3

The Needed Changes in Bilateral Exchange Rates

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This chapter presents sets of bilateral exchange rates consistent with alternative assumptions about "sustainable" current accounts.[1] It makes no direct attempt to assess what sustainable current accounts might be. Instead, it examines what exchange rates are implied by alternative assumptions about sustainable current accounts in the medium term.

The results presented here update work presented in Wren-Lewis (2003) that was part of the UK Treasury's assessment of entry into the European Monetary Union. The methods used are similar to that in Driver and Wren-Lewis (1998), and they have been applied extensively by a number of researchers, including John Williamson and economists at the International Monetary Fund. The approach goes under a variety of names, including fundamental equilibrium exchange rates (FEERs), dynamic equilibrium exchange rates (DEERs), and the macroeconomic balance approach. However, the results presented here are derived from a new global model (the five-area bilateral equilibrium exchange rate, or FABEER, model), which for the first time implements this approach by simultaneously determining equilibrium bilateral values for the dollar, yen, euro, and pound sterling.

The main text of the chapter focuses on the key results, and a more academic discussion of technical issues is contained in the appendices. The second section briefly outlines the key concepts behind the model. The third section presents medium-term equilibrium rates for the major four curren-

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1. "Sustainable" here means the current account that is implied by medium-term (cyclically adjusted) private- and public-sector savings behavior. The concept is discussed further below.

cies under alternative assumptions about sustainable current accounts. The fourth section looks at three relatively minor currencies: the Australian and New Zealand dollars, and the Chinese renminbi. The fifth section extends the model to look at the implications for sustainable current accounts of two US-based macroeconomic shocks: a technology shock and a fiscal shock.

Key Concepts and the FABEER Model

In this chapter, I present medium-term estimates for bilateral exchange rates. Although "medium term" in macroeconomics can simply refer to a time period (e.g., five years), it can be given a more counterfactual interpretation, which is where the economy would be if there were no Keynesian frictions (nominal inertia). This is the meaning of "medium term" as used here.[2]

Within this medium-term time frame, it also makes sense to abstract from other, relatively short-lived effects. For example, I ignore the consequences of expectations errors. In addition, I abstract from any lags that may occur before changes in activity or competitiveness feed through into trade prices or volumes.

The main way that the business cycle influences actual exchange rates is through interest rates. An economy that is cyclically strong is likely to have relatively high interest rates, which will appreciate the exchange rate. By abstracting from this effect, I also calculate exchange rates that are independent of monetary policy.

A key assumption behind the calculations presented here is that the economy as a whole faces a downward-sloping demand curve for its production. Aggregate equations for exports and imports have traditionally found this to be the case, and more recently the "new international macroeconomics" (see Lane 2001) has focused on theoretical models based on imperfectly competitive goods markets for traded goods.

Appendix 3A sets out the theoretical basis for my estimates in more detail. They can be described in two, mutually consistent ways. The first is to say that I calculate a set of bilateral rates that will be consistent with the current accounts implied by medium-term savings behavior. (These are labeled "sustainable" current accounts.) The second is to describe the bilateral exchange rate estimates as matching the medium-term demand for domestic production with its supply.

Abstracting from cyclical effects allows me to describe my calculations as delivering estimates of medium-term equilibrium exchange rates. They

2. An alternative description might be cyclically adjusted exchange rates. Woodford and others use the term "natural" to describe a similar idea.

differ from long-run equilibrium rates, because long-run equilibrium refers to a position in which asset stocks are constant. Because sustainable current accounts may be nonzero in the analysis, asset stocks could well be changing. The approach in this chapter is very similar to Williamson's fundamental equilibrium exchange rate: Abstracting from the Keynesian business cycle is similar to assuming that economies are in "internal balance." As a result, this approach is often referred to as the macroeconomic balance approach, and it has been widely used by both individual authors and institutions such as the IMF (for an example of the latter, see Isard and Farquee [1998]).

A key feature of the calculations presented here is that I make no attempt to estimate what the sustainable current account is for each country. Instead, I use the model to calculate the set of bilateral rates that are consistent with exogenous projections for these sustainable current accounts. In this sense, the model and analysis are a partial equilibrium exercise.

Partial equilibrium models are not fashionable in macroeconomics. Why not estimate a complete model, which predicts sustainable current accounts as well? (The problem with a partial equilibrium approach is that it may ignore feedback from exchange rates to medium-term savings behavior; see Driver and Wren-Lewis [1999].) The simple answer is that knowledge of what determines consumption and investment in the medium term is far more imprecise than the understanding of aggregate trade relationships. Below, I do examine a general equilibrium version of the model, but this chapter looks only at simulations rather than forecasts.

Traditionally, this partial equilibrium approach to calculating equilibrium exchange rates has been implemented on an individual-country basis, and it has involved in the first instance estimating an effective exchange rate for each country. In a study of the Group of Seven (G-7), Driver and Wren-Lewis (1998) convert these effective exchange rate numbers into bilateral rates. In this chapter, I use the FABEER model, which simultaneously determines bilateral exchange rates for the four major currencies: the dollar, euro, yen, and pound sterling. Appendix 3B outlines the specification of the model in detail. Appendix 3C describes some of the main features of the model's calibration.

The macroeconomic balance approach is quite different from calculations of equilibrium exchange rates based on purchasing power parity (PPP). (Driver and Westaway [2003] present a recent and extensive discussion of alternative equilibrium exchange rate measures.) PPP implies a constant equilibrium exchange rate (EER) independent of shifts in demand or supply, whereas the macroeconomic balance approach would imply a constant EER only if trade competitiveness elasticities were infinite. Barisone, Driver, and Wren-Lewis (2004) suggest that FEER-type calculations track medium-term movements in exchange rates for the G-7 better than does PPP.

Equilibrium Rates for the Four Major Currencies

As a pedagogical device, the equilibrium exchange rate calculation can be split into two stages. In the first stage, the "underlying current account" conditional on actual exchange rates is calculated. This involves cyclical adjustment (i.e., eliminating the business cycle), but it also involves eliminating dynamic and erratic elements in trade. At this first stage, exchange rates are kept at their historical values. The second stage involves moving the exchange rate to its EER to eliminate the gap between the underlying current account and the sustainable current account. The advantage of this two-stage presentation is that the first stage is independent of any assumption about sustainable current accounts, yet it gives a strong indication of the implications for the EER of assuming alternative values for domestic savings and investment.

Underlying Current Accounts

Calculating the underlying current account involves stripping out from the actual current account those elements that are due to the business cycle, and other erratic or temporary effects. In particular, this approach calculates the full implications of any historical change in exchange rates (for given asset stocks). For example, suppose a current account deficit suggests that a currency is overvalued. The J curve tells us that a depreciation might initially lead to a deterioration in the current account. A naive assessment might conclude that a further depreciation was required to achieve a sustainable current account. However, the deterioration following the J curve is temporary, and the model allows one to see past these dynamics.

The danger in using a model to calculate the underlying current account is that the model may be misspecified. Suppose, for example, that there is a permanent but unexplained upward shift in a country's export share. The model on its own will treat this shift as temporary, and ignore it when calculating the underlying current account. As a result, the underlying current account will persistently look worse than the actual data, and the EER will be incorrectly estimated.[3]

Table 3.1 shows the actual and underlying current accounts for the five blocs of FABEER in 2002. (Data for 2003 for some key variables, particularly asset stocks, are incomplete.) The US underlying deficit in 2002 is close to the actual. However, this reflects some offsetting factors. Actual rest of

3. Some partial equilibrium macroeconomic balance calculations calculate underlying current accounts by adjusting actual data to take out the effects of the business cycle (i.e., cyclically correcting) and dynamic effects (e.g., Brooks and Hargreaves 2000). This avoids the problem outlined above, but it will also retain any unexplained movements in trade that are in fact temporary. Which method is better amounts to a judgment about how stationary are errors in trade equations.

Table 3.1 Actual and underlying current accounts for FABEER blocs, 2002

Bloc	Actual	Underlying
United States (percent of GDP)	–4.6	–4.6
Japan (percent of GDP)	2.8	4.3
Euro area (percent of GDP)	1.1	3.1
United Kingdom (percent of GDP)	–1.8	–3.5
Rest of world[a] (billions of dollars)	334.9	237.9

FABEER = five-area bilateral equilibrium exchange rate model

a. Including the global statistical discrepancy (i.e., this figure matches exactly the sum of the current accounts of the four major blocs).

Source: OECD Economic Outlook 2003 and author's calculations.

the world (RoW) imports are assumed to be 7 percent below trend levels in 2002, leading to an improvement in the underlying current account based on trend RoW imports. However, we also assume a positive US output gap; underlying output is above actual, so this raises imports. There is also an interesting puzzle associated with recent US export behavior, which is discussed in box 3.1.

In Japan, the underlying surplus is significantly larger than actually recorded. There are three main reasons for this:

- Despite a large increase in the value of overseas assets in 2002, actual interest receipts did not rise (both as a share of GDP). The model assumes that underlying receipts were higher. Very roughly, this adds 0.5 percent to the underlying surplus.
- In 2002 the underlying export volume share was well above actuals. This result seems robust to alternative competitiveness elasticities. This adds about 0.5 percent to the underlying surplus.
- Underlying exports in 2002 are boosted by the fact that underlying RoW imports are well above actual levels, which adds about 0.5 percent to the underlying surplus.

The underlying euro area surplus in 2002 was also significantly larger than the actual surplus. More than 1.5 percent of this is due to higher RoW imports; this figure is well above the impact on Japan and the United States because exports are a much larger share of GDP for the euro bloc.

The underlying UK deficit is larger than the actual, despite the RoW factor (which reduces the underlying deficit by 0.8 percent of GDP). This reflects

- higher interest receipts than would be expected from the net assets position, worth more than 1 percent in 2002 (preliminary figures for 2003 suggest a much smaller interest payments surplus);

Box 3.1 Recent US export behavior

The model's export equations determine the share of exports in world trade (where world trade is a weighted average of imports from the other blocs of the model) as a function of manufacturing price competitiveness (export prices relative to competitors' export prices). Figure 3.1 shows the actual and predicted values for the volume of US exports of goods and services, where the constant and competitiveness elasticities are estimated by static ordinary least squares during the 1980–2002 period (the latter is 0.96). The equation systematically underpredicts by about 10 percent during the past few years. One could reduce the underprediction by reducing the competitiveness elasticity, but then the equation would fail to track the mid-1980s period (see figure 3.1).

Because the equation is static, short-term errors are explicable, but large systematic errors are problematic. One possible explanation is that the variety of goods produced in the United States has expanded in recent years as the result of a US-based technological shock. I have allowed for this in a simple way by shifting the constant in the equation from the late 1990s onward. However, if this judgment proves incorrect, the model may be significantly underestimating the underlying US current account deficit, and therefore overestimating the equilibrium dollar.

- import volumes that appeared to be unusually low in 2002 (but this appears to have continued in 2003); and
- actual export volumes that were higher than underlying levels in 2002 (although probably much less so in 2003).

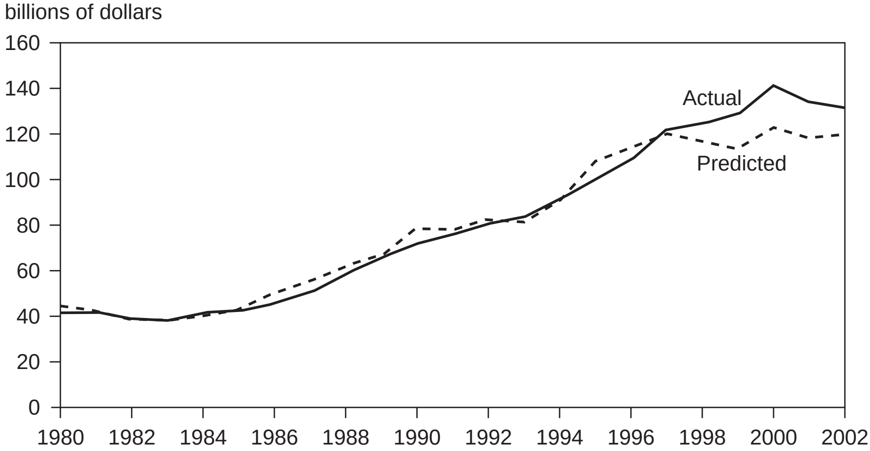
Both these last two effects could represent attempts by UK producers to counteract the effects of a perceived temporary appreciation in the exchange rate. Overall preliminary figures for 2003 suggest much less of a gap between actual and underlying deficits, suggesting that perhaps 2002 was somewhat erratic.

These figures give a good indication of the direction that bilateral EERs would move relative to actual exchange rates in 2002. Unless the sustainable Japanese surplus is very high, one would expect an appreciation in the yen, and likewise an appreciation in the euro. In contrast, both the dollar and pound sterling look overvalued.

Alternative Equilibrium Exchange Rates for Different Sustainable Current Account Assumptions

The second and final stage in calculating EERs is to choose some value for sustainable current accounts and to solve for the set of bilateral exchange rates that will produce these sustainable current accounts. However, choosing values for sustainable current accounts, which is difficult at the best of times, seems particularly hazardous at the moment. This is because of two factors, both involving the United States. First, some part of recent US deficits could well be the result of a positive technology shock. Second, it is very difficult to evaluate the trend US fiscal position. Both factors are discussed and modeled below.

Figure 3.1 Actual and predicted US export volumes, 1980–2002



Note: The figure shows the constant and competitiveness elasticity as estimated by static ordinary least squares.

Source: OECD *Economic Outlook 2003* and author's calculations.

Several tables below show the relationship between exchange rates and a variety of sustainable current accounts. For single-country EER studies, this is reasonably straightforward, because one can look at effective rates and not worry about where any change in surplus or deficit goes. In FABEER, it is necessary to be explicit about the allocation of changes in sustainable current accounts.

In table 3.2, I look at alternative values of the US sustainable deficit using the following simple rule: For each 1 percent increase in the sustainable US deficit, we have an equivalent 0.75 percent increase in the Japanese surplus, and a move to surplus of 0.5 percent in the UK and euro bloc. This allocation means that a larger US deficit is also accompanied by an increase in the RoW surplus.

The table shows the pattern of dollar bilateral rates that would be consistent with different US deficits using the assumed allocation across blocs. In all cases, the sustainable US deficit, and the sustainable Japanese surplus, are smaller than actual current accounts for 2002, and so the equilibrium value of the yen relative to the dollar appreciates substantially compared with actual values.

In addition, the sustainable RoW surplus is much smaller than actual 2002 values. The model does not invent a RoW exchange rate, but it does include a measure of RoW export prices (in dollars), which adjust along with exchange rates to achieve sustainable current accounts (see appendix 3B). In all three cases shown in table 3.2, RoW export prices are much higher than recorded levels in 2002. Implicit, therefore, is a substantial appreciation of

Table 3.2 Equilibrium exchange rates for alternative US sustainable deficits, 2002

US current account (percent of GDP)	Euro area plus UK current account (percent of GDP)	Japan current account (percent of GDP)	Rest of world[a] current account (billions of dollars)	Equilibrium rate: Yen-dollar	Equilibrium rate: Dollar-euro	Equilibrium rate: Dollar-pound
Sustainable						
–1.0	0.5	0.75	3	79	1.26	1.70
–2.0	1.0	1.50	23	88	1.18	1.59
–3.0	1.5	2.25	59	98	1.09	1.49
Actual						
–4.6	1.1, –1.8	2.80	337	125	0.94	1.50

a. Including statistical discrepancy. Note that this residual is based on equilibrium exchange rates, not actual exchange rates.

Source: OECD Economic Outlook 2003 and author's calculations.

other currencies against the dollar required to achieve sustainable current accounts. One example of such a currency would be the renminbi, which we examine in the next section.

Table 3.3 varies the sustainable current account for individual blocs relative to the second set above, assuming an offsetting change in the rest of the world (i.e., keeping sustainable current accounts in the other blocs constant).

Increasing the sustainable US deficit from 2 to 3 percent of GDP, with a corresponding increase in the RoW surplus, leads to an appreciation in the dollar of 5.1 percent against the yen, 6.4 percent against the euro, and 5.4 percent against the pound sterling. The euro depreciates against the yen because of relatively stronger Japan–United States links, and likewise for the United Kingdom. (The sensitivity of the euro-sterling cross rate to developments in the United States is highlighted in Wren-Lewis 2003.)

Eliminating the sustainable euro surplus appreciates the euro against the dollar by about 3 percent, with a similar appreciation against the yen. An increase in the sustainable Japanese surplus depreciates the yen by nearly 8 percent. The difference between these two numbers largely reflects the greater openness of the euro area. The United Kingdom is similar to the euro area in this respect. Table 3.4 presents additional cases of surplus/deficit combinations.[4] In the first row, case A, we set the sustainable current account

4. Although the model is used to produce table 3.4, as a fairly good approximation we could use tables 3.2 and 3.3 as a "ready reckoner" by assuming linearity and symmetry. For example, using these tables, a 3 percent US deficit combined with a 2.5 percent Japanese surplus would imply a depreciation of 13 percent in the yen relative to the dollar compared with the base case, or a rate of about 100, whereas a model simulation gives a depreciation of 13.5 percent.

Table 3.3 Equilibrium exchange rates for alternative sustainable current accounts, 2002

US current account (percent of GDP)	Euro area current account (percent of GDP)	United Kingdom current account (percent of GDP)	Japan current account (percent of GDP)	Current account for rest of world[a] (billions of dollars)	Equilibrium rate		
					Yen-dollar	Dollar-euro	Dollar-pound
–2.0	1.0	1.0	1.5	23	88.3	1.177	1.592
–3.0	1.0	1.0	1.5	139	92.8	1.106	1.510
–2.0	0.0	1.0	1.5	107	88.2	1.212	1.604
–2.0	1.0	0.0	1.5	40	88.3	1.180	1.629
–2.0	1.0	1.0	2.5	–25	95.3	1.183	1.593

a. Including statistical discrepancy. Note that this residual is based on equilibrium exchange rates, not actual exchange rates.

Source: OECD Economic Outlook 2003 and author's calculations.

equal to the actual current account for 2002. If the trend deficit were equal to the actual deficit in that year, then the equilibrium exchange rate would equal the actual exchange rate. Case A therefore gives us another indication of the extent to which actual current accounts were a misleading indication of trend current accounts. The most notable example is the yen, where the equilibrium rate is ¥113.5/$1, compared with an actual rate for that year of ¥125/$1. This accords with table 3.1, where the underlying surplus in Japan for 2002 is well above the actual surplus, so an appreciation in the yen is required to bring the large trend surplus back to the actual. The euro is also stronger against the dollar, for similar reasons. The second row, case B, simply sets the sustainable current account at half the actual recorded current account. The dollar depreciates substantially relative to actual recorded rates, as we would expect.

Case C of table 3.4 is close to the numbers assumed in Wren-Lewis (2003). This allows for a high sustainable US current account deficit, partly reflecting the impact of a favorable technological shock (see below), with corresponding surpluses for the euro area and Japan. However, there appear to be no grounds for assuming a sustainable UK deficit. The yen is at 100, while the euro is much stronger than it was in 2002, but closer to its actual value in 2003. Case D of the table is based on chapter 2 of this volume by John Williamson; compared with case C, the US sustainable deficit is slightly smaller, and there is no euro area surplus. As a result, the dollar depreciates relative to case C, particularly against the euro.

Other Countries

In this section, I calculate equilibrium bilateral rates for three other currencies: the Australian dollar, the New Zealand dollar, and the Chinese

Table 3.4 Additional cases of equilibrium exchange rates for alternative sustainable current accounts, 2002

	Current account (percent of GDP)				**Equilibrium rate**		
Case	**United States**	**Japan**	**Euro area**	**United Kingdom**	**Yen-dollar**	**Dollar-euro**	**Dollar-pound**
A	–4.6	2.8	1.0	–1.8	113.5	0.985	1.451
B	–2.3	1.4	0.5	–0.9	88.8	1.177	1.645
C	–3.0	2.5	1.0	0.0	100.2	1.114	1.547
D	–2.5	2.5	0.0	0.0	97.6	1.185	1.601
Actual exchange rate (2002)					125.0	0.940	1.500
Actual exchange rate (2003)					118.0	1.120	1.627

Source: OECD Economic Outlook 2003 and author's calculations.

renminbi. There is one important difference between the way these currencies are modeled compared with the major four. The major four were modeled simultaneously, so that movements in one currency would have implications for all the others. The three bilateral rates considered here are modeled recursively, so their movements have no impact on the major four.

Australia and New Zealand

Australia and New Zealand are both major commodity exporters. However, commodities account for only about one half of their exports, the remainder being manufactured goods and services. As a result, the demand for these countries' aggregate production will still be sensitive to the real exchange rate, so the overall approach of the model remains valid. Appendices 3A and 3B show how the specification of the model needs to change to allow for a significant proportion of commodity exports.

Both Australia and New Zealand have run large current account deficits in recent years. In both cases, I make the fairly arbitrary assumption that the sustainable deficit is 4 percent of GDP. Although I assume that developments in these two economies do not influence the major four currencies, I do allow interaction between the two.

Table 3.5 presents rates for the Australian and New Zealand dollars against the four major currencies, based on the sustainable current accounts for the major four set out in case C of table 3.4. Both currencies were undervalued against the US dollar in 2002. However, the subsequent depreciation of the US dollar has completely reversed this position, with both currencies appreciating strongly. Against a basket of currencies, both the Australian and New Zealand currencies appeared close to their equilibrium value in 2002, so they have become significantly overvalued (against all of the major four) in 2003 and 2004 (for

Table 3.5 Selected equilibrium bilateral exchange rates for New Zealand and Australian dollars, 2002
(actual rates for 2002 in parentheses)

Currency	New Zealand dollar	Australian dollar
US dollar	1.96 (2.16)	1.65 (1.84)
New Zealand dollar		0.84 (0.85)
Australian dollar	1.19 (1.18)	
Euro	2.19 (2.03)	1.84 (1.72)
Pound sterling	3.03 (3.23)	2.56 (2.76)
Yen	0.02 (0.02)	0.02 (0.01)

Source: OECD Economic Outlook 2003 and author's calculations.

more details, see Wren-Lewis 2004). Note, however, that the two currencies were close to equilibrium against each other in 2002; the two tend to move together.

Because both are "commodity currencies," it is interesting to note how changes in commodity prices would influence the two equilibrium rates. Wren-Lewis (2004) shows that a sustained 10 percent increase in all commodity prices would lead to an appreciation in both currencies (in effective terms) of 5 percent. This is toward the lower end of the range estimated in Chen and Rogoff (2003). There are two main effects at work here. First, higher commodity prices raise the value of exports and improve the underlying current account. Second, higher export prices raise the profitability of commodity production, which diverts labor toward this sector and away from other traded goods production. Lower output of noncommodity traded goods implies a higher price.

China

Calculations for China are more uncertain, for two reasons. First, I have fewer data for Chinese trade, with no breakdown of values into volumes and prices.[5] Second, the Chinese economy is more likely to be subject to structural change.

For China, I have calibrated the trade value equations with the following properties: an imposed import competitiveness elasticity of 0.5,[6] an activity elasticity for imports of 1.6 (which, given the above, fits data from

5. Data come from the International Monetary Fund, *International Financial Statistics.* The model therefore includes equations for export and import values, which simply combine the specifications for trade prices and volumes; see appendix 3B.

6. Assuming that a 1 percent increase in world prices will raise import prices by 0.7 percent.

Table 3.6 Putting China's current account to trend, 2002 (percent of GDP)

Aspect	Current account
Actual	2.9
Excluding erratic trade	2.6
World activity to trend	3.0
World activity and commodity prices to trend	3.4

Source: OECD Economic Outlook 2003 and author's calculations.

1990 to 2003), a competitiveness elasticity of exports of –2,[7] and a trend rise in the export share of about 11 percent a year (which again fits the 1990–2003 period).

Once again the calculation was split into two stages. First, I calculate the underlying current account using actual exchange rates. Second, I consider the implications of alternative values for the sustainable current account. Table 3.6 shows that in 2002, the underlying current account surplus was a little larger than the actual surplus. This is partly because actual imports in the RoW were below trend, and partly because trend oil prices were below actual.

The underlying surplus in 2003 is likely to be larger still. The depreciation of the renminbi in 2002 and 2003, following the US dollar, helped lead to a large increase in exports. The actual current account surplus did not rise substantially, but this is mainly due to a very rapid increase in imports. This increase in imports cannot be explained by higher activity or competitiveness, and so it is likely to be erratically high. As a result, the underlying surplus for 2003 is likely to be substantially higher than the actual.

Table 3.7 looks at an equilibrium exchange rate against the dollar, euro, and yen for 2002 either assuming a 1 percent sustainable surplus or current account balance. (For contrasting views on whether the sustainable current account for China is a small surplus or a deficit, see Bosworth [2004] and Goldstein and Lardy [2003].) Even with a 1 percent surplus, the analysis suggests a 20 percent depreciation against the dollar.

Global Implications of Two US Shocks

Above, I identified two major uncertainties associated with the sustainable US current account. The first was in assessing the implications of a US-

7. Assuming that a 1 percent increase in world prices will raise export prices by 0.7 percent. This high value relative to those assumed for the major 4 seems justified given that, at this stage of development, the economy is likely to be producing relatively homogenous manufactured goods.

Table 3.7 Renminbi equilibrium exchange rate with alternative sustainable current accounts, 2002

Sustainable current account	US dollar	Euro	Yen
Actual	8.28	7.79	0.066
Assuming 1 percent surplus	6.71	7.47	0.067
Assuming current account balance	6.47	7.21	0.065

Source: OECD Economic Outlook 2003 and author's calculations.

based technology shock. The second was in judging the size and impact of future government budget deficits. Both issues are examined here. To do so, we transform our partial equilibrium model into a general equilibrium model of the four major currency blocs.

Completing the model requires specifying the determinants of domestic demand: consumption and investment. The consumption functions split consumers into two types: those who are credit constrained, who consume all their current income; and those who are not, whose spending depends on discounted lifetime income and financial wealth (see appendix 3B for the details). The discount rate used by non-credit-constrained consumers exceeds the real rate of interest because of uncertainty, including uncertainty about the time of death. (This is the Blanchard-Yaari formulation, where there are no bequests.) We therefore have two departures from Ricardian Equivalence.

The investment equations are based on a Tobin *q* model, with share prices depending on expected future profits. There are therefore two forward elements in the model: expected future labor income and expected future profits.

A US Fiscal Shock

Examining the global implications of a US fiscal shock is something of a "standard simulation" for global models; for example, see Ralph Bryant (1995). However, these simulations have often focused on the short-term dynamics associated with Keynesian multipliers. Instead, FABEER looks at the medium term.

The fiscal shock used here is a tax cut, worth 1 percent of GDP in 2004, which declines by 0.05 percent of GDP each year. Overlaid on this is a reaction function for tax, which raises taxes in response to higher government debt. Tables 3.8 and 3.9 give figures for tax and debt as a share of GDP.

It is instructive to look at a preliminary simulation, where real interest rates are fixed (table 3.8). Fixed real rates imply fixed investment, output, and capital. The absence of Ricardian Equivalence means that consumption increases by about half the decrease in taxes. The increase in consumption,

Table 3.8 US fiscal shock with fixed interest rates, selected years (percent of GDP)

	2004	2010	2015
US tax	–0.91	–0.37	–0.13
US debt	0.88	3.26	3.22
US consumption	0.39	0.15	0.02
US current account	–0.45	–0.23	–0.11
Dollar appreciation against:			
Yen (percent)	2.2	0.7	0.2
Euro (percent)	3.0	0.8	0.1
Pound (percent)	2.6	0.7	0.1

Source: OECD Economic Outlook 2003 and author's calculations.

coupled with an appreciation in the dollar, generates a deterioration in the trade balance, leading to a current account deficit of about half the size of the tax cut. This is the familiar twin deficits story. The size of the current account deficit depends critically on the degree on non-Ricardian behavior. In the main case, the proportion of income going to credit-constrained consumers is 30 percent; reducing this to 10 percent would halve the current account effect.

The current account deficit is associated with an appreciation of the dollar against all currencies. The appreciation is slightly greater against the euro than the yen, reflecting the factors discussed above. The depreciation of nondollar currencies reduces real incomes and consumption in those countries, leading to small surpluses. It is interesting to note that the relationship between US deficits and exchange rate changes from the partial equilibrium model shown in tables 3.2 and 3.3 still holds to a first approximation in this general equilibrium version of the model.

Once one endogenizes interest rates, some of the quantitative conclusions change substantially. US real interest rates do not rise by much: just 6 basis points initially, with a gradual reduction thereafter. This is very much at the lower end of the range noted in Mühleisen and Towe (2004), although not as low as one estimate by the George W. Bush administration. However, it is enough to substantially dampen the increase in US consumption and current account deficit, with a correspondingly smaller appreciation in the dollar.

A US Technology Shock

Table 3.10 shows the impact of technical progress, which added 0.2 percent to GDP each year from 1996 to 2000, so that GDP is at least 1 percent higher from 2000 onward. The simulation starts in 1995, implying that the full

Table 3.9 US fiscal shock with endogenous interest rates, selected years (percent of GDP)

	2004	2010	2015
US tax	–0.91	–0.36	–0.12
US debt	0.90	3.36	3.32
US consumption	0.15	0.08	0.03
US interest rates (basis points)	6	4	3
US current account	–0.15	–0.10	–0.06
US GDP (percent)	0.00	–0.01	–0.02
Dollar appreciation against:			
Yen (percent)	0.7	0.3	0.1
Euro (percent)	0.8	0.4	0.1
Pound (percent)	0.7	0.4	0.1

Source: OECD Economic Outlook 2003 and author's calculations.

1 percent gain is anticipated from 1995. Anticipation is very important in assessing the current account implications of this technical progress shock.

The US current account goes into deficit following the technology shock principally because consumers and firms anticipate higher future incomes and production. (Consumption remains higher as a share of GDP after 2000 in this simulation because taxes are cut following a reduction in the debt/GDP ratio.) The majority of consumers attempt to smooth consumption, and therefore consumption rises in advance of the increase in GDP. Firms invest to build the capital stock, although the parameters in the model imply that the increase in investment is fairly slow.

However, both effects are significantly dampened by an increase in US interest rates. The short-term reduction in US net savings puts significant pressure on global financial markets, leading to an increase in US interest rates of nearly 20 basis points. Without this increase in interest rates, the current account deficit as a share of GDP in 1995 would have been more than 0.6 percent of GDP, compared with the 0.2 percent shown in table 3.10.

In the model, the dollar depreciates as a result of this shock. The reason is that higher GDP leads to an increase in imports, but there is no corresponding rise in overseas demand to raise exports. As a result, a real depreciation is required. The depreciation is modest to begin with, but it rises to between 1.5 and 2.0 percent in the medium term.

The model produces this result because it implicitly assumes that higher US GDP involves producing more of the same type of goods, so those goods have to be made cheaper to create additional demand. In this particular context, it makes more sense to assume that the United States is producing new types of goods, which would lead to an autonomous increase in exports. (See box 3.1 on p. 42 for some evidence on this.) If this shift in the demand for US exports were enough to leave the long-run

Table 3.10 US technical progress shock, selected years

Aspect of shock	1995	1998	2000	2005
US GDP (percent)	0.00	0.61	1.02	1.05
US consumption (percent of GDP)	0.18	0.12	0.08	0.08
US interest rates (basis points)	18.00	17.0	0.00	–1.00
US current account (percent of GDP)	–0.19	–0.04	0.08	0.07

Source: OECD Economic Outlook 2003 and author's calculations.

value of the dollar unchanged, then the short-term appreciation of the dollar due to higher consumption and investment might be about 1 percent.

Conclusions

Simulations of a general equilibrium version of FABEER confirm that an anticipated technology shock and a fiscal expansion in the US will both increase the value of the sustainable current account deficit. However, the model also suggests that both shocks will lead to increases in US interest rates that significantly dampen this current account effect.

The results are of course sensitive to the calibration of the model. However, they do provide a guide to the qualitative significance of both shocks. If the technology shock that hit the United States had been large enough, it could have accounted for a good part of the increase in the deficit observed at the end of the 1990s and early 2000. However, this current account effect is significant only during the period in which the technology shock is anticipated but not yet realized. It seems unlikely that it could justify a deficit continuing into the second half of the decade, particularly because the technology gain is likely to be dispersed to other countries. A sustainable deficit in the second half of this decade would be a consequence of the US fiscal expansion during the period, although a maximum figure here would seem to be about 1 percent of GDP.

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Appendix 3A
Microfoundations

This appendix outlines the microfoundations of the FABEER implementation of the macroeconomic balance approach. This approach to estimating equilibrium exchange rates dates back at least as far as Williamson (1985) and has at its heart aggregate trade equations that have an even longer pedigree (e.g., Houthakker and Magee 1969). However, it would be a mistake to condemn this approach as "old-fashioned." In fact, it fits in with one of the central characteristics of the new international macroeconomics (Lane 2001), which stresses the importance of imperfect competition in the market for traded goods.[8]

A Baseline Model

Consider the following, deliberately simple, small open economy. There are two goods, one produced overseas (subscript w) and one produced domestically (subscript z). Assume that all domestically produced goods are exported, so that only overseas goods are consumed. Production only requires labor, and the production function is simply

$$Y_Z = a_Z L_Z = a_Z L \tag{3A.1}$$

where Y is output and L total labor supply. For simplicity, assume that labor supply is fixed. Producers face a demand curve for their product, given by

$$Y_Z = A(p_Z/p_W)^{-\theta} \tag{3A.2}$$

where $\theta > 1$, and p_Z/p_W are the terms of trade, both measured in a common currency.

If we assume a time period in which prices are fully flexible, such that demand and supply are equal ("internal balance"), then we have

$$a_Z L = A(p_Z/p_W)^{-\theta} \tag{3A.3}$$

This equation determines the terms of trade. A country-specific increase in labor productivity will require a depreciation (a fall in p_Z) to sell the additional goods, while an increase in world demand (A) will generate an appreciation. Viewing the real exchange rate as a relative price equating domestic aggregate supply and demand is a key characteristic of the macroeconomic balance approach.

8. A macroeconomic balance approach can be rationalized using more traditional microfoundations using perfect competition, as in Dvornak, Kohler, and Menzies (2003).

We can define three measures of the real exchange rate in this economy:

- the terms of trade,
- the price of output at home relative to overseas, and
- the price of consumption at home relative to overseas.

In this very simple model, the first two definitions are equal, while the third is always unity, if we assume the economy is small so that overseas consumers mainly consume good *w*.

The consumption real exchange rate becomes endogenous if we add nontraded goods, denoted by subscript *N*. Consumer preferences across the two goods are given by

$$U = c_N^{\epsilon} c_W^{1-\epsilon} \tag{3A.4}$$

so we get the standard result that the share of each good in total consumption is constant, that is,

$$c_N p_N = \epsilon(c_N p_N + c_W p_W) = \epsilon(Y_N p_N + Y_Z p_Z) \tag{3A.5}$$

assuming no savings.

The markup in the export-producing sector from profit maximization is given by

$$p_Z = \frac{w}{a_Z} \frac{\theta}{\theta - 1}. \tag{3A.6}$$

If wages are equal for labor in the traded and nontraded sectors, then relative prices will be given by

$$\frac{p_Z}{p_N} = \frac{a_N}{a_Z} B(..) \tag{3A.7}$$

where a_N represents productivity in the nontraded sector, and $B(. .)$ will be a function of variables such as demand elasticities. Given the demand function for nontraded goods (and $C_N = Y_N$), we can write

$$a_Z L = A(p_Z / p_W)^{-\theta} B'(\epsilon, \theta, ..). \tag{3A.8}$$

Once again, the terms of trade move to equate domestic demand and supply. The output price real exchange rate will move with the terms of trade, but it will also depend on relative productivity movements between traded and nontraded goods.

Given preferences, the consumer price index (CPI) will be given by

$$CPI = p_N^{\epsilon} p_W^{1-\epsilon}. \tag{3A.9}$$

We can immediately see that the consumer price real exchange rate will no longer be constant but will depend on the terms of trade (with an elasticity ϵ). In addition, relative productivity movements between traded and nontraded goods will influence this definition of the real exchange rate, which is the Balassa-Samuelson effect.

The macroeconomic balance approach is often described as finding the real exchange rate that brings about a particular current account. In this simple economy with no financial assets, the current account is always zero. Exports are given by the demand function in 3A.2 above, while imports are given by the demand curve

$$c_W p_W = (1 - \epsilon)(Y_N p_N + Y_Z p_Z). \tag{3A.10}$$

Equating exports and import solves for the terms of trade in exactly the same way as equation 3A.8. Export equations typically used in macroeconomic balance models are exactly of the form of equation 3A.2, where A is some measure of world trade or world demand. Import equations typically take the traditional form

$$c_W = M(Y, p_W/p_D) \tag{3A.11}$$

where Y is a measure of total output and p_D is the price of that output. This formulation again follows naturally from equation 3A.10.[9]

In this simple model, export prices are a markup on domestic costs, and import prices (in overseas currency terms) are exogenously determined overseas. Empirical data for the major industrial economies strongly suggest a more complex picture, where export prices are influenced in part by competitors' prices, and import prices depend in part on the price of domestically produced goods. If p_{MD} and p_{XD} respectively denote the price of actual imports and exports, we can write

$$\begin{aligned} p_{MD} &= p_W^{\gamma} p_D^{1-\gamma}, \\ p_{XD} &= p_W^{\delta} p_D^{1-\delta}. \end{aligned} \tag{3A.12}$$

The trade balance can then be written as

$$p_{XD} A(p_{XD}/p_W)^{-\vartheta} - p_{MD} M(Y, p_{MD}/p_D). \tag{3A.13}$$

Assuming some value for the trade balance, world demand A and total domestic output Y, we can use expressions 3A.12 and 3A.13 to solve for the output price exchange rate p_D/p_W.

9. Once we allow for saving, so that the current account may not be balanced, then whether the activity term should be total output or total domestic demand becomes an issue.

Adding Commodity Trade

Not all trade in advanced industrial countries can be characterized as selling differentiated goods in imperfectly competitive markets. However, if we identify such trade as involving commodities (i.e., not manufactured goods or services),[10] then the proportion of such goods in imports is typically small: often about 10 percent and rarely exceeding 25 percent. In such cases, a very simple way to incorporate such trade into the macroeconomic balance framework is to define *total* import and export prices, p_M and p_X, as

$$\begin{aligned} p_M &= p_{MD}^{\kappa} p_C^{1-\kappa} \\ p_X &= p_{XD}^{\lambda} p_C^{1-\lambda} \end{aligned} \tag{3A.14}$$

where p_C are world commodity prices, and $1 - \kappa$ and $1 - \lambda$ are the share of these commodities in total trade. The trade balance can then be written as

$$p_X A(p_{XD}/p_W)^{-\vartheta} - p_M M(Y, p_{MD}/p_D) \tag{3A.15}$$

where it is assumed that trade in commodities is demand inelastic. This is how commodity production is treated in the FABEER model.

Although this approach may be an appropriate simplification when commodity production is small, it becomes problematic when a significant proportion of exports involves commodities. In Australia and New Zealand, nearly half of exports are commodities.

If *all* domestic exports involved commodities, then the macroeconomic balance approach would no longer be an appropriate way to determine real exchange rates. The price of exported goods would now be determined on world markets, and so the terms of trade would be exogenously given by world conditions. Shifts in domestic supply would have no impact on the terms of trade. Note, however, that PPP would not hold for such an economy, because shifts in the price of exported commodities would influence nontraded goods prices and therefore the CPI.

The more interesting case (at least for Australia and New Zealand) is where there is mixed commodity/differentiated goods production. In one extreme case, adding commodity production would make no difference to the way we model trade—if the proportion of labor going to produce commodity exports was fixed. The terms of trade for differentiated goods production (p_{XD}/p_{MD}) would still move to equate demand for exports with supply, where supply was now some fixed proportion of total labor. However, this extreme case is unlikely to be realistic; an increase in the

10. Of course, in reality, some manufactures or services may be fairly homogenous goods and some national commodity production may be facing a downward-sloping demand curve.

price of commodities relative to differentiated exports goods would attract labor into the commodity-producing sector.

An alternative extreme case is where the production function for commodities is linear. In this case commodity prices would effectively set wages and, given equation 3A.6, the price of differentiated goods exports. The demand curve for these goods would simply give the proportion of labor in this sector, with any residual labor used to produce commodities.

A more likely case is where commodity production is subject to decreasing returns to scale. As a simple example, suppose commodity production (denoted by subscript *O*) is governed by the following production function:

$$L_O = a_{O1} Y_O + \frac{a_{O2}}{2} Y_O^2. \tag{3A.16}$$

Wage equalization implies

$$Y_O = \frac{1}{a_{O2}} \left(\frac{\theta - 1}{\theta a_Z} \frac{p_O}{p_Z} - a_{O1} \right). \tag{3A.17}$$

Total exports now become

$$p_X \left[A(p_{XD}/p_W)^{-\vartheta} + \frac{1}{a_{O2}} \left(\frac{\theta - 1}{\theta a_Z} \frac{p_O}{p_Z} - a_{O1} \right) \right]. \tag{3A.18}$$

This is a hybrid demand and supply relationship. The volume of total exports continues to be influenced by world demand and competitiveness, but now the share of differentiated goods production in total exports reduces their impact. A rise in relative commodity prices *for a given level of differentiated goods competitiveness* will raise total exports, by shifting labor into the commodity-producing sector. In the model as a whole, of course, such a relative price shift would reduce the supply of differentiated goods production, requiring a rise in its price to choke off demand.

Data Availability and Model Specification

For the four major blocs in the FABEER model, trade is determined by equations of the form 3A.12, 3A.14, and 3A.15. Data on noncommodity trade prices are not generally available, so we use manufacturing trade prices as a proxy. The GDP deflator is used as a measure of P_D.

In the case of Australia, data on manufacturing trade prices were not available. However, a series for the price of manufacturing output is published, denoted by P_I. It seems reasonable that we can augment expression 3A.12 in the following way:

$$
\begin{aligned}
p_{MD} &= p_W^{\gamma} p_I^{1-\gamma} \\
p_{XD} &= p_W^{\delta} p_I^{1-\delta} \qquad (3A.12a) \\
p_I &= p_W^{\kappa} p_D^{1-\kappa}.
\end{aligned}
$$

As a result, we can substitute P_I for P_{XD} and P_{MD} in the trade volume equations.

In the case of China, the IMF publishes data on trade values only. However, we can write out value equations by simply combining the specifications for price and quantity discussed above. The details are set out in appendix 3B.

The Partial Equilibrium Approach

The system just described represents one part of a complete macroeconomy; for the complete model, we need to add equations for domestic output and overseas demand, as well as determinates of the capital flows that have to match any trade balance. In fact such a structure does represent many if not most large macroeconometric models (e.g., see Williamson 1994). However, the partial equilibrium approach to calculating equilibrium exchange rates treats these variables as exogenous inputs.

For such a partial equilibrium approach to be completely valid, the economy would have to have a recursive structure, where the real exchange rate did not influence medium-term capital flows or the trend level of output. There are a number of economic mechanisms that mean that this assumption is bound to be false; the key issue is rather whether it represents a useful approximation. There is a partial discussion of this issue in Driver and Wren-Lewis (1999). Above, this chapter suggests that feedback from the equilibrium exchange rate to the sustainable current account is not strong enough to make the partial equilibrium calculations grossly misleading.

Appendix 3B
FABEER Model Specification

This appendix describes the basic structure of the five-area bilateral equilibrium exchange rate model.

Notation

Let X_i denote variable X for country/bloc i. Two "atypical" blocs are the rest of the world ($i = r$) and the United States ($i = u$). Suppose there are n blocs, including r and u.

Exchange Rate Determination

Suppose, for simplicity, that export prices for country i = domestic prices for i. For each country, we define p_i as an index of domestic prices in dollars. The trade balance for country i in nominal dollars is given by

$$p_i x_i(p_i, all\ p_j\ j \neq i) - pm_i(all\ p_j\ j \neq i) m_i(p_i, all\ p_j\ j \neq i) \tag{3B.1}$$

where $x_i(. .)$ are real exports (measured in base year dollars), $pm_i(. .)$ the import deflator, and $m_i(. .)$ real imports for i. (We ignore all other arguments in these functions for simplicity, and we take the standard homogeneity assumptions as given.) The sum of each of these expressions across all i (including $i = r$) must equal zero, or whatever the world current account balance is (which we take as exogenous). As a result, we can drop one of these expressions (specifically $i = r$), which will then be determined by the residual. We lose no information by doing this, although it also allows us to avoid issues of cross-equation restrictions, which may or may not be a good thing.

Suppose that for each bloc we have some exogenous projection for the current account/GDP ratio = *cay*, and also assume interest flows are zero (so trade balance = current balance). We could then write $n - 1$ equations of the form

$$cay_i = \{x_i(p_i, all\ p_j\ j \neq i) - pm_i(all\ p_j\ j \neq i) m_i(p_i, all\ p_j\ j \neq i)/p_i\}/y_i \tag{3B.2}$$

where y_i is real GDP (also exogenous). For each country, we also define pdc_i as domestic prices *in domestic currency terms,* which we also assume is exogenous. (The exogeneity of *pdc* is innocuous, for the model is essentially defined in real terms.[11]) Thus we have

11. One can also think of monetary policy as targeting output price inflation, so the exogeneity assumption may not be unreasonable.

$$p_i = ex0_i pdc_i / ex_i \qquad (3B.3)$$

where ex_i is the dollar exchange rate (currency per dollar), and $ex0$ this value in the base year, for all i—except u.

Equation 3B.2 represents $n - 1$ independent equations determining $n - 1$ unknowns ex_i. This includes an equation for cay_u, which can be thought of as an equation "determining" ex_r, although of course all equations determine all unknowns simultaneously.[12] The model therefore determines all bilateral dollar rates, with no need to work backward from effective rates to bilaterals (e.g., as in Wren-Lewis and Driver [1998], or as reduced-form studies like Alberola et al. [1999] need to do).

One problem may appear to be that ex_r does not in practice exist. However, we simply omit equation 3B.3 for $i = r$, and 3B.2 still determines p_r. Data for p_i may exist, but we could use instead a measure of export prices—see below.

The Trade Model for Each Country

For each country except $i = r$, we need to elaborate on our model of trade determination. We drop the assumption above about export prices, and we introduce three new variables: px, the export price deflator; qx, the manufacturing export price; and qm, the manufacturing import price—defined in dollars for each i. We assume that each deflator is a function of the manufacturing price and a country-specific weighted commodity price index:

$$px = qx^a cx^{(1-a)} \qquad (3B.4)$$

$$pm = qm^b cm^{(1-b)} \qquad (3B.5)$$

where cx and cm are the commodity price bundles, a and b are parameters that can be derived from data on the composition of trade, and we drop the i subscript because these equations are common across all i, $i \neq r$. (These equations will in practice need constants and possibly trends, reflecting measurement errors and trade in services.)

For both qx and qm, we assume that prices are a weighted average of domestic prices and other countries' export prices; that is,

$$qx_i = p_i^c \left(\sum_{j \neq i} wx_{ij} qx_j \right)^{1-c} \qquad (3B.6)$$

$$qm_i = p_i^d \left(\sum_{j \neq i} wm_{ij} qx_j \right)^{1-d} \qquad (3B.7)$$

12. Using iterative solution techniques here may be tricky, because p_i does not appear on the left-hand side of any of these equations.

where c and d are again parameters (to be calibrated), and wx and wm are weights summing to 1 (which can be derived from direction of trade statistics). Finally, we have the specification of the two volume equations. For imports, we have

$$m = m(y, qm/p). \tag{3B.8}$$

The function $m(. .)$ is partly calibrated, but its constant at least is estimated. There are three problematic issues here. The first is using y as the activity measure. It could be replaced by TFE (i.e., $y + m$) or by a weighted demand variable. The second is the log-linear specification, which is not consistent with a log-linear model for the demand for domestic output (see Anderton, Pesaran, and Wren-Lewis 1992). The third is that qm/p is not an ideal measure of competitiveness, because p contains many nontraded goods, and traded goods that are not subject to strong competitiveness effects (like commodities). One possibility here is to define an additional domestic price variable (e.g., a price of domestic manufactures), and add a linking equation between this and the GDP deflator p. The disadvantage of this is that domestic manufacturing prices are likely to depend on overseas prices to some extent, so the system becomes complex in terms of simultaneity.

For exports, we have

$$x_i \Big/ \left(\sum_{j \neq i} wd_{ij} m_j \right) = f\left[qx_i \Big/ \left(\sum_{j \neq i} wc_{ij} qx_j \right) \right]. \tag{3B.9}$$

The function $f(. .)$ is calibrated, but its constant is estimated. Here wd and wc are weights (based on direction of trade statistics) reflecting the direction of exports and third-party competition respectively. The equations say that the share of exports in a weighted demand variable is a function of export price competitiveness.

Exchange Rate Determination Revisited, and the RoW Bloc

Specifying the trade equations allows us to delineate more precisely how countries interact. There are two forms of interaction: (1) Changes in imports in one country influence exports in another; and (2) changes in export prices in one country influence other countries both by changing import prices and through export competitiveness.

Output prices only influence other countries via these two effects. As a result, it is not necessary to define output prices for the rest of the world. Instead, the endogenous "exchange rate" variable for this bloc will be qx: manufacturing export prices.

What about RoW imports? In this exercise, they are treated exogenously, although in Wren-Lewis (2003) they did vary with qx.

Interest Flows

The IMF publishes data on the stock of overseas assets held by domestic residents and domestic assets held by overseas residents. We can calculate an implicit rate of return by combining this information with recorded interest flows (*ipd*). Modeling these flows involves two major problems. First, the composition of assets by type is diverse, and so modeling the return is likely to be very difficult. A nominal deposit will attract the (short) nominal interest rate. There will be an inflation loss on these assets, but this is not recorded in the official data. An indexed deposit will suffer no inflation loss and will return a real interest rate. Shares will receive dividends, which appear in the data, plus some capital gain that is not recorded there. Direct investment returns a profit stream. Ex ante, arbitrage should ensure that the total return on all these assets should be equal after allowing for risk premia. However, the data do not measure the total return (i.e., they exclude capital gains), and ex post there will be unexpected gains and losses.

The second major problem involves modeling changes in the asset stock. Historic estimates of EERs have normally been conditional on actual stocks (the EER is a flow equilibrium, not a stock equilibrium concept), so at first sight no modeling may appear necessary. However, overseas assets will be held in different currencies, and it is important to allow deviations in the EER from actual rates to influence asset stocks. Uncovered interest parity (UIP) should ensure that expected capital gains are offset by interest rate differentials, but the data only record the latter and there will be unexpected gains and losses.

Tackling the first problem for a simple model involves making heroic assumptions that do the least damage to the EER estimates. A key aspect of EER estimates is that they abstract from cyclical effects. Because the economic cycle is likely to influence interest rates as much as output, it would be inconsistent to use actual interest rates in modeling *ipd,* although this has been the approach normally adopted in the literature. Instead, what we do here is construct a synthetic "smoothed world *ipd* return" time series, and then relate *ipd* returns for each country to this rate, using a simple linear relationship:

$$ipd\ return_{it} = a + b\ world\ ipd\ return_t \tag{3B.10}$$

This enables us to take account of any permanent differences that appear to occur in individual countries' rates of return (see Lane and Milesi-Ferretti 2002) and knock out any cyclical effects. However, any persistent but temporary idiosyncratic movements in returns will be lost.

We also want the dollar value of assets to move in simulations with changes in the exchange rate. We can define a simple "deviation from base" equation as

$$a_i = \hat{a}_i \sum_j w_{ij} p_j / \hat{p}_j \tag{3B.11}$$

where a "hat" over a term denotes the base value, and w is a set of weights reflecting the proportion of currency j assets in total assets for country i.

Previous FEER studies have implicitly treated these weights w as equal to the weights in the effective exchange rate index, although in some studies a percentage of US overseas assets is assumed to be in dollars. Equation 3B.11 offers greater flexibility.

Smaller Countries

The specification of the New Zealand (NZ) bloc is very similar to the typical non-US bloc, with two key exceptions. First, neither NZ imports nor export prices are involved in the weighted world trade or price variables discussed above. This makes the NZ bloc recursive.

The same is true for the Australian bloc, although Australian imports and export prices do influence New Zealand variables and vice versa. However, Australia differs from New Zealand in that there are no manufacturing export or import price series. Instead, we define an additional variable, domestic manufacturing prices. This variable depends on total domestic output prices, plus a trend. The variable then replaces the two missing manufacturing trade price series in determining import volumes, total import prices, total export prices, and export volumes, as well as NZ manufacturing export and import prices.

The second difference in the Australian and New Zealand blocs is in the aggregate export equation. This adapts equation 3B.9 above in two ways. First, the coefficient on world trade and price competitiveness is halved, to allow for the fact that only about half these countries' exports are relative price and demand sensitive. Second, we add a term in the relative price of commodity production to manufacturing exports. If this term rises, commodity production becomes more profitable, and labor moves into commodity production and away from other export goods. (See appendix 3A for more details on this derivation.)

For the China bloc, there is no volume/price split at all. Instead, the model has reduced-form equations for total values (exports and imports). Specifically, the share of exports in total GDP is given by

$$
\begin{aligned}
px_i \cdot x_i / p_i y_i &= qx_i^a cx_i^{1-a} \sum_{j=majors} wd_j \cdot m_j \left(\frac{qx_i}{\sum_{j=majors} wc_j \cdot qx_j} \right)^{\beta} \Big/ p_i y_i \\
&= \left(p_i^c \left(\sum_{j=majors} wc_j \cdot qx_j \right)^{1-c} \right)^{a+\beta} cx_i^{1-a} \sum_{j=majors} wd_j \cdot m_j \left(\sum_{j=majors} wc_j \cdot qx_j \right)^{-\beta} \Big/ p_i y_i
\end{aligned}
\qquad (3B.12)
$$

and similarly for imports.

Endogenizing the Sustainable Current Account

Above, this chapter extended FABEER to endogenize the sustainable current account. This involves adding equations for medium-term consumption and investment. We treat fiscal policy as exogenous, although we make sure the government's intertemporal budget constraint holds. We also endogenize real interest rates. This involves at the national level ensuring that UIP holds, and at the global level ensuring that global saving and investment match.

Consumption

Our model is based on two sets of consumers: intertemporal maximizers of the Blanchard-Yaari type, and rule-of-thumb consumers who consume all of their current income. Consumption as a percentage share of GDP is then given by

$$cy_t = ccc\left(\frac{p_t}{pm_t}\right)^{cs} 100(1 - ps - tr_t) + mpc\left(hy_t + \left(\frac{p_t}{pm_t}\right)^{cs} wy_t\right) \tag{3B.13}$$

where *ccc* is the proportion of income going to credit-constrained consumers, *cs* is the share of imports in total consumption, *ps* is the share of profits in total income (assumed constant), *tr* is the tax rate, *mpc* is the propensity for non-credit-constrained consumers to consume out of total wealth, *hy* is the ratio of human capital to income, and *wy* is the ratio of financial wealth to income. (Because all variables refer to an individual economy, we drop the country subscript but add a time subscript.)

Human wealth (as a percentage share of GDP) is given by

$$hy_t = \frac{hy_{t+1}}{rrrc_t} + (1 - ccc)\left(\frac{p_t}{pm_t}\right)^{cs} 100(1 - ps - tr_t) \tag{3B.14}$$

where *rrrc* is a discount factor that adds a risk premium to the real interest rate. Financial wealth (as a percentage share of GDP) is given by

$$wy_t = 100 \cdot rsp_t \cdot \frac{k_t}{y_t} + dy_t + ay_t - ly_t \tag{3B.15}$$

where *rsp* is the real share price, *k* is capital (related to investment in the standard way), *dy* is the government debt to income ratio, and *ay* and *ly* are the overseas asset and liability ratios already discussed.

Investment

Investment is given by

$$i_t = k_{t-1}(c_0 + c_1 rsp_t) \tag{3B.16}$$

and the real share price is given by

$$rsp_t = \frac{rsp_{t+1}}{rrrf_t} + ps\,\frac{y_t}{k_t} \tag{3B.17}$$

where *rrrf* is a discount factor. This is a Tobin *q*–type formulation: Share prices depend on expected, discounted future profits, and investment responds to the ratio of share prices to the book value of the capital stock.

Appendix 3C
A Bilateral Global Model: Calibration

For most model variables, calibration is based on data from the Organization for Economic Cooperation and Development's (OECD's) *Economic Outlook* for December 2003.

Output Gap Estimates

FABEER models output assuming a Cobb-Douglas production function, with a parameter of 0.3 on capital. In the partial equilibrium model, historical EERs are computed using actual values for the labor force and the capital stock. The main judgment involves assessing the output gap in some reference year, and assuming some value for trend productivity growth. In the results in this chapter, I have followed the OECD's calculations for the output gap in 2000. My assumptions about trend productivity growth are very similar but not identical to the OECD's figures, so my output gap figures for 2003 are slightly different. The details are set out in table 3C.1.

Trade Volume Equations

All equations have a constant estimated using static ordinary least squares (OLS) over a period in which the equation appears stable. In addition, the elasticity on output in the import equations is estimated in the same way, as are some of the competitiveness elasticities (table 3C.2).

Trade Price Equations

The price of imports or exports of goods and services is a weighted average of commodity prices and manufacturing prices. Manufacturing prices depend on domestic output prices and competitors' prices. The majority of parameters, and always the trend and constant, are estimated using static OLS (table 3C.3).

Manufacturing export prices are mainly influenced by domestic output prices, with (unsurprisingly) the largest weight for the United States, and the smallest for the United Kingdom. Again, it is not unexpected that domestic prices have a large influence on manufacturing import prices in the United States and the euro area, but the low weight for Japan is more surprising.

Table 3C.1 Output gap estimates (actual and trend, percent)

Bloc	OECD, 2000	OECD, 2003	Wren-Lewis (2003)	Implied TFP growth (percent)
Euro area	0.9	–2.2	–2.5	1.0
Japan	–1.1	–1.9	–1.5	1.0
United Kingdom	1.2	–1.4	–1.4	1.5
United States	2.2	–1.5	–1.3	1.2

TFP = total factor productivity

Sources: OECD Economic Outlook 2003 and author's calculations.

Table 3C.2 Elasticities in import and export equations

Bloc	Activity	Competitiveness	Estimation period
Exports			
United States	1.0	.89[a]	1980–2003[b]
Japan	1.0	.80	1988–2003
Euro area	1.0	1.00	1986–2003
United Kingdom	1.0	.87[a]	1975–2002[c]
Imports			
United States	1.80[a]	.73[a]	1975–2002[c]
Japan	1.73[a]	.80	1990–2003
Euro area	1.87[a]	.40	1980–2002[c]
United Kingdom	1.45[a]	.80	1980–2003

a. Estimated from a static regression.
b. Also includes a shift dummy worth 10 percent from 1999; see box 3.1.
c. Using data from *OECD Economic Outlook 2002,* taken from Wren-Lewis (2003).

Sources: OECD Economic Outlook 2003 and author's calculations.

Table 3C.3 Trade prices

	Aggregate		Manufacturing	
Bloc	Coefficient on commodity prices	Trend (percent per annum)	Coefficient on domestic prices	Trend (percent per annum)
Exports				
United States	0.12	0.8	0.88	–2.8
Japan	0.02	–1.6	0.68	0.6
Euro area	0.10	0.0	0.72	–1.0
United Kingdom	0.14	0.4	0.39	–0.1
Imports				
United States	0.20	0.2	0.54	–1.8
Japan	0.28	1.0	0.15	–0.4
Euro area	0.17	0.1	0.56	–1.0
United Kingdom	0.10	0.3	0.34	–1.0

Sources: OECD Economic Outlook 2003 and author's calculations.