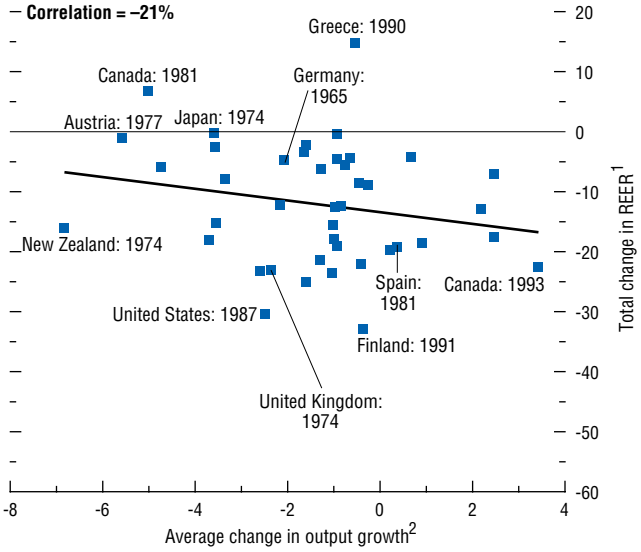
The following common patterns emerged from the reversal episodes:

- At the start of the reversal, the current account surplus averaged 2½ percent of GDP for advanced economies, and had higher ratios to GDP for emerging markets and oil exporters (about 5 percent and 20 percent of GDP, respectively). The average size of the adjustment was also much larger in emerging markets and for oil exporters than in advanced economies, although the reversal occurred over a similar time frame—four to five years (see Table 3.1).
- Surplus reversals in advanced economies and emerging markets have been associated with both an acceleration of GDP growth and a real appreciation (see Table 3.1). In particular, in both advanced economies and emerging markets, real effective exchange rates appreciated strongly and real GDP growth tended to accelerate when the reversals occurred (Figure 3.6).
- While these findings indicate symmetry between surplus and deficit reversals, only for advanced economies was it possible to find some weak evidence of a trade-off between the increase in GDP growth after the reversal and real exchange rate appreciation. For emerging markets, a stronger real appreciation did not reduce the magnitude of the increase in output growth associated with the reversal.

To shed further light on the relative role of GDP growth and real appreciation for emerging markets during surplus reversals, expansionary episodes (in which the surplus decline was accompanied by a strong increase in GDP

Figure 3.4. Advanced Economies: Total Change in Real Effective Exchange Rate and Average Change in GDP Growth During Deficit Reversals

Depreciation in real effective exchange rate (REER) has helped reduce the output costs associated with a deficit reversal (the larger the depreciation of the currency, the lower the output costs of the reversal).



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

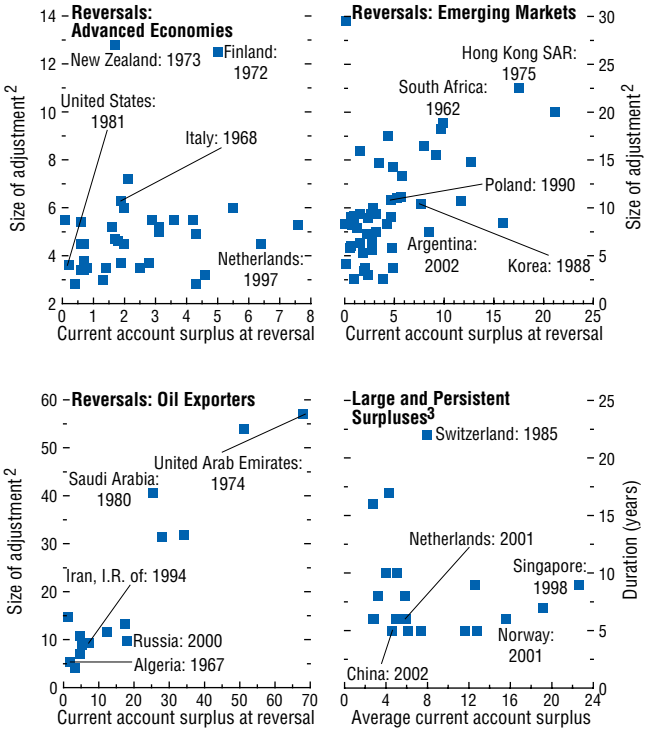
[1]Maximum change in REER within the period surrounding the reversal ($-T \ldots T$). A decrease represents a real depreciation of a country's currency relative to its trading partners.

[2]Average real GDP growth after the reversal ($1 \ldots T$) less average real GDP growth before the reversal ($-T \ldots -1$).

Figure 3.5. Episodes of Surplus Reversals and Large and Persistent Surpluses[1]

(1960–2006; current account surplus in percent of GDP)

The chapter identifies 36 episodes of large and sustained surplus reversals in advanced economies, 49 episodes in emerging markets, and 15 episodes in oil-exporting countries. Moreover, 20 cases of large and persistent surpluses were identified in the sample.



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

[1]See Appendix 3.1 for the definition of surplus reversals and large and persistent surplus episodes, and information on country group composition.

[2]Change in current account surplus, in percent of GDP, from the peak to the end of the reversal episode.

[3]The x-axis refers to the average current account surplus, in percent of GDP, during the episode. The y-axis refers to the number of years the large current account surplus was sustained.

growth) were distinguished from contractionary reversals (in which the surplus decline was accompanied by a substantial fall in GDP growth) (Figure 3.7):

- In the expansionary cases, the surplus reversals were characterized by a strong acceleration in GDP growth relative to trading partners and a reduction of the output gap. The turnaround in the investment cycle and the strong increase in import volumes led to a rapid narrowing of the surplus.[11]
- In the contractionary cases, the surplus buildup was associated with a period of faster growth relative to trading partners and a relatively undervalued currency. The reversal of these surpluses was then characterized by a more significant real appreciation and, especially, a sizable increase in domestic demand (in particular, consumption) accompanied by more expansionary monetary and fiscal policies. Still, GDP growth slowed somewhat during the reversal as the increase in domestic demand did not offset the smaller contribution to growth from net exports.[12]

Overall, an increase in domestic demand appears to play a key role in both types of surplus reversals—either from an increase in investment that drives the growth acceleration in the expansionary episodes or from an increase in consumption that marks the shift from net exports to domestic demand as the main engine

[11]The modest median real appreciation for these episodes masks a vast dispersion in exchange rate changes within this group, with cases of both large appreciation (Argentina in 1978) and large depreciation (China in 1982). Such heterogeneity is probably responsible for the lack of a clear trade-off between the roles of GDP growth and real appreciation in the adjustment process for emerging markets.

[12]Clearly, despite lower output growth, the increase in consumption could enhance welfare. In addition, in the majority of the episodes in this group, the slowdown in GDP growth associated with the decline of the surplus is only a temporary phenomenon, as over the medium term GDP growth tends to return to its pre-reversal average. Typical cases are Korea in 1977 and Poland in 1990; in these episodes, GDP growth returned to its pre-reversal rate after four and six years, respectively.

of growth in the contractionary cases. Real appreciation seems to have played a larger role in the contractionary cases, in particular by correcting an initial undervaluation of the real exchange rate.

Surplus reversals in oil-exporting countries do not fit the above patterns, as the deterioration of the external position has occurred with both a substantial slowdown in GDP growth and a large total real appreciation of their currencies. For these countries, the initial buildup of external surpluses owes much to the positive terms-of-trade effect from a surge in commodity prices (Figure 3.8). In turn, this leads to an increase in domestic demand and inflation, which drives up the real value of the currency. While the sharp decline of the external surplus is related to the reversal of the terms-of-trade increase (causing a sharp decline in export revenues), the currency continues appreciating in real terms, as domestic demand growth and inflation are sustained even after the decline in the terms of trade.

In sum, this analysis of surplus reversal episodes suggests that while surplus reversals for oil exporters have followed a decline of commodity prices, reversals in advanced and emerging market economies have been associated with some real appreciation of domestic currencies and, even more importantly, an increase in domestic demand.

How Responsive Are U.S. Trade Volumes to Exchange Rate Movements?

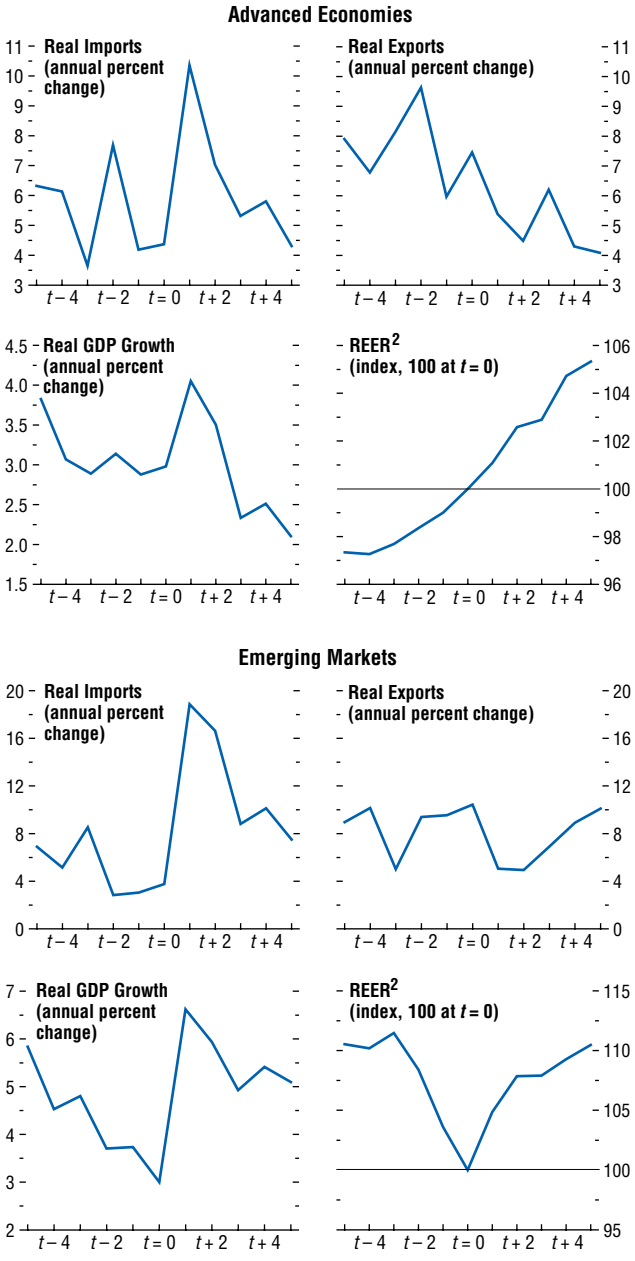
The analysis of the historical episodes suggests that changes in real exchange rates have been important in the reversal of external imbalances, with a clear role in helping to sustain growth during deficit reversals. The conventional wisdom for the United States, however, is that large exchange rate changes are needed because of the low price elasticities of trade volumes and the partial response of trade prices to changes in nominal exchange rates.

The case for elasticity pessimism can be illustrated by looking at the standard "workhorse"

Figure 3.6. Key Indicators During Surplus Reversals[1]

(Medians across episodes; t = 0 is the peak year of the ratio of current account surplus to GDP; x-axis in years before and after t = 0)

In both advanced economies and emerging markets, real effective exchange rate (REER) appreciates and GDP growth increases after the peak year of the current account surplus.



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

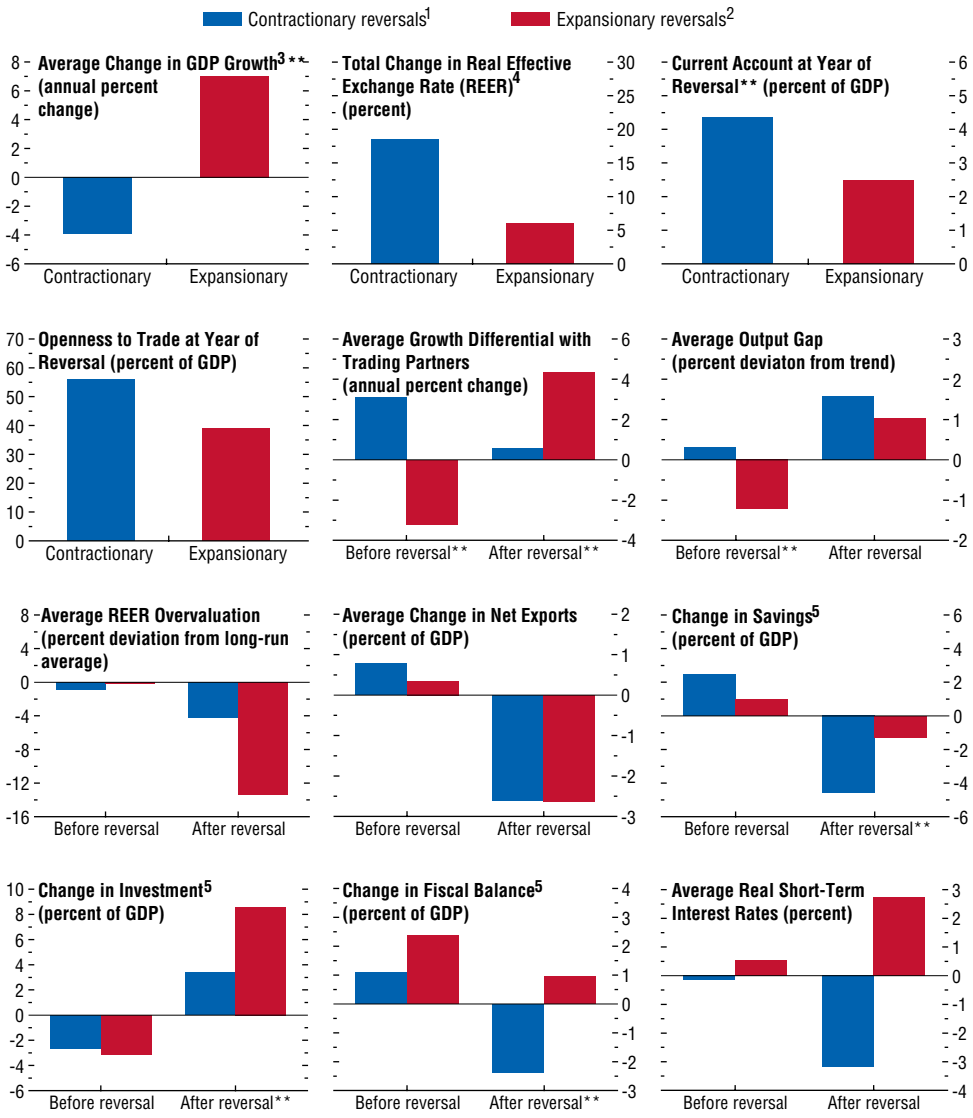
[1]See Appendix 3.1 for the definition of surplus reversals and information on country group composition.

[2]An increase in the index represents a real appreciation while a decrease represents a real depreciation of a country's currency relative to its trading partners.

Figure 3.7. Surplus Reversals in Emerging Markets: Episode Characteristics by Average Change in GDP Growth

(Medians across the two groups of episodes; asterisks show that the difference between the medians in the contractionary and expansionary surplus reversals is statistically significant at the 10 percent confidence level)

Reversals of current account surpluses were characterized by an increase in investment in the expansionary reversals and an increase in consumption (decrease in savings) in the contractionary reversals.



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

[1]Contractionary surplus reversals are the 13 surplus reversals with the largest average decline in GDP growth (the bottom quartile in the sample ordered by the change in growth).

[2]Expansionary surplus reversals are the 12 surplus reversals with the smallest average decline in GDP growth (the top quartile in the sample ordered by the change in growth).

[3]Average of GDP annual growth rates in the period after the reversal (1 . . . *T*) less average annual growth rates in the period before the reversal (–*T* . . . –1).

[4]Maximum change in REER within the period surrounding the reversal (–*T* . . . *T*). An increase represents a real appreciation of a country's currency relative to its trading partners.

[5]"Before reversal" is the change in the variable between –*T* and 0. "After reversal" is the change in the variable between 0 and *T*.

empirical trade model—relating the volume of exports and imports to real foreign and domestic incomes and relative export and import prices. A vast empirical literature exists on this model for the United States and elsewhere, with estimates of trade elasticities varying greatly depending on the methodology, time period, and choice of variables.[13] A general result is that price elasticities tend to be quite small, especially in the short run, and at times too low to satisfy the Marshall Lerner condition.[14] Thus, an exchange rate depreciation would weaken the trade balance as its negative effect on the terms of trade would outweigh its positive effect on trade volumes.

This chapter revisits the standard empirical trade model to correct for biases that may lower estimates of trade elasticities. To provide a benchmark for this exercise, the standard model has been re-estimated for the United States over the post–Bretton Woods period (1973–2006).[15]

The results of the estimation conform to the elasticity pessimism view. In particular, the long-run estimates of U.S. import and export elasticities are quite low—indeed too low to satisfy the traditional Marshall Lerner condition (Table 3.2). Moreover, the U.S. income elasticity of imports is about 0.5 higher than the income elasticity of the trading partners' demand for U.S. exports (as in Houthakker and Magee, 1969). This suggests that foreign GDP growth would need to be about double that in the United States to start reducing the U.S. trade deficit from its 2005 level—a seemingly unrealistic condition as historically

[13]See Goldstein and Khan (1985); Hooper, Johnson, and Marquez (2000); and IMF (2006).

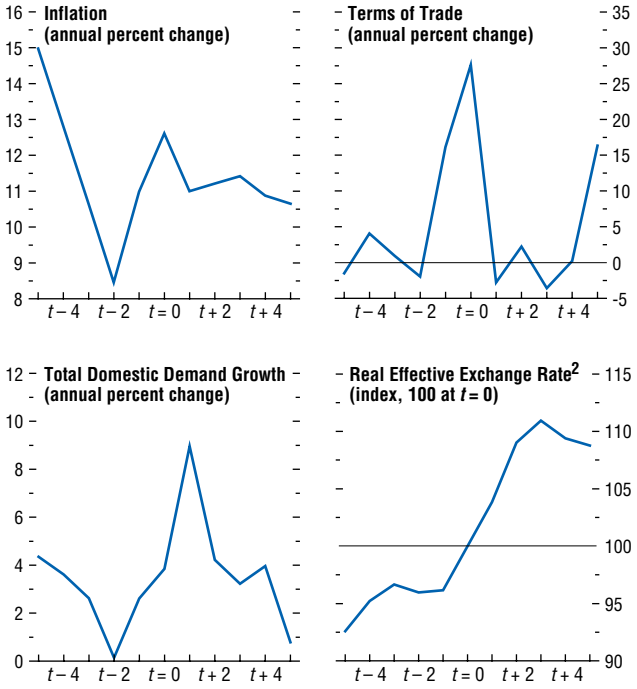
[14]The Marshall Lerner condition is that when changes in exchange rates are fully passed through to import prices at home and abroad, the import and export price elasticities (in absolute value) must sum to greater than one for a depreciation to improve the trade balance.

[15] See Appendix 3.2 for details on the econometric methodology and a full set of tables with the results of this section.

Figure 3.8. Oil Exporters: Surplus Reversals[1]

(Medians across episodes; t = 0 is the peak year of the ratio of current account surplus to GDP; x-axis in years before and after t = 0)

Current account surpluses for oil exporters mainly reflect large shifts in the terms of trade.



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

[1]See Appendix 3.1 for the definition of surplus reversals and information on country group composition.

[2]An increase in the index represents a real appreciation while a decrease represents a real depreciation of a country's currency relative to its trading partners.

Table 3.2. Standard Trade Model: Estimates of U.S. Trade Elasticities

	Estimated over 1973–2006				Estimated over 1986–2006	
	Without correcting for biases		Correcting for aggregation bias	Correcting for vertical integration bias[3]	Without correcting for biases	
	RP[1]	REER[2]	RP[1]	RP[1]	RP[1]	REER[2]
Imports						
Price elasticity	–0.69	0.37	–1.45	–1.48	–0.82	0.48
Income elasticity	2.03	2.46	1.68	0.64	1.86	2.46
Exports						
Price elasticity	0.02	–0.49	–0.26	. . .	–1.06	–0.60
Income elasticity	1.85	1.82	1.60	. . .	0.76	1.97

Source: IMF staff calculations based on estimates in Appendix 3.2.
[1]Price elasticities with respect to relative prices (RP).
[2]Price elasticities with respect to real effective exchange rate (REER). Increase in REER denotes real appreciation.
[3]The correction for vertical integration bias is based on estimates on the 1979–2006 sample.

the United States has grown at about the same pace as the rest of the world.[16]

Before looking at two possible sources of misspecification of the standard empirical model, two caveats should be made about these results. First, the traditional Marshall Lerner condition is based on the assumption of complete pass-through of exchange rate movements to import prices. In the context of limited exchange rate pass-through, however, a U.S. dollar depreciation could still improve the nominal trade balance even with the low trade price elasticities estimated in the standard empirical model. The reason is that with partial pass-through, a U.S. dollar depreciation reduces the U.S. terms of trade by less than when exchange rate movements are fully transmitted to trade prices, making it easier for an improvement in real net exports to generate an adjustment in the nominal trade balance (Box 3.3).

Second, restricting the sample to the past two decades yields higher estimates of the U.S. trade price elasticities. This finding is consistent with the view that globalization is likely to have increased the responsiveness of trade volumes to changes in real exchange rates (Obstfeld, 2002). In particular, the increasing importance of outsourcing and of trade in intermediate products should induce firms to respond more strongly to changes in relative prices by switching between domestic and imported inputs, or by shifting tasks across borders.

Does the Standard Empirical Trade Model Underestimate the Response of Trade Volumes to Relative Prices?

The U.S. trade equations estimated above represent a basic, "stripped-down" version of the standard empirical trade model. Several efforts have been made over the years to improve upon this model and find more plausible values for trade elasticities in the long run. This subsection explores two particular variations on the standard empirical model, both of which yield larger estimates of long-run trade price elasticities and smaller (and less divergent) estimates of income elasticities of imports and exports, thus providing some ground for greater elasticity optimism.

First, low measured long-run price elasticities of U.S. trade volumes may reflect an aggregation bias. It is well known that estimates of trade price elasticities using microeconomic data (that is, at the level of individual goods or sectors) yield a wide range of values across sectors and

[16]One puzzling implication of the higher estimated income elasticities of imports than of exports is that if U.S. growth is the same or faster than its trading partners, the U.S. trade deficit will keep expanding, with unchanged relative prices. Counter to this prediction, however, is the finding that fast-growing countries tend to have higher income elasticities of exports than of imports, which explains why they have not experienced a trend depreciation or an exploding trade deficit (Krugman, 1989).

Box 3.2. Large and Persistent Current Account Imbalances

The size and persistence of the U.S. current account deficit has raised concerns about the possibility of an abrupt and disorderly adjustment.[1] However, as a number of observers have argued, large and protracted external imbalances may be a reflection of investors' decisions to allocate their savings toward the most profitable uses.[2] Even if a correction is eventually required, large and persistent deficits may not need to end in a more severe adjustment than do shorter-lived imbalances.

This box discusses the experiences that countries have had with large and persistent current account imbalances, focusing on current account deficits for advanced economies and on current account surpluses for advanced economies, emerging markets, and oil exporters. It first examines 13 episodes of large and persistent deficits in advanced economies, especially their experience with deficit reversals. It then examines 20 episodes of large and persistent surpluses for all countries in the sample, looking for common patterns during these episodes.[3]

Large and Persistent Current Account Deficits in Advanced Economies

While the criteria chosen to identify *large and persistent current account deficits*—a deficit amounting to more than 2 percent of GDP for more than five years—may seem undemanding, the actual current account deficit across the 13 episodes identified for the advanced economies averaged about 5 percent of GDP and lasted about 11 years. Seven of these episodes eventually ended with a reversal, while the remaining six are still ongoing (Australia, Greece, New Zealand, Portugal, Spain, and the United States).[4]

On average, during the 13 episodes of *large and persistent current account deficits*, GDP growth tended to be slower and consumption growth faster than outside these periods (for both variables, the difference between the cross-country medians is statistically significant at 10 percent or better; see first figure). Moreover, these episodes were characterized by faster growth in private credit and a stronger stock market performance. Taken together, these findings appear consistent with an intertemporal smoothing view of current account imbalances—that the persistent external deficits were an optimal response to a permanent increase in productivity.[5]

If these deficits reflect appropriate saving and investment decisions, one could expect their reversal to occur smoothly and without a large growth slowdown (driven by the return of investment and saving ratios to their new long-run levels). Indeed, the experience with the reversal of *large and persistent current account deficits* in advanced economies shows that the correction of these deficits has not been characterized by a larger decline in GDP growth or by a greater real effective exchange rate depreciation than the other reversal episodes identified and discussed in the main text (see Table 3.1).[6] Moreover, reversals after large and persistent deficits, on average, occurred over a similar time frame as the other reversal episodes (between four and five years). These results suggest that the adjustment of *large and persistent current account deficits in advanced economies* have generally reflected macroeconomic developments within the economy, rather than following externally driven events where the size and persistence of the current account deficit

Note: The main author of this box is Roberto Cardarelli.

[1]See, among others, Roubini and Setser (2004).

[2]See, among others, Backus and Lambert (2005).

[3]Clearly, the relatively small number of large and persistent episodes of external imbalances suggests caution in drawing general conclusions from these patterns.

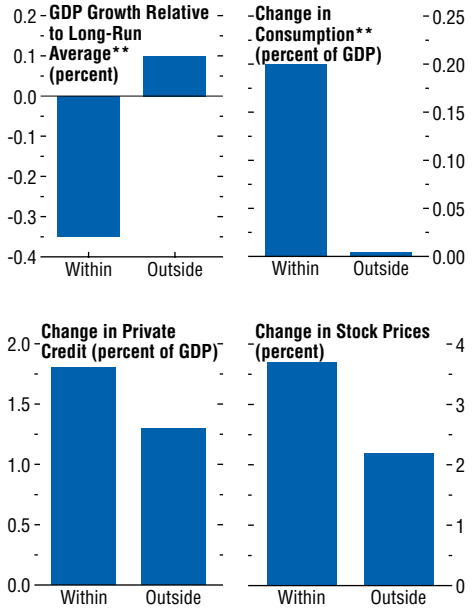
[4]See Appendix 3.1 for a list of all episodes.

[5]Following an increase in productivity, expected future income increases more than current income, as the capital stock takes time to adjust. At the same time, consumption ratios increase in anticipation of higher future income. Both lower saving rates and higher investment ratios lead to a deficit in the current account balance (Ghosh and Ostry, 1995).

[6]See also Freund and Warnock (2005) for a similar finding.

Box 3.2 *(concluded)*

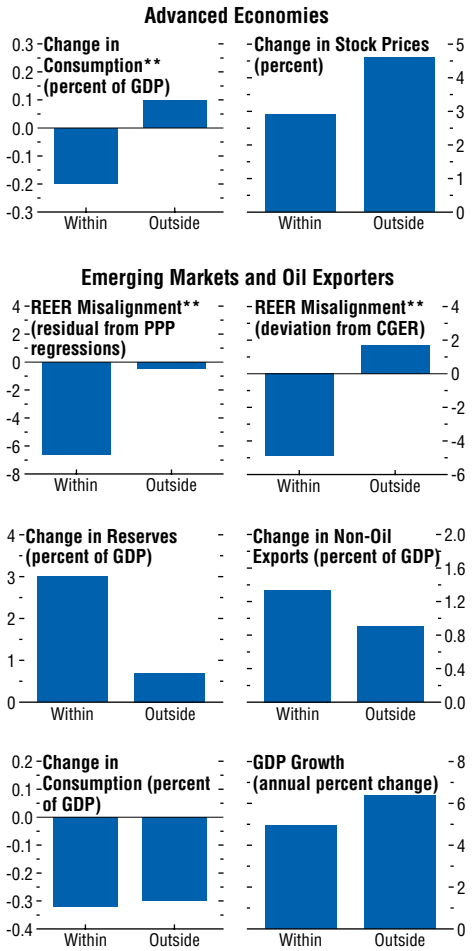
Advanced Economies: Key Indicators of Large and Persistent Deficits[1]



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

[1]"Within" refers to the cross-country median of the average value of the variable during episodes of large and persistent imbalances. "Outside" refers to the cross-country median of the average value of the variable for the same countries but in different periods. Asterisks show that the difference between the two medians is statistically significant at the 10 percent confidence level.

Key Indicators of Large and Persistent Surpluses[1]



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); and IMF staff calculations.

[1]"Within" refers to the cross-country median of the average value of the variable during episodes of large and persistent imbalances. "Outside" refers to the cross-country median of the average value of the variable for the same countries but in different periods. Asterisks show that the difference between the two medians is statistically significant at the 10 percent confidence level. REER stands for real effective exchange rate, PPP for purchasing power parity, and CGER for Consultative Group on Exchange Rate issues. See footnote 8 in Box 3.2 for more information.

itself has precipitated the adjustment (see also Debelle and Galati, 2005).[7]

Large and Persistent Current Account Surpluses in Advanced Economies and Emerging Market Countries

As in the deficit episodes, the average size and duration of the episodes of *large and persistent current account surpluses* were well above the thresholds required—at least 2 percent of GDP for at least five years. In particular, across

[7]The findings that the nature of capital flows does not seem to vary prior to a current account adjustment for advanced economies (Debelle and Galati, 2005) and that the extent of the adjustment in advanced economies (the changes in GDP and currency values) does not seem to be related to the level of foreign debt (Freund and Warnock, 2005) are consistent with this interpretation.

the eight episodes of *large and persistent current account surpluses* identified for the advanced economies, the current account surplus averaged about 6 percent of GDP and lasted on average about 12 years. Across the 12 episodes identified for emerging markets and oil exporters, the current account surpluses averaged about 9 percent of GDP and lasted six years on average.

The experiences during the eight episodes of *large and persistent current account surpluses in the advanced economies* identified in the chapter again appear consistent with the intertemporal smoothing view of current account imbalances. In particular, these cases were associated with slower growth in consumption and a weaker performance of the stock market during the episodes (see second figure).

A key characteristic of the 12 episodes of *large and persistent current account surpluses in emerging markets and oil exporters* has been a relatively undervalued real effective exchange rate (see second figure).[8] Moreover, these episodes have been characterized by faster accumulation of foreign reserves, faster export growth, and slower consumption growth. However, for these variables, the difference with the averages outside these periods is not statistically significant. Interestingly, GDP growth was not faster on average when these countries experienced a large and sustained surplus, suggesting that currency undervaluation is not likely to result in permanently higher growth.[9]

[8]The difference in medians is significant at a 10 percent or better confidence interval for the two measures of currency misalignment shown in the figure, namely, the residuals from the regressions of real exchange rates on PPP-adjusted relative per capita incomes (from Johnson, Ostry, and Subramanian, 2007) and the deviation of real exchange rates from the medium-term equilibrium values estimated by the Consultative Group on Exchange Rate issues.

[9]Johnson, Ostry, and Subramanian (2007) document the role of currency undervaluation in past growth episodes in developing countries.

goods, most of which are much higher than the range typically found in the macroeconomic literature.[17] The large heterogeneity in these estimates raises the possibility that trade elasticities estimated on the basis of aggregate data could be different from the average of sector- or goods-specific estimates. For example, goods with relatively low price elasticities could be exposed to stronger price variations and thus exert a dominant effect on the estimated aggregate price elasticities, which would then underestimate the average response of trade volumes to relative prices (Goldstein and Khan, 1985; and Orcutt, 1950).

Second, measured long-run import price elasticities may be biased by vertical integration. Conventional empirical estimates of U.S. import price elasticities do not recognize that goods imported into the United States often are produced using intermediate goods exported from the United States (the share of U.S.-made intermediate goods in U.S. imports is estimated at about 30 percent).[18] Thus, data on U.S. imports used in econometric estimates can be interpreted as the sum of two components, the imported foreign value added and the U.S. exports of intermediate goods. As a result, measured U.S. import price elasticities will also be the sum of two components, the "true" price elasticity of imports and the effect of exchange rates on U.S. exports of intermediate products. As real exchange rate depreciation will reduce the demand for imports but increase the

[17]See, among others, Broda and Weinstein (2006) and Broda, Limão, and Weinstein (2006) for estimated elasticities of substitution for U.S. imports and exports at different levels of aggregation.

[18]See Appendix 3.2. There are no reliable estimates of the share of U.S. imports in U.S. exports (see National Research Council, 2006).

Box 3.3. Exchange Rate Pass-Through to Trade Prices and External Adjustment

The extent to which changes in nominal exchange rates pass through to changes in export and import prices—in short, exchange rate pass-through—affects the role of exchange rates in the process of external adjustment through two channels.[1] First, a limited pass-through at home and abroad can mute the expenditure-switching effect of exchange rate changes on trade volumes, as it forestalls movements in relative trade prices. Second, different degrees of pass-through at home and abroad affect the impact of exchange rate movements on the domestic terms of trade—the ratio between domestic-currency-denominated export and import prices—with a high pass-through at home and abroad associated with a worsening of the domestic terms of trade. It is the combination of the two effects, that is, the response of nominal trade balances, that ultimately matters for external adjustment.

Against this background, this box first reviews the available empirical evidence on exchange rate pass-through. It then discusses the implications of this evidence for nominal external adjustment. Finally, it draws some implications on the potential for a depreciation of the U.S. dollar to spur a change in the U.S. trade imbalance.

Evidence on Exchange Rate Pass-Through

A vast body of research shows that exchange rate movements are only partially transmitted to import prices—on average for OECD countries between 1975 and 2003, only 64 percent of the change in exchange rates has been transmitted to import prices after one year (see the table). Moreover, pass-through into prices at the border varies considerably across sectors—being lower for highly differentiated manufacturing products—and across countries, likely reflecting differences in the sectoral composition of imports as well as in market size. In particular, the United States tends to have a much lower pass-through to import prices than do other advanced economies—about 0.5—while smaller, more open economies have rates closer to one.[2] This difference may be related to the stronger domestic competition for imported goods in the United States and may also reflect the international use of the dollar in invoicing export and import transactions (Goldberg and Tille, 2005).

While there is broad consensus on the fact that pass-through to U.S. import prices is lower than in most other economies, it is not clear whether pass-through has declined in advanced economies over the recent past, with several studies reaching different conclusions depending on the methodology and data used.[3] For emerging markets, pass-through coefficients have declined considerably in recent years, following the decline in inflation rates, and are now comparable to those in advanced countries (Frankel, Parsley, and Wei, 2005; and IMF, 2006).

The literature on pass-through of exchange rate movements into domestic-currency-denominated export prices is considerably less extensive. Most studies assume pass-through coefficients for exports derived as the average of the coefficients of pass-through to import prices of partner countries. For the United States, this gives an export pass-through of about 0.8.

Note: The author of this box is Cedric Tille.

[1]This box focuses on pass-through to trade prices at the border. Pass-through to retail prices of traded goods is further limited by distribution costs (Campa and Goldberg, 2005).

[2]These estimates, however, may underestimate the degree of pass-through as they fail to take into account the compositional effect associated with firms' entry and exit following exchange rate movements (Rodríguez-López, 2006).

[3]Campa and Goldberg (2005) find some decline of pass-through between 1975 and 2003 that primarily reflects a change of the import mix toward goods with low pass-through. Marazzi and others (2005) argue that the pass-through to U.S. import prices has declined further in recent years. Hellerstein, Daly, and Marsh (2006) find no evidence of a declining pass-through, while Thomas and Marquez (2006) argue that the measurement of foreign prices is central to the results and find that pass-through to import prices has remained constant at about 0.5 for the United States.

Exchange Rate Pass-Through into Import Prices After One Year

Country	
United States[1]	0.42
Euro area[2]	0.81
Japan[3]	0.53–1.00
Open advanced economies[4]	0.60
Developing countries and emerging markets[5]	0.66
Average excluding the United States[6]	0.66–0.77
Average including the United States[6]	0.61–0.70
Average for OECD countries[1]	0.64

Source: Campa and Goldberg (2005) unless otherwise noted.
[1]Campa and Goldberg (2005).
[2]Faruqee (2006).
[3]Faruqee (2006); Campa and Goldberg (2005); and Otani, Shiratsuka, and Shirota (2006).
[4]Campa and Goldberg (2005). Average of Australia, Canada, Denmark, New Zealand, Norway, Sweden, Switzerland, and the United Kingdom.
[5]Frankel, Parsley, and Wei (2005).
[6]Average of the estimates above with low and high estimates for Japan.

Pass-Through and Nominal Trade Adjustment

An important implication of the incomplete exchange rate pass-through to import prices is that the traditional Marshall Lerner condition—which states that for an exchange rate depreciation to increase the nominal trade balance, the sum of the export and import price elasticities must be greater than one ($\eta_x + \eta_m > 1$)—no longer holds.[4]

Indeed, the Marshall Lerner condition is based on the assumption of complete pass-through to import prices at home and abroad.[5] With complete pass-through, an exchange rate depreciation is fully transmitted to a country's domestic terms of trade, since, as expressed in domestic currency, import prices increase by the full amount of the depreciation while export prices remain constant (though they decrease in foreign currency).[6] In this case, the nominal trade balance improves only if the expenditure-switching effect from the changes in relative prices is sufficiently strong, that is, if the sum of trade price elasticities is larger than one. Moreover, if trade volumes respond more slowly than prices, the improvement will come with a lag and the trade balance will initially deteriorate (J-curve effect).

With zero pass-through at home and abroad, however, an exchange rate depreciation still improves the nominal trade balance even if price trade elasticities are low—and the traditional Marshall Lerner condition is not satisfied. In this case, expressed in domestic currency, import prices do not move with the exchange rate depreciation while export prices increase, as they are held constant in the currency of the destination market.[7] In this environment, the exchange rate depreciation improves the nominal trade balance, thanks to more favorable terms of trade, even though the expenditure-switching channel on trade volumes is neutralized as relative trade prices do not change with the exchange rate.

The empirical evidence suggests that the pass-through environment for the United States is a combination of the two cases described above—with low pass-through of exchange rate changes into U.S. import prices and higher pass-through into foreign-market prices of U.S. exports. Hence, both U.S.-dollar-denominated export and import prices tend to be relatively insensitive to movements of the U.S. dollar (Goldberg and Tille, 2005).

In this context, a U.S. exchange rate depreciation is likely to improve the trade balance even if the trade price elasticities are low, as

[4]Both elasticities are with respect to relative prices and are taken in absolute value.

[5]Defining the coefficient of pass-through to import prices at home as β_m and the coefficient of pass-through to export prices as $1 - \beta_x$, the adjusted Marshall Lerner condition can be expressed as $\eta_m\beta_m + \eta_x\beta_x > \beta_m + \beta_x - 1$, where the left-hand side is the impact of a 1 percent depreciation on real net exports and the right-hand side is the impact of a 1 percent depreciation on the terms of trade. The traditional Marshall Lerner condition follows from assuming a complete pass-through to import prices at home ($\beta_m = 1$) and to import prices abroad ($\beta_x = 1$) (Gust and Sheets, 2006).

[6]This is the traditional case of producer-currency pricing (e.g., Obstfeld and Rogoff, 1996 and 2000).

[7]This is the case of local-currency pricing (e.g., Devereux and Engel, 2002).

Box 3.3 *(concluded)*

limited pass-through to the terms of trade reduces the burden of the adjustment on export and import volumes. Specifically, considering a pass-through to U.S. import prices of 0.5 and a pass-through to the foreign-market price of U.S. exports of 0.8,[8] a 10 percent depreciation of the U.S. dollar would imply a 0.3 percent deterioration in the U.S. terms of trade. Even with the low U.S. trade price elasticities estimated in the standard empirical trade model (see Table 3.2), a depreciation of the U.S. dollar would narrow the trade deficit. This reduction would be mainly associated with stronger export volumes, following the decline in the foreign-currency-denominated price of U.S. export goods. However, as U.S. imports exceed exports by about 50 percent, this scenario would lead to only a partial narrowing of the trade deficit in the absence of other changes, such as a decline in the domestic demand for imports or an increase in foreign demand for U.S. products.

Overall, the main implication from this analysis is that given the particular pass-through environment for the United States, a U.S. dollar depreciation could contribute to some narrowing of the U.S. trade deficit even if trade price elasticities are relatively low. This contribution would take the form of an improvement in the real trade balance, with the terms of trade deteriorating less than with full pass-through.

[8]As stressed by Dillon and Goldberg (2006), however, using this coefficient as a measure of the pass-through to U.S. export prices is valid only as a first approximation, as this estimate applies to all the imports of those countries, not just those from the United States. Faruqee's (2006) direct estimates of pass-through to U.S. export prices in U.S. dollars are consistent with a pass-through to foreign-currency prices of U.S. exports of about 0.85 after 18 months.

demand for U.S. intermediate exports, ignoring vertical integration will cause the measured import price elasticities to be underestimated.[19]

Against this background, the basic standard empirical model was re-estimated controlling for the heterogeneity in individual sector price elasticities and for vertical integration:

- To control for the presence of heterogeneity in elasticities across sectors, the standard model was estimated for 17 categories of U.S. imports and 16 categories of U.S. exports, and aggregate trade price elasticities were calculated as the simple averages of individual elasticities.[20] This methodology yields much higher estimates of U.S. trade price elasticities—import price elasticities more than double while export price elasticities increase from zero to about 0.3 (in absolute value)—and the Houthakker-Magee asymmetry in income elasticities disappears (see Table 3.2).
- To correct for vertical integration, the basic model for U.S. imports was re-estimated adding U.S. exports of key intermediate products as an additional explanatory variable. This specification yields estimates of U.S. import price elasticities that are about twice as high as in the standard empirical model and have a much lower income elasticity (see Table 3.2).

Finally, the standard trade model was adapted to allow for the possibility that the responsiveness of trade to relative price changes depends on the size of the relative price changes—owing to the existence of fixed costs of entry into trade emphasized in the "new trade theory." In particular, the standard trade model for the United States was re-estimated using a nonlinear error correction specification that allows trade volumes to return to their long-run level at a faster pace when the change in relative trade prices

[19]See Chinn (2005) and Khatri and Oguro (2007) for other studies that estimate the impact of vertical integration on trade elasticities.

[20]These averages are consistent estimates of the aggregate relation in the presence of heterogeneity in the parameters (Pesaran and Smith, 1995). However, these estimates do not take into account the possibility that individual elasticities are affected by other sectors' relative trade prices.

is above a certain threshold.[21] The results show strong evidence of a nonlinear dynamic adjustment for U.S. import volumes. Specifically, they indicate that when relative import prices change by more than 2 percent per quarter (in absolute value), U.S. import volumes return to their long-run level much more rapidly, that is, after 5 quarters compared with 11 quarters when the changes are slower than the threshold.[22]

Applying the same methodology to other OECD countries generally confirms that import and export volumes tend to react more strongly to changes in relative prices above a certain threshold. These thresholds varied considerably across countries, however, raising the question of whether the effectiveness of real exchange rate changes depends on structural differences across these economies.

Exchange Rate Effectiveness and Flexibility of Markets

Does the effectiveness of changes in real exchange rates increase with the flexibility of labor and product markets? In the traditional macroeconomic approach to trade modeling, countries expand their exports by exporting more "existing" goods, while the "new trade theory" has long emphasized the importance of trade in new varieties and new markets (Krugman, 1989). A growing body of empirical evidence supports the notion that fast-growing countries tend to increase their market share essentially by expanding the range of goods that they export.[23]

This finding carries important implications for the role of exchange rate movements in external adjustment. As entry and exit into export markets require firms to sustain fixed costs, only large and persistent changes in relative prices may induce firms to incur such costs—consistent with the evidence of nonlinearities in trade responsiveness discussed above. Moreover, more flexible production structures (that is, with lower fixed costs of entry and exit) could help firms take advantage of new opportunities when relative prices change permanently, and thus enhance a country's aggregate trade responsiveness to exchange rate movements.

Two pieces of evidence point to a correlation between the effectiveness of real exchange rates and economic flexibility. First, there is a negative correlation between the thresholds in relative price changes found in the nonlinear model of trade volumes described above and an index of flexibility of product and labor markets (Figure 3.9).[24] This suggests that relative prices may need to change less to generate a faster adjustment of trade volumes in countries in which labor and product market rigidities are smaller. Second, separating the reversal episodes analyzed earlier based on the degree of flexibility of the economies in which they occurred suggests that changes in real effective exchange rates during adjustment have been smaller in relatively more flexible economies. Moreover, the negative trade-off between total real exchange rate depreciation and the average change in GDP after the reversal is found only for the more flexible economies, suggesting that only for them have the exchange rate movements been effective in cushioning (other things being equal) the output costs associated with adjustment (see Figure 3.9).

[21]Clarida, Goretti, and Taylor (2007) find evidence of threshold behavior in current account adjustment for the G-7 countries so that the dynamics of adjustment depend upon whether the current account balance breaches estimated, country-specific current account balance thresholds.

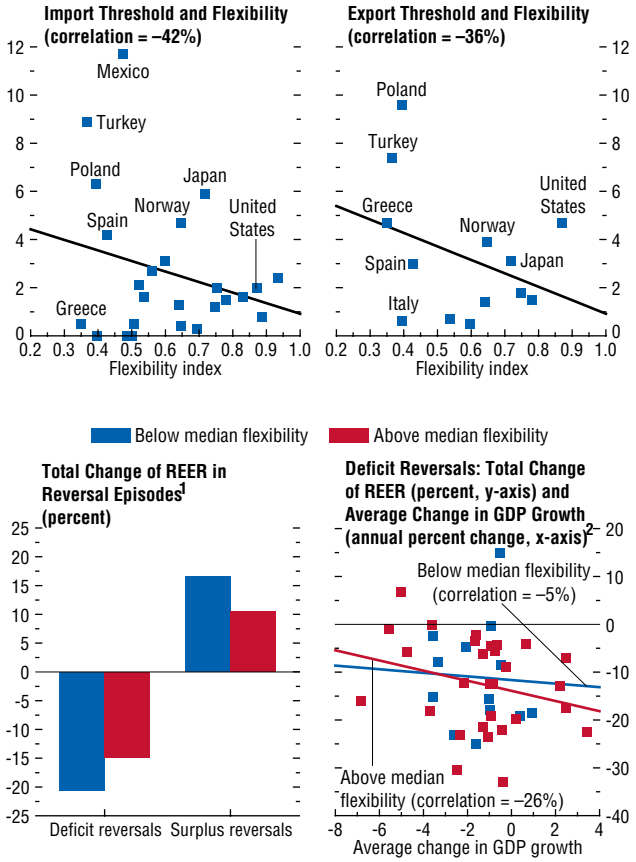
[22]Over the 1973–2006 sample period, U.S. relative import prices have exceeded the threshold level only 25 percent of the time.

[23]Several papers show that the measured U.S. import income elasticity is lower—and the puzzling Houthakker-Magee result disappears—when the classic workhorse trade model takes into account a "varieties term" in import demand. See, among others, Marquez (2003); Gagnon (2002); Mann and Plück (2007); and Justiniano and Krajnyák (2005).

[24]The index is constructed using indicators of the cost of starting and closing a firm, and of hiring and firing labor, from the Cost of Doing Business database (World Bank). For each indicator, the values for each country were re-scaled between 0 and 1 (with 1 indicating a higher degree of flexibility), and the overall flexibility index was constructed as a simple average of these values.

Figure 3.9. Thresholds in Relative Trade Prices, Real Effective Exchange Rate, and Flexibility of Markets

Countries with higher values of the flexibility index tend to have lower thresholds in the growth rate of relative prices of imports and exports. More flexible economies have experienced smaller movements in real effective exchange rate (REER) during reversal episodes. Only for these economies does there appear to be a trade-off between REER depreciation and GDP growth during deficit reversals.



Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); World Bank, *World Development Indicators* (2006); World Bank, Cost of Doing Business database; and IMF staff calculations.

[1]Maximum change in REER within the period surrounding the reversal (–*T* . . . *T*), median across episodes. An increase represents a real appreciation while a decrease represents a real depreciation of a country's currency relative to its trading partners.

[2]Advanced economies only. Average real GDP growth after the reversal (1 . . . *T*) less average real GDP growth before the reversal (–*T* . . . –1) on the x-axis. Maximum change in REER within the period surrounding the reversal (–*T* . . . *T*) on the y-axis. Median across episodes.

These findings suggest that changes in real exchange rates needed for a given amount of external adjustment will likely be larger for economies where rigidities in product and labor markets make it more difficult for firms to enter and exit trade.[25] Moreover, increased protectionism, by reducing effective flexibility in economies, would tend to raise the growth costs associated with deficit reversals for any given adjustment in relative prices.

Implications for Global Imbalances

The findings in the previous sections support the view that real exchange rate changes are likely to help reduce the output costs associated with a narrowing of external imbalances. What are the implications for the present conjuncture?

To be sure, the unprecedented scale of the U.S. deficit should make one cautious about drawing strong conclusions from the historical experience for a range of countries. Nevertheless, the 1987 deficit reversal in the United States is consistent with the more general cross-country evidence that a realignment of real exchange rates matters for external adjustment (Krugman, 1991). The adjustment of the late 1980s partially reflected a cyclical weakening in domestic demand, particularly of investment. While the gyration in growth differentials with trading partners was primarily induced by stronger growth abroad, rather than lower growth in the United States, the large real exchange rate depreciation contributed to the surge in real export growth and helped stabilize economic activity (see Kamin, Reeve, and Sheets, 2006).

The 15 percent real effective depreciation of the U.S. dollar since mid-2002 (17 percent

[25]This evidence is consistent with Burgess and Knetter (1998), who consider the interaction between real exchange rate changes and labor markets across the G-7 countries (with the more flexible U.S. economy more responsive than Germany and Japan), and Gourinchas (1998), who shows that U.S. import-competing sectors seem to be more responsive to exchange rates than other less flexible sectors, including nontradables sectors.

in nominal terms) is now starting to have an impact on the non-oil trade deficit as a ratio to GDP, although the impact on the current account has been obscured by rising oil prices and a deteriorating net income position (Figure 3.10). Consistent with the finding of low pass-through of exchange rate movements to U.S. import prices and high pass-through to import prices abroad (see Box 3.3), the effect of the dollar depreciation came mainly through a strong acceleration in export volumes. Import volumes, meanwhile, have continued growing, reflecting not only the modest increase in U.S. import prices but also the faster growth of the U.S. economy relative to that of its trading partners until very recently.[26]

How much would the U.S. dollar need to decline in the long run to reduce the current account deficit? Typical estimates from the standard econometric models of the U.S. economy suggest that narrowing the ratio of current account deficit to GDP by 1 percentage point would require a real depreciation ranging from 10 percent to 20 percent. The evidence on trade elasticities presented in this chapter is consistent with estimates at the lower end of this range. Incorporating estimates that correct for either aggregation or vertical integration biases into a partial equilibrium analysis of trade adjustment suggests that a real depreciation of between 10 percent and 15 percent is needed to lower the trade deficit by 1 percent of GDP. Using elasticities that correct for both biases brings the required real dollar depreciation down to below 10 percent (Figure 3.11).[27]

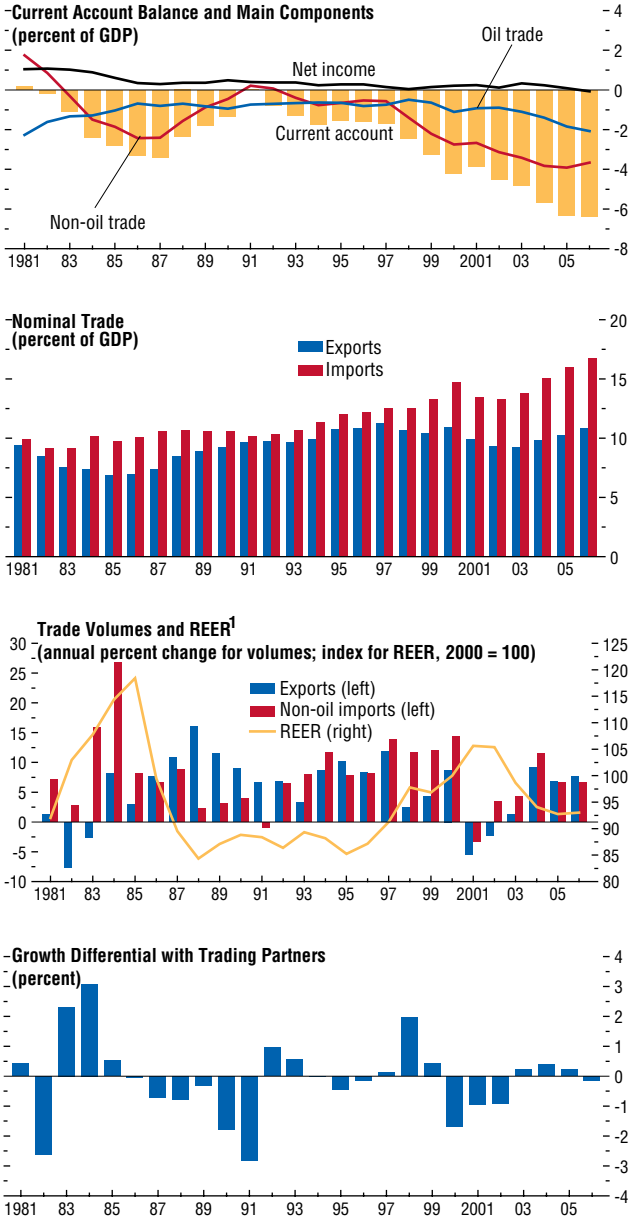
These estimates are based on a partial-equilibrium analysis of trade balance adjustment and thus do not take into account other changes in the U.S. economy, particularly policy shifts and changes in consumption and investment behavior. Historical evidence suggests

[26]The U.S. terms of trade have deteriorated over the past four years (cumulatively by about 8 percent), even if less than one-for-one with the U.S. dollar, reflecting the peculiar U.S. pass-through environment described in Box 3.3.

[27]See Appendix 3.2 for details of the calculations.

Figure 3.10. United States: Trade Flows, Real Effective Exchange Rate (REER), and Growth Differential with Trading Partners

The U.S. dollar REER depreciation since 2002 has positively affected export volumes. Import volume growth has remained strong though, partly reflecting positive growth differential with trading partners until 2005.



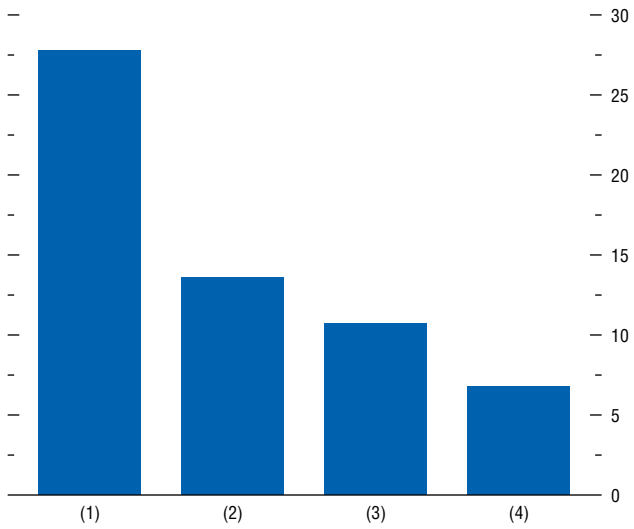
Sources: IMF, *International Financial Statistics;* OECD, *Economic Outlook* (2006); OECD, Analytical Database; World Bank, *World Development Indicators* (2006); and IMF staff calculations.

[1]An increase in the REER index represents a real appreciation while a decrease represents a real depreciation of the U.S. dollar relative to its trading partners.

Figure 3.11. Required Exchange Rate Change for a 1 Percentage Point Reduction in the Ratio of U.S. Trade Deficit to GDP[1]
(Percent)

Correcting for aggregation and vertical integration biases increases the impact of the real effective exchange rate (REER) depreciation on the U.S. trade balance.

(1) Based on the standard empirical trade model discussed in the main text (1986–2006)
(2) Based on model (1) adjusted for vertical integration bias
(3) Based on model (1) adjusted for aggregation bias
(4) Based on model (1) adjusted for both aggregation and vertical integration biases



Source: IMF staff calculations.
[1]All scenarios are based on price elasticities with respect to REER, an import-to-export ratio of 1.56, and no growth differential with trading partners. Details of the calculations are in Appendix 3.2.

that in addition to movements in real exchange rates, successful and smooth external adjustments have been characterized by significant increases in saving rates and strong fiscal consolidation in deficit countries. Moreover, according to the evidence presented earlier, the narrowing of surplus positions seems to be associated with a pickup in domestic demand in surplus countries. As discussed in other recent analysis (see the September 2006 *World Economic Outlook*), the adjustment of global imbalances will likely involve a combination of exchange rate movements with a rebalancing of domestic demand—rising rates of absorption in surplus countries and a slower pace of demand growth in the United States. In part, this demand rebalancing will follow from a reversion of U.S. household saving rates to levels closer to historical averages, following the steep decline since the late 1990s in the context of strong capital gains from asset price increases. Fiscal consolidation aimed at ensuring that the U.S. economy is well placed to face the fiscal cost of population aging would also make a significant contribution.

Conclusions

The causes and implications of global imbalances have become an increasingly controversial subject in recent years. Different views exist on whether imbalances can be sustained for a long period of time, the conditions under which they could narrow, and the role of exchange rate movements in this adjustment.

The analysis in this chapter of historical episodes of large and sustained imbalances and their reversal clearly suggests that a market-led realignment of real exchange rates can play an important complementary role to demand rebalancing across countries to facilitate a smooth unwinding of external imbalances. Advanced economies have tended to experience a smaller impact on growth during deficit reversals when changes in real exchange rates have contributed to the adjustment. For both advanced economies and emerging market countries, reversals

of external surpluses have tended to involve real appreciations of their currencies.

Historical evidence also suggests that while exchange rate changes may help to contain the output costs associated with deficit reversals, the role of other macroeconomic and structural policies is also very important. Episodes where deficit reversals have been achieved without serious damage to growth have typically involved fiscal consolidation and a significant increase in saving rates, which allowed investment rates to continue near pre-adjustment values. On the side of surplus countries, increases in domestic demand—associated with more expansionary monetary and fiscal policies—have played a key role in narrowing imbalances. More flexible economies have also helped by facilitating producers' response to relative price changes occurring through exchange rate movements. The evidence also suggests that the larger the initial imbalances, the lower the chance that a benign resolution can be achieved.

This chapter finds that the U.S. trade balance may be more responsive to changes in the real value of the U.S. dollar than often assumed. First, aggregate estimates have tended to underestimate the responsiveness of U.S. trade volumes, as they failed to account for aggregation and vertical integration biases—that is, differences in trade responsiveness across goods and the export content of imports. Second, long-run U.S. trade price elasticities have tended to increase over time, reflecting greater competition among firms in an increasingly globalized economy. Accounting for these channels significantly increases estimates of the impact of a real exchange rate depreciation on the U.S. external imbalance.

The implications of these findings for the current conjuncture are that market-led movements of real exchange rates—involving a real U.S. dollar depreciation and a real appreciation of the currencies of countries with persistent surpluses—would support a broader rebalancing of domestic demand across key regions that could facilitate the unwinding of the imbalances. The rebalancing of demand is likely to involve a reversion of the U.S. private saving rate to more normal levels, further fiscal consolidation in the United States, and rising absorption in both oil-exporting and key emerging market countries. A major role for policy in this context is to make sure that structural factors do not impede the associated shifting of productive resources between sectors and the realignment of real exchange rates.

Appendix 3.1. Event Analysis: Methodology and Data

The main author of this appendix is Roberto Cardarelli.

The event analysis, which covered 1960–2006, comprised those 47 countries that had the largest GDP per capita (in PPP exchange rates against the dollar) in 2004. They were divided into three groups:

- 20 advanced economies: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States;
- 21 emerging market economies: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Hong Kong SAR, Hungary, Israel, Korea, Malaysia, Mexico, Poland, Romania, Singapore, Slovak Republic, South Africa, Taiwan Province of China, Thailand, Turkey, and Ukraine; and
- 6 oil exporters: Algeria, Islamic Republic of Iran, Norway, Russia, Saudi Arabia, and the United Arab Emirates.

To identify large and sustained reversals of ratios of current account to GDP (defined as *ca*), four criteria were adopted: one for the identification of the year when the reversal began, one for the identification of the year when it ended, one to make sure the correction was sufficiently large, and the final one to make sure the correction was relatively persistent.

- The beginning of the reversal (year 0): a non-negligible correction must be starting at year 0, as the average reduction of the imbalance

over the next three years must be at least ½ percentage point of GDP. This serves to exclude very slow starts.

- The end of the reversal (year T): the episode finishes when a local maximum (for deficit reversals) or minimum (for surplus reversals) is reached. This happens when
  - $|ca_t|$ remains below $|ca_T|$ for three consecutive years; and
  - ½ percent or more of the reversal is overturned, that is, $\frac{|ca_T - ca_{T-1}|}{|ca_0 - ca_{T-1}|} \geq 0.5$.
- The size criterion: compared with the initial year, the current account ratio in T must change by at least |2.5| percentage points of GDP, and by at least one-half of the initial level ca_0.
- The persistence criterion: in each of the five years after the beginning of the episode, the current account ratio must be larger (in absolute values) than ca_0.

Large and persistent imbalances were identified as episodes where the current account ratio is larger than |2| percent of GDP for at least five years in which no reversal has occurred.

Tables 3.3–3.6 list the episodes of external imbalances identified in this chapter. Table 3.7 describes the variables analyzed in the event analysis and in the annual econometric estimates discussed in Appendix 3.2.

Appendix 3.2. Econometric Estimates of Trade Models

The main author of this appendix is Alessandro Rebucci.

This appendix provides further details on the econometric methodology and results discussed in the main text, and on the results shown in Figure 3.11.

Standard Empirical Trade Model

The standard empirical trade model relates import volumes to relative import prices and domestic income, and export volumes to relative export prices and foreign income.[28] The log-linear specification of the model is therefore

$$\begin{aligned}\mu(L)\ln M_t &= \alpha + \eta(L)\cdot\ln Y_t \\ &\quad + \varepsilon_t(L)\cdot\ln\left(\frac{Pm_t}{Py_t}\right) + u_{Mt} \\ \mu(L)\ln X_t &= \delta + \varphi(L)\cdot\ln Y_t^* \\ &\quad + \xi_t(L)\cdot\ln\left(\frac{Px_t}{Py_t^*}\right) + u_{Xt},\end{aligned} \tag{1}$$

where M and X denote real imports and exports, Y and Y^* denote real home and foreign GDP, Pm and Px denote the aggregate import and export deflators (in local currency), Py and Py^* denote the domestic and foreign GDP deflators (in local currency), and u_{Mt} and u_{Xt} are the error terms.[29]

An alternative specification includes the real effective exchange rate, rather than relative trade prices, as the price variable in the model. The elasticities with respect to the real exchange rate take into account the incomplete degree of pass-through from exchange rates to relative prices.

The analysis focused on the long-run elasticities: $\eta = \eta(L)/\mu(L), \varepsilon = \varepsilon(L)/\mu(L)$ and $\varphi = \varphi(L)/\mu(L), \xi = \xi(L)/\mu(L)$. These elasticities were obtained by estimating, with ordinary least squares (OLS), the static version of the equations above, which can be interpreted as the first stage of the two-step cointegration procedure of Engle and Granger (1987).

This model was first estimated for U.S. imports and exports of goods and services for the period 1973–2006 using the annual data described in Table 3.7 (from the *World Economic Outlook* and the *World Development Indicators*). The main results (discussed in the text) were a higher estimated income elasticity of imports than of exports, and relatively low price

[28]This is the empirical counterpart of the standard imperfect substitution model, with constant elasticity and perfectly elastic supply of domestic and foreign-produced goods (e.g., Armington, 1969).

[29]Y^* and P_y^* are weighted averages of trading partners' GDP and GDP deflators, respectively, and are expressed in local currency. The weights used are as described in Table 3.7.

Table 3.3. List of Reversal Episodes

(Percent of GDP)

	Deficits				Surpluses		
Country	Year	Deficit at $t = 0$	Size of adjustment[1]	Country	Year	Surplus at $t = 0$	Size of adjustment[1]
			Advanced economies				
Australia	1968	–3.30	4.0	Australia	1972	0.7	3.8
Austria	1977	–4.22	3.1	Austria	1990	0.7	3.8
Austria	1980	–2.02	3.0	Belgium	1972	1.7	4.7
Austria	1999	–3.16	5.1	Belgium	2002	4.6	3.2
Belgium	1980	–2.98	6.7	Canada	1970	0.6	5.4
Canada	1975	–4.79	2.5	Canada	1982	0.6	4.5
Canada	1981	–4.16	4.8	Denmark	1993	2.8	3.7
Canada	1993	–3.86	4.4	Finland	1972	5.0	12.5
Canada	1998	–1.25	4.0	Finland	1978	1.8	4.6
Denmark	1970	–4.34	3.7	Finland	1984	0.1	5.5
Denmark	1986	–6.20	9.0	Finland	2002	7.6	5.3
Denmark	1998	–0.89	4.1	France	1978	1.4	3.5
Finland	1975	–7.46	9.3	France	1999	2.9	5.5
Finland	1991	–5.44	12.9	Germany	1978	1.3	3.0
France	1990	–0.79	3.7	Germany	1989	4.2	5.5
Germany	1965	–0.83	2.9	Ireland	1993	3.6	5.5
Germany	1980	–1.69	5.9	Italy	1968	1.9	6.3
Germany	2000	–1.78	6.0	Italy	1978	2.0	4.5
Greece	1985	–9.30	6.9	Italy	1986	0.4	2.8
Greece	1990	–5.61	4.2	Italy	1996	3.1	5.2
Ireland	1981	–13.02	16.6	Japan	1971	2.5	3.5
Italy	1974	–4.38	6.4	Japan	1986	4.3	2.8
Italy	1981	–2.47	2.7	Netherlands	1973	4.3	4.9
Italy	1992	–2.39	5.5	Netherlands	1997	6.4	4.5
Japan	1967	–0.15	2.7	New Zealand	1973	1.7	12.8
Japan	1974	–1.04	2.7	Portugal	1986	3.1	5.0
Japan	1980	–1.03	5.3	Spain	1971	0.7	4.5
Netherlands	1980	–0.41	4.0	Spain	1978	0.8	3.5
New Zealand	1974	–11.13	8.2	Spain	1986	1.6	5.2
New Zealand	1984	–8.22	7.2	Sweden	1973	1.9	3.7
Portugal	1981	–15.13	18.2	Sweden	1978	0.7	3.4
Spain	1965	–5.26	6.0	Sweden	1986	0.6	3.4
Spain	1976	–3.98	4.8	Switzerland	1976	5.5	6.0
Spain	1981	–2.67	4.3	United Kingdom	1971	2.0	6.0
Spain	1991	–3.56	3.3	United Kingdom	1981	2.1	6.0
Sweden	1982	–2.58	3.8	United States	1981	0.2	3.6
Sweden	1992	–2.83	6.9				
Switzerland	1980	–0.53	5.7				
United Kingdom	1967	–3.92	5.9				
United Kingdom	1974	–3.99	6.1				
United Kingdom	1989	–5.12	4.9				
United States	1987	–3.39	3.4				
			Emerging markets				
Argentina	1980	–6.20	5.1	Argentina	1967	2.3	3.0
Argentina	1987	–3.81	7.0	Argentina	1978	3.2	9.4
Argentina	1998	–4.84	13.3	Argentina	1990	3.2	7.5
Brazil	1974	–7.16	4.3	Argentina	2002	8.5	7.5
Brazil	1982	–5.79	5.8	Brazil	1992	1.6	6.3
Brazil	1986	–1.98	3.3	Chile	1969	2.6	9.4
Brazil	2001	–4.57	6.5	Chile	1976	1.5	16.0
Chile	1984	–10.98	10.7	China	1982	2.8	6.5
Chile	1998	–4.94	5.0	China	1997	3.9	2.6
China	1979	–0.18	3.0	Colombia	1979	1.6	9.4
China	1985	–3.74	7.2	Colombia	1991	5.7	11.1
China	1993	–2.64	6.5	Colombia	2000	0.9	2.6
Colombia	1971	–5.80	7.7	Czech Republic	1993	1.2	7.9
Colombia	1983	–7.75	8.9	Hong Kong SAR	1975	17.5	22.5
Colombia	1997	–5.39	6.3	Hong Kong SAR	1989	8.2	15.5
Czech Republic	1996	–6.71	4.6	Hungary	1973	0.7	8.2
Hong Kong SAR	1961	–10.93	24.8	Hungary	1984	0.1	4.2
Hong Kong SAR	1980	–4.97	12.4	Hungary	1991	0.9	9.2
Hong Kong SAR	1995	–6.28	17.7	Israel	1986	4.3	8.3

Table 3.3 *(concluded)*

Country	Deficits			Country	Surpluses		
	Year	Deficit at $t = 0$	Size of adjustment[1]		Year	Surplus at $t = 0$	Size of adjustment[1]
			Emerging markets (continued)				
Hungary	1978	–7.47	7.6	Israel	1989	0.5	5.8
Hungary	1986	–4.11	5.0	Korea	1977	0.0	8.3
Hungary	1994	–8.26	4.8	Korea	1988	7.7	10.4
Israel	1975	–14.77	12.2	Korea	1998	11.7	10.7
Israel	1982	–9.19	13.5	Malaysia	1969	4.7	9.1
Israel	1987	–3.97	4.5	Malaysia	1979	4.4	17.5
Israel	1996	–5.30	4.1	Malaysia	1987	8.0	16.5
Israel	2001	–1.45	3.3	Malaysia	1999	15.9	8.4
Korea	1974	–19.74	19.7	Mexico	1983	4.8	5.8
Korea	1980	–8.32	16.0	Mexico	1987	2.9	10.0
Korea	1996	–4.15	15.8	Poland	1990	4.7	10.8
Malaysia	1974	–5.33	10.3	Poland	1994	0.9	8.3
Malaysia	1982	–13.14	21.1	Romania	1988	9.7	18.2
Malaysia	1995	–9.73	25.6	Singapore	1966	0.1	29.5
Mexico	1981	–6.09	10.9	Slovak Republic	1994	4.9	14.3
Mexico	1994	–7.06	6.6	South Africa	1962	9.9	18.9
Mexico	1998	–3.81	3.1	South Africa	1979	5.3	11.0
Poland	1981	–6.75	11.5	South Africa	1987	4.9	3.7
Poland	1993	–6.15	7.0	South Africa	1993	2.1	3.7
Poland	1999	–7.43	5.9	South Africa	2002	0.6	6.0
Romania	1980	–10.66	17.5	Taiwan Province of China	1964	2.8	5.6
Romania	1990	–8.50	7.1	Taiwan Province of China	1972	5.8	13.3
Singapore	1971	–29.45	24.9	Taiwan Province of China	1986	21.2	20.0
Singapore	1980	–13.34	35.6	Thailand	1986	0.6	9.1
Slovak Republic	1975	–3.11	5.3	Thailand	1998	12.7	14.8
Slovak Republic	1996	–9.41	5.9	Turkey	1973	2.2	7.3
South Africa	1965	–9.02	6.6	Turkey	1988	1.8	5.3
South Africa	1971	–7.53	6.6	Turkey	1994	2.0	3.4
South Africa	1975	–6.49	11.8	Turkey	2001	2.3	8.9
South Africa	1981	–5.73	10.6	Ukraine	1984	3.5	14.7
Taiwan Province of China	1960	–6.61	9.4				
Taiwan Province of China	1968	–2.76	8.6				
Taiwan Province of China	1974	–7.50	13.6				
Taiwan Province of China	1980	–1.93	23.1				
Thailand	1983	–7.18	7.8				
Thailand	1996	–8.09	20.8				
Turkey	1980	–4.96	3.5				
Turkey	1983	–2.94	4.7				
Ukraine	1975	–0.64	2.9				
Ukraine	1991	–11.18	10.4				
Ukraine	1998	–3.09	13.7				
			Oil exporters				
Algeria	1978	–13.43	14.0	Algeria	1967	2.0	5.3
Algeria	1988	–3.45	8.7	Algeria	1974	1.4	14.8
Algeria	1998	–2.35	23.4	Algeria	1991	5.2	8.8
Iran, I.R. of	1960	–11.04	9.8	Iran, I.R. of	1974	28.0	31.4
Iran, I.R. of	1969	–5.46	33.5	Iran, I.R. of	1982	4.6	7.0
Iran, I.R. of	1991	–13.78	21.1	Iran, I.R. of	1994	7.3	9.4
Iran, I.R. of	1998	–2.09	14.4	Iran, I.R. of	2000	12.3	11.7
Norway	1977	–12.32	17.1	Norway	1985	4.8	10.8
Norway	1986	–5.96	10.2	Russia	1984	3.2	4.1
Norway	1998	0.01	15.4	Russia	2000	18.0	9.8
Russia	1992	–0.26	3.1	Saudi Arabia	1974	51.2	54.0
Russia	1997	–0.02	18.0	Saudi Arabia	1980	25.3	40.7
Saudi Arabia	1968	–23.29	74.5	United Arab Emirates	1974	68.1	57.1
Saudi Arabia	1984	–15.42	11.8	United Arab Emirates	1980	34.1	31.9
Saudi Arabia	1991	–20.95	21.3	United Arab Emirates	2000	17.4	13.3
Saudi Arabia	1973	–0.60	68.7				
United Arab Emirates	1973	–0.60	68.7				

Source: IMF staff calculations.
[1]Change in current account from $t = 0$ to the end of the reversal episode.

Table 3.4. List of Large and Persistent Episodes

Deficits				Surpluses			
Country	Year	Duration (years)	Average current account surplus (percent of GDP)	Country	Year	Duration (years)	Average current account surplus (percent of GDP)
Advanced economies							
Australia	1964	5	–2.8	Belgium	1986	17	4.3
Australia	1980	27	–4.5	Denmark	2001	6	2.8
Canada	1989	5	–3.7	Japan	1991	16	2.8
Denmark	1964	7	–3.1	Netherlands	1988	10	4.0
Denmark	1979	8	–4.1	Netherlands	2001	6	5.9
Greece	1975	11	–5.2	Sweden	1997	10	5.1
Greece	1995	12	–6.4	Switzerland	1985	22	8.0
Ireland	1969	13	–6.1				
New Zealand	1978	7	–5.0				
New Zealand	1989	18	–5.0				
Portugal	1996	11	–7.3				
Spain	1999	8	–4.9				
United States	1998	9	–4.7				
Emerging markets							
Argentina	1994	5	–3.5	China	2002	5	4.6
Brazil	1970	5	–3.6	Hong Kong SAR	1967	9	12.6
Brazil	1977	6	–4.5	Hong Kong SAR	1985	5	7.4
Czech Republic	1998	9	–4.1	Malaysia	2002	5	12.8
Hungary	1996	11	–7.0	Romania	1984	5	6.1
Israel	1965	11	–7.9	Singapore	1998	9	22.6
Israel	1977	6	–5.7	Taiwan Province of China	1999	8	5.8
Korea	1965	10	–11.9	Ukraine	1979	6	2.9
Malaysia	1991	5	–6.5				
Mexico	1970	12	–3.5				
Poland	1973	9	–5.0				
Romania	1995	12	–6.2				
South Africa	1967	5	–6.0				
Thailand	1975	9	–5.4				
Thailand	1990	7	–7.0				
Ukraine	1994	5	–2.6				
Oil exporters							
				Algeria	2000	7	19.2
				Norway	2001	6	15.6
				Russia	1977	8	3.2
				United Arab Emirates	1994	6	5.0
				United Arab Emirates	2002	5	11.6

Source: IMF staff calculations.

elasticities with respect to both relative trade prices and real exchange rates (Table 3.8). Restricting the sample period to 1986–2006 yielded higher estimates of trade price elasticities, even if the difference was statistically significant only for U.S. exports. The implied pass-through to U.S. import prices—obtained from comparing price elasticities with respect to relative prices and those with respect to the real exchange rate—was about 0.5, similar to that measured directly in the literature reported in Box 3.3. Moreover, it was stable over time.

Aggregation Bias

To explore the potential for aggregation bias, the standard empirical trade model was estimated for 17 categories of import of goods and services and 16 categories of export of goods and services, using quarterly data from the Bureau of Economic Analysis (BEA) from 1973:Q1 to 2006:Q3. Figure 3.12 shows trade price elasticities for individual groups.

Given that price elasticities differ considerably across groups, an OLS estimate of the benchmark aggregate model may yield

Table 3.5. Advanced Economies: Contractionary and Expansionary Deficit Reversals

	Contractionary Deficit Reversals[1]			Expansionary Deficit Reversals[2]	
Country	Year	Average change in GDP growth[3]	Country	Year	Average change in GDP growth
Spain	1965	–3.35	Japan	1967	0.66
Italy	1974	–2.59	Switzerland	1980	2.19
Japan	1974	–3.60	Spain	1981	0.37
New Zealand	1974	–6.84	Sweden	1982	2.46
Finland	1975	–4.74	Greece	1985	0.92
Austria	1977	–5.58	Finland	1991	–0.37
Canada	1981	–5.02	Sweden	1992	0.21
Italy	1981	–3.56	Canada	1993	3.42
Portugal	1981	–3.70	Canada	1998	2.46
United States	1987	–2.48	Austria	1999	–0.26
Spain	1991	–3.55			

Source: IMF staff calculations.
[1]Contractionary deficit reversals are the 11 deficit reversals with the largest average decline in GDP growth (the bottom quartile in the sample ordered by the change in GDP growth).
[2]Expansionary deficit reversals are the 10 deficit reversals with the smallest average decline in GDP growth (the top quartile in the sample ordered by the change in growth).
[3]Average of GDP annual growth rates in the period after the reversal (1. . .*T*) less average annual growth rates in the period before the reversal (–*T*. . .–1).

Table 3.6. Emerging Markets: Contractionary and Expansionary Surplus Reversals

	Contractionary Surplus Reversals[1]			Expansionary Surplus Reversals[2]	
Country	Year	Average change in GDP growth[3]	Country	Year	Average change in GDP growth[3]
Chile	1969	–5.15	Singapore	1966	7.27
Taiwan Province of China	1972	–5.08	Chile	1976	8.67
Hungary	1973	–5.18	Argentina	1978	4.73
Korea	1977	–3.04	China	1982	6.33
Colombia	1979	–3.37	Thailand	1986	6.21
Malaysia	1979	–1.88	Malaysia	1987	5.88
Mexico	1983	–4.60	Argentina	1990	8.91
Ukraine	1984	–3.93	Czech Republic	1993	8.69
Romania	1988	–7.30	South Africa	1993	4.75
Hong Kong SAR	1989	–3.09	Poland	1994	6.78
Poland	1990	–3.39	Slovak Republic	1994	11.21
China	1997	–3.97	Argentina	2002	9.94
Thailand	1998	–1.90			

Source: IMF staff calculations.
[1]Contractionary surplus reversals are the 13 reversals with the largest average decline in GDP growth (the bottom quartile in the sample ordered by the change in growth).
[2]Expansionary surplus reversals are the 12 surplus reversals with the smallest average decline in GDP growth (the top quartile in the sample ordered by the change in growth).
[3]Average of GDP annual growth rates in the period after the reversal (1. . .*T*) less average annual growth rates in the period before the reversal (–*T*. . .–1).

inconsistent estimates of the "true" aggregate relations both in the short and in the long run, with the sign and magnitude of the bias depending on the specific characteristics of the data (Pesaran and Smith, 1995).[30] Following Pesaran and Smith (1995), simple averages of the individual estimates were therefore calculated as they generally provide consistent estimates of the true aggregate relations.[31] The results, reported in Table 3.9, show that the average of individual trade price elasticities is much higher than the aggregate estimate from the standard empirical trade model (over the same period and using the same data), and that not only does the gap between the income elasticity of import and that of export disappear but also the value of these elasticities is much smaller. This is particularly notable given that the relatively small level of disaggregation used in this chapter is probably insufficient to uncover the full scope for aggregation bias.

In addition to the simple average of individual price elasticities, weighted averages were also computed, using relative trade shares at end-2005 as weights. Compared with simple averages, they yielded a similar estimate of the price elasticity for exports but a lower estimate of the price elasticity of imports (–0.25 and –0.63, respectively), even if the latter is still above the estimated elasticity in the standard empirical model. The result for imports, though, is driven by two categories (automotive and petroleum products) with a relatively imprecise estimate of the import price elasticities. Indeed, using a generalized least square estimator (which amounts to weighting the individual estimates using the inverse of the standard errors) yielded a higher price elasticity of imports (at about –1.13).

[30]In particular, the inconsistency reflects the fact that the difference between the aggregate and the individual relations ends up in the regression residuals.
[31]See Imbs and others (2005) for the application of this analysis to exchange rate dynamics.

Table 3.7. Variable Definitions

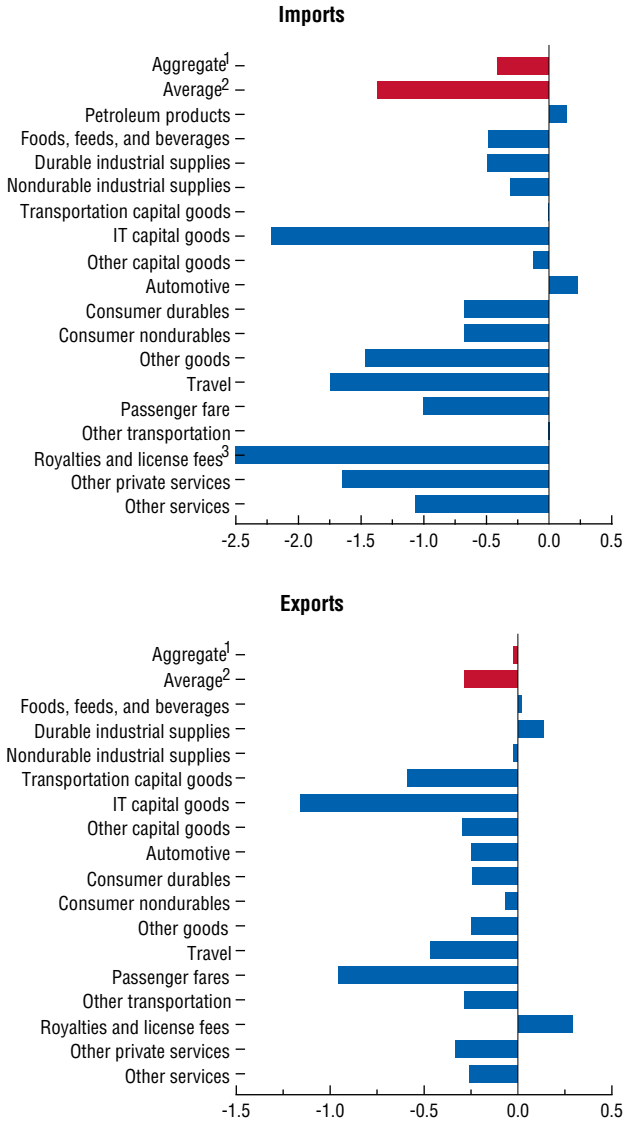
Variable	Sources	Notes
Current account balance	(1) OECD, *Economic Outlook* (OECDEO), (2) *World Development Indicators* (WDI), (3) *World Economic Outlook* (WEO), and (4) *International Financial Statistics* (IFS)	Percent of GDP
Net foreign assets	(1) Lane and Milesi-Ferretti (2006)	Percent of GDP
Private credit	(1) Lane and Milesi-Ferretti (2006)	Percent of GDP
Stock prices	(1) WEO (2006)	Annual percent change
Reserves	(1) Lane and Milesi-Ferretti (2006)	Percent of GDP
Nominal and real exports and imports	(1) WDI and (2) WEO	
Fiscal balance	(1) WDI and (2) WEO	Percent of GDP
Structural fiscal balance	(1) OECDEO and (2) WEO	Percent of GDP
Consumption	(1) OECDEO, (2) WDI, and (3) WEO	Total consumption, as percent of GDP
Investment	(1) WEO (2006), (2) WDI, and (3) WEO	Gross total investment, as percent of GDP
Nominal and real exports and imports	(1) OECDEO, (2) WDI, and (3) WEO	From balance of payment data
Nominal and real GDP	(1) OECDEO, (2) WDI, and (3) WEO	
Output gap	(1) OECDEO, (2) WEO, and (3) Derived	Percent; spliced OECDEO data with WEO and deviation from Hodrick-Prescott (HP)-filtered GDP series
Savings	(1) WEO (2006), (2) WDI, and (3) WEO	National savings
Terms of trade	(1) WEO	Ratio of export and import price deflators
Real total domestic demand	(1) WEO	
Trade balance	See exports and imports	Exports – imports, as percent of GDP
Inflation	(1) WEO, (2) OECDEO, and (3) WDI	Annual changes in CPI index
Openness to trade	See nominal exports and imports	(Exports + imports) / GDP
Overvaluation (deviations from CGER)	Derived	100*(REER – CGER) / CGER
Overvaluation (deviation from long-run average)	Derived	100*(REER – average of REER over the whole sample) / average of REER over the whole sample
Overvaluation (deviation from trend)	Derived	100*(REER – HP-filtered REER) / HP-filtered REER
Overvaluation, residual from PPP regressions	Johnson, Ostry, and Subramanian (2007)	Residuals of cross-sectional regressions of real exchange rate (measured as the price level of GDP relative to the United States from the Penn World Tables) on the log PPP-adjusted per capita income (from Penn World Tables)
Real effective exchange rate (REER)	(1) OECDEO and (2) IMF staff calculations	CPI-based (higher values = appreciation)
Real long-term interest rates	(1) IFS and (2) IMF staff calculations	Nominal rates deflated by same year changes in CPI
Real short-term interest rates	(1) WEO (2006), (2) IFS, and (3) IMF staff calculations	Nominal rates deflated by same year changes in CPI
Differentials with trading partners	Derived	Estimated as the difference between the variable (GDP) for a country and the weighted average of the same variable for its trading partners. The weights are the same ones used for the construction of the IMF real effective exchange rate indices and vary over time (three sets of weights cover the whole sample of 1960–2006).

Note: Numbers in the "Sources" column refer to the priority given to the relative data sets, that is, sources denoted with 1 were used when data were available; when data from source 1 were not available or missing, data from source 2 were used instead or the series was extended by splicing it using data from source 2. PPP = purchasing power parity; CGER = Consultative Group on Exchange Rates.

Figure 3.12. Sectoral Price Elasticities of Trade

(Coefficients)

Estimating the standard empirical model on individual sectors yields very different estimates of trade price elasticities. Averages of these elasticities are higher than the aggregate estimates from the standard empirical model.



Sources: U.S. Bureau of Economic Analysis, *Survey of Current Business* (2006); and IMF staff calculations.
[1]Estimates from the standard empirical model over the 1973–2000 sample.
[2]Simple averages of sectoral price elasticities.
[3]Out of scale.

Table 3.8. Standard Empirical Trade Model: Long-Run U.S. Trade Elasticities

	Estimated over 1973–2006		Estimated over 1986–2006	
	RP[1]	REER[2]	RP[1]	REER[2]
		Imports		
Prices	–0.69 (0.12)	0.37 (0.08)	–0.82 (0.19)	0.48 (0.09)
Income	2.03 (0.07)	2.46 (0.03)	1.86 (0.08)	2.46 (0.04)
		Exports		
Prices	0.02 (0.10)	–0.49 (0.12)	–1.06 (0.31)	–0.60 (0.24)
Income	1.85 (0.18)	1.82 (0.04)	0.76 (0.32)	1.97 (0.10)

Source: IMF staff calculations.
Note: Exports and imports of goods (excuding oil) and services. Variables in logarithms. Standard errors in parentheses.
[1]Price elasticities with respect to relative prices (RP).
[2]Price elasticities with respect to real effective exchange rate (REER). Increase in REER denotes real appreciation.

Vertical Integration and U.S. Imports

Data on U.S. gross imports (M) can be expressed as the sum of two components, both function of the real exchange rate (R): the foreign value added $m(R)$ and U.S. exports of intermediates $X^e(R)$:

$$M = m(R) + \alpha \cdot X^e(R),$$

where α is the fraction of U.S. intermediate exports used in the assembly of products that are shipped back to the United States (a phenomenon also known as "round tripping"). Assuming that $m(R)$ and $X^e(R)$ depend linearly on R, with ε and ξ denoting the long-run price elasticity of imported value added and intermediate exports, respectively, the total estimated elasticity of gross imports with respect to the real exchange rate would be $(-\varepsilon + \alpha \cdot \xi)$, which is lower than ε (in absolute value).

One way to control for this bias is to add U.S. exports of intermediate products as an explanatory variable in the standard empirical trade model of import volumes:

$$\ln M_t = \alpha + \eta \cdot \ln Y_t + \varepsilon \cdot \ln\left(\frac{Pm_t}{Py_t}\right) + \alpha_j \cdot \ln X^e_{jt}, \quad (2)$$

Table 3.9. Long-Run U.S. Trade Elasticities and Aggregation Bias

	Aggregate Estimates[1]		Average Estimates[2]	
	Imports	Exports	Imports	Exports
Relative prices	–0.49 (0.05)	–0.06 (0.04)	–1.25 (0.63)	–0.34 (0.10)
Income	1.93 (0.03)	1.77 (0.03)	1.68 (0.35)	1.60 (0.16)

Source: IMF staff estimates.
Note: Exports and imports of goods and services. Variables in logarithms. Standard errors in parentheses.
[1]Ordinary least square estimates of the standard trade model over 1973:Q1–2006:Q3.
[2]Simple averages of individual sectors' estimates of price and income trade elasticities (from the standard empirical model estimated over 1973:Q1–2006:Q3).

Table 3.10. Long-Run U.S. Import Elasticities and Vertical Integration

	No Control for Vertical Integration[1]		Controlling for Vertical Integration[2]	
	(1979–2006)	(1986–2006)	(1979–2006)	(1986–2006)
Relative prices	–0.82 (0.16)	–1.16 (0.32)	–1.61 (0.16)	–1.52 (0.09)
Income	1.98 (0.13)	1.70 (0.29)	0.64 (0.02)	0.64 (0.02)

Source: IMF staff estimates.
Note: Imports of goods (excluding oil). Variables in logarithms. Standard errors in parentheses.
[1]Results from the standard trade model applied to U.S. non-oil imports.
[2]Results from equation (2) in Appendix 3.2.

where X^e_{jt} represents the jth category of U.S. exports of intermediate products. In particular, five categories of exports were considered, as they are the ones that are most likely subject to a large degree of round tripping: parts (engines, engine parts, and other parts) for autos; parts (engines, engine parts, and other parts) for planes; chemical products—excluding medicines; semiconductors; and metal products. The initial specification included five lags and was estimated based on quarterly data on U.S. imports of goods (excluding oil) from the BEA, from 1978:Q1 to 2006:Q3 (the initial date corresponds to the earliest observation for disaggregated exports) and from 1986:Q1 to 2006:Q3 (the choice of 1986 was motivated by the anticipatory effects of the adoption of the U.S.-Canada free trade agreement in 1987). The sum of the α_j across the five categories of imports—the round-tripping "elasticity"—was 0.3 and stable in the two periods. This estimate suggests that nearly ⅓ of U.S. exports of intermediates come back in the form of imports. The estimated elasticities, reported in Table 3.10, show that for both sample periods, the estimated price elasticity of imports increased substantially compared with the standard empirical model (estimated over the same periods and using the same data). Moreover, the income elasticity of imports was much lower than in the standard model.

Nonlinear Dynamics

The presence of nonlinear dynamics was tested for all OECD countries for which quarterly data were available over the whole sample period of 1973–2006. The tests used were the higher-order Taylor expansion tests of Teräsvirta, Lin, and Granger (1993) and Blake and Kapetanios (2003).

The specific nonlinear dynamic considered in the chapter took the form of a threshold effect in an error-correction representation of the standard empirical trade model (with one lag only). In particular, the existence of threshold effects were estimated within the following model:

$$T_t = I(|Q(t)| \leq \theta)\, Z_t + I(|Q(t)| > \theta)\, Z_t + e_t, \qquad (3)$$

where T_t is the growth rate of import (export) volumes; Z_t includes all variables in the error-correction specification, that is, the constant, the error-correction term, and the first lag of import (export) growth, and domestic (trading partner) GDP growth and relative import (export) price growth; $Q(t)$ is the triggering variable, the growth rate of relative import (export) prices; and I is an indicator function, with value of one if the absolute value of the growth rate of relative import (export) prices is above the threshold level θ, zero otherwise.

The results of the nonlinearity tests on import and export volumes are reported in Table 3.11,

Table 3.11. Nonlinearity Tests (*p* value) and Thresholds for Changes in Relative Import Prices

	Nonlinearity Test[1]		Threshold for Relative Import Price Growth[2] (in percent)	
Country	Imports	Exports	Imports	Exports
Australia	0.11	0.86	0.8	0.2
Austria	0.00	0.00	1.6	0.7
Belgium	0.01	0.24	2.0	2.9
Canada	0.00	0.15	2.4	0.6
Denmark	0.09	0.00	1.2	1.8
France	0.32	0.48	1.6	3.4
Germany	0.62	0.89	1.2	1.3
Greece	0.00	0.09	0.5	4.7
Hungary	0.00	0.20	0.5	0.9
Ireland	0.00	0.15	0.3	1.8
Italy	0.89	0.00	1.3	0.6
Japan	0.00	0.09	5.9	3.1
Korea	0.00	0.95	2.7	0.7
Mexico	0.00	0.25	11.7	2.7
Netherlands	0.00	0.05	1.3	1.4
New Zealand	0.01	0.26	1.6	5.1
Norway	0.02	0.04	4.7	3.9
Poland	0.01	0.00	6.3	9.6
Portugal	0.00	0.21	2.1	2.5
Spain	0.00	0.09	4.2	3.0
Sweden	0.00	0.06	3.1	0.5
Switzerland	0.07	0.63	0.4	2.9
Turkey	0.00	0.03	8.9	7.4
United Kingdom	0.00	0.07	1.5	1.5
United States	0.01	0.91	2.0	4.7

Source: IMF staff calculations.
[1]Probability values of Teräsvirta, Lin, and Granger (1993) test for nonlinearity (values below 0.05 denote evidence of nonlinearity at a 5 percent confidence level).
[2]Values of thresholds in relative import price growth (import volumes react more strongly for growth rates larger than these thresholds).

together with the threshold values on the growth rates of relative import and export prices. The table shows strong evidence of nonlinearity for the vast majority of OECD countries, and a large dispersion in the values of the thresholds. The results for the threshold model of U.S. imports are reported in Table 3.12, together with the results from the (nonlinear) error correction model, and show a significant increase in the speed of adjustment in U.S. import volumes when the change in relative import prices is above the threshold level (the upper regime) compared with when the change in relative import prices is below the threshold level (the lower regime).

Table 3.12. Error Correction Model for U.S. Imports, Sample 1973:Q1–2006:Q3

		Nonlinear Model	
	Linear Model	Lower regime	Upper regime
Constant	–0.002	0.008	–0.011
	(0.00)	(0.00)	(0.01)
Error correction	–0.139	–0.121	–0.252
	(–0.13)	(0.05)	(0.09)
$(\text{Import volumes growth})_{-1}$	0.229	0.256	0.212
	(0.24)	(0.10)	(0.18)
$(\text{GDP growth})_{-1}$	1.254	1.048	2.448
	(1.34)	(0.31)	(0.77)
$(\text{Change in relative import prices})_{-1}$	–0.085	–0.192	–0.141
	(–0.14)	(0.21)	(0.12)
Error correction term coefficients			
Constant	42.2		
Relative prices	0.7		
GDP	–1.9		

Source: IMF staff calculations.
Note: Imports of goods (excluding oil). Standard errors in parentheses.

U.S. Trade Balance and the U.S. Real Effective Exchange Rate

To quantify the implications on trade balance adjustment of the different estimates of trade elasticities, the standard partial equilibrium condition for the trade balance (see, for example, Krugman, 1989) was modified to take into account an unbalanced initial trade position and the presence of vertical integration on the import side.

In particular, the ratio of trade balance to GDP was defined as

$$nx = \frac{X(R,Y^*)}{Y} - R\frac{M(R,Y,X)}{Y},$$

where R is the real exchange rate (defined in such a way that an increase is a depreciation). Total differentiating this equation yields

$$\hat{nx} = \left[\frac{X}{X-RM}\cdot(\varepsilon_x\cdot\hat{R}+\eta_x\cdot\hat{Y}^*) - \frac{R\cdot M}{X-RM}\cdot\left(-\varepsilon_m\cdot\hat{R}+\eta_m\cdot\hat{Y}+\alpha\cdot(\varepsilon_x\cdot\hat{R}+\eta_x\cdot\hat{Y}^*)\right) - \frac{R\cdot M}{X-RM}\cdot\hat{R}\right]-\hat{Y},$$

where $\hat{Z}$ denotes the growth rate of variable Z; the price elasticities for exports and imports are

$$\varepsilon_x = \frac{R}{X} \cdot \frac{\partial X}{\partial R} \text{ and } \varepsilon_m = -\frac{R}{M} \cdot \frac{\partial M}{\partial R},$$

respectively; the income elasticities for exports and imports are

$$\eta_x = \frac{Y^*}{X} \cdot \frac{\partial X}{\partial Y^*} \text{ and } \eta_m = \frac{Y}{M} \cdot \frac{\partial M}{\partial Y},$$

respectively; the "vertical integration" elasticity is

$$\alpha = \frac{X}{M} \cdot \frac{\partial M}{\partial X};$$

and $\hat{Y}$, $\hat{Y}^*$ are the rate of growth of domestic and of foreign GDP, respectively.

If $X - RM \neq 0$, the equation above implies

$$\hat{R} = \frac{\hat{nx} + \left[\left(\frac{\gamma}{1-\gamma}\right)\cdot\eta_m + 1\right]\hat{Y} - \left[\left(\frac{1}{1-\gamma}\right) - \left(\frac{\gamma}{1-\gamma}\right)\cdot\alpha\right]\cdot(\eta_x \cdot \hat{Y}^*)}{\left[\left(\frac{1}{1-\gamma} - \frac{\gamma}{1-\gamma}\alpha\right)\cdot\varepsilon_x + \left(\frac{\gamma}{1-\gamma}\right)\cdot\varepsilon_m - \left(\frac{\gamma}{1-\gamma}\right)\right]}, \quad (4)$$

where γ denotes the ratio of real imports to real exports $\left(\gamma = \frac{R \cdot M}{X}\right)$.

This expression gives the cumulative change in the real exchange rate that is consistent with any percent change in the ratio of trade balance to GDP ($\hat{nx}$), for a given set of elasticities ($\varepsilon_x, \varepsilon_m, \eta_x, \eta_m$), an initial trade imbalance (γ), a degree of vertical integration (α), and a cumulative growth differential during the adjustment period ($\hat{Y} - \hat{Y}^*$).

Figure 3.11 in the main text plots different values of $\hat{R}$ associated with a 1 percentage point of GDP decline of the U.S. trade deficit from its end-2005 level. In this calculation, the following parameters and assumptions were used:

- *Trade price elasticities* ($\varepsilon_x, \varepsilon_m$). The results shown in the first column of Figure 3.11 are based on the elasticities with respect to real exchange rates from the standard empirical model (equation (1)), estimated over the 1986–2006 period (Table 3.8). The results shown in the other columns of Figure 3.11 are based on these elasticities corrected for the aggregation and vertical integration biases. For example, the size of the aggregation bias for U.S. import price elasticity was estimated as the difference between the third and first columns in Table 3.9. This difference was multiplied by the ratio between the estimated elasticities with respect to the real exchange rate and that with respect to relative trade prices from the standard trade empirical model (the ratio between the fourth and third column in Table 3.8), and added to the elasticities with respect to real exchange rates from the standard empirical model.
- *Trade income elasticities* (η_x, η_m). The results shown in the first column in Figure 3.11 are based on the income elasticities from the standard empirical model estimated over the 1986–2006 period (Table 3.8). The results shown in the other columns in Figure 3.11 are based on these elasticities corrected for the aggregation and vertical integration biases in a similar manner.
- *Initial ratio between import and export volumes* (γ). This was set at 1.56, the ratio of U.S. import and export volumes at end-2005.
- *Degree of vertical integration* (α). Following the results from estimating equation (2), this was set at 30 percent.
- *Cumulative growth differential* ($\hat{Y} - \hat{Y}^*$). For a period of five years, the GDP growth rate was set at 3 percent a year for both the United States and its trading partners, so the cumulative growth differential was set at zero.
- *Exchange rate pass-through.* In equation (4), the incomplete pass-through of exchange rate changes to relative trade prices is taken into account by considering trade price elasticities with respect to real exchange rates. In addition, the last term in the denominator of equation (4) (the change in the terms of trade after 1 percent exchange rate depreciation, adjusted for the unbalanced initial trade position) was multiplied by 0.5 to take into account the partial response of terms of trade under incomplete pass-through (see also Box 3.3).

In equation (4), only import volumes have been adjusted for the vertical integration bias. As, in principle, vertical integration could affect export price elasticities in a similar manner, the impact of vertical integration on the U.S. trade deficit has also been estimated by assuming that the downward bias on export price elasticities is the same as that on import prices, and the share

of foreign intermediate products incorporated in U.S. exports is also 30 percent. Modifying equation (4) accordingly yields very similar estimates of the required depreciation rate.

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