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A macroeconomic balance measure of New Zealand's equilibrium exchange rate

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Abstract[2]

We estimate the fair value of the New Zealand dollar using the macroeconomic balance approach. The model's elasticities are calibrated so that they are more appropriate to a small commodity-exporting economy. Over the 1990s, the model estimates that the fair value for the TWI fluctuated between 52 and 59. For the final quarter of 1999, the model estimates that a TWI of around 56 would have been consistent with macroeconomic balance, implying that the TWI (which was around 54.5) was then approximately at fair value. However, this result is subject to a significant amount of uncertainty.

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[2] The views expressed in this paper are those of the authors and do not necessarily represent the views of the Reserve Bank of New Zealand. All errors and omissions are the responsibility of the authors.

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1 Introduction

In preparing forecasts for the economy, it is necessary to analyse the current position of the exchange rate, and the impact it is likely to be having on the economy. Is the exchange rate likely to rise from current levels over the projection period, or fall? Is the current level of the exchange rate having a restraining or stimulatory effect on net exports? Wadwhani (1999) describes how the assumptions a central bank makes in this area can crucially affect inflation projections and, as a result, influence the stance of policy. For example, if the exchange rate is generally understood to be undervalued, but expected to appreciate back towards some concept of fair value, then other things being equal, interest rates would be set lower than if the exchange rate were likely to remain at a lower level.

One piece of information that can assist in assessing these issues is an understanding of the long-run equilibrium level of the exchange rate. The notion of an equilibrium exchange rate stems from the belief that short and medium-term factors will often cause short term fluctuations and medium-term cycles in the exchange rate, but over a longer time horizon the exchange rate will gradually return to some equilibrium value. The long-run equilibrium is where the exchange rate would be if short-term 'noise' (like speculative trading) and medium-term factors (such as monetary policy) were not affecting the actual exchange rate.

Unfortunately, the equilibrium exchange rate cannot be directly observed, which makes it very difficult to estimate. To complicate matters further, it is possible that the equilibrium may change over time in response to structural factors that affect New Zealand's relative competitiveness. There are, however, a number of approaches to estimating the equilibrium exchange rate.[3]

This paper focuses on the role of the current account balance in determining the equilibrium exchange rate. Because New Zealand has run persistent current account deficits for some time, we have accumulated a large stock of net foreign liabilities. In turn, this has put downward pressure on the equilibrium exchange rate. This is

[3] For example, see MacDonald (2000) for an overview of some of these methodologies.

because, in equilibrium, the exchange rate must be such that it will produce a level of net exports that will offset the expected outflow from servicing New Zealand's net foreign liabilities. A large stock of liabilities will increase the investment income deficit and thus need to be offset by a larger surplus on the balance of goods and services. To achieve this, a lower exchange rate is required.

The role of the external balance, as described in the previous paragraph, has been more formally integrated into what is known as the macroeconomic balance (MB) model of the exchange rate. This general concept has been used by the IMF in exchange rate assessments since the 1970s (see Artus (1977)), was used by Jeffrey Williamson (1985, 1994) in his 'Fundamental Equilibrium Exchange Rate' (FEER) modelling, and has recently been extended in an IMF volume edited by Isard and Faruqee (1998).

In this paper, we apply the methodology described in Isard and Faruqee (hereafter IF) to New Zealand data. Because the IF model is designed to be reasonably parsimonious and apply to a large number of countries, we find it worthwhile to modify the methodology in a number of ways to better reflect the specific characteristics of the New Zealand economy. For example, the large negative net foreign asset position of the New Zealand economy means that negative investment income balances are an important feature of our current account. However, because the investment income balance is also very volatile, we explicitly smooth the data when cyclically adjusting the current account. To better reflect New Zealand's circumstances we also recalibrate the elasticities of export and import prices and export volumes. For example, as a small economy, New Zealand has little pricing power on world markets. This means that export prices tend to vary with the exchange rate and New Zealand exporters face a higher elasticity of export prices to the exchange rate than may be the case in larger markets.

In the next section, we introduce the macroeconomic balance approach. In section three, we discuss the parameterisation of the model. In the fourth section, we describe the assumptions we have made about the current and capital accounts, and use these assumptions to calculate an equilibrium for the currency. Section five concludes.

2 A simple introduction to the macroeconomic balance approach

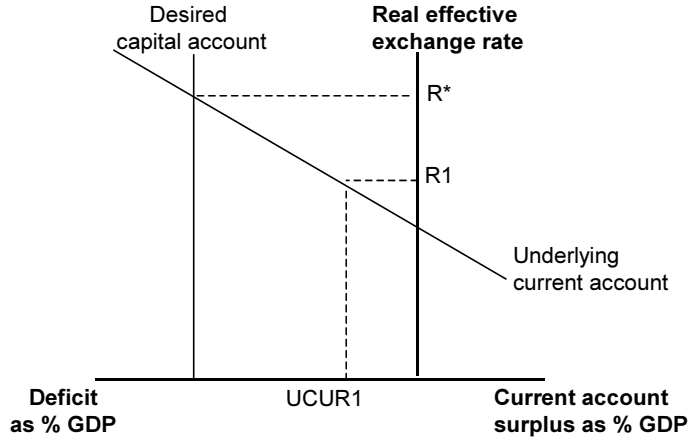
The macroeconomic balance framework focuses on the extent to which prevailing exchange rates are consistent with simultaneous internal and external equilibrium over the medium run. This section provides a brief introduction to this model. Interested readers should consult Isard and Faruqee (1998) for a more complete description of the model, as well as a discussion of its limitations.

The macroeconomic balance approach stems from the balance of payments identity, namely, the fact that the current account balance must equal the inverse of the capital account. By making judgements about what capital account can be sustained in the medium term and how the current account is likely to evolve, we can use this identity to back out an approximate medium-term 'equilibrium' for the exchange rate.

The first step is to estimate the *desired* (or 'equilibrium') capital account. This can be thought of as the amount domestic agents wish to borrow from foreigners in the steady state, given foreigners' willingness to lend to them. In the figure below, the real exchange rate is plotted on the vertical axis and the current account (as a per cent of GDP) is shown on the horizontal axis. The desired capital account is shown as a vertical line, reflecting the assumption that the desired quantity of capital inflow is a function of household savings and investment decisions in New Zealand and is independent of the level of the real exchange rate.[4] We discuss our assumption for New Zealand's desired capital account in section 4.1.

[4] This may not be a reasonable assumption if investors are concerned about the competitiveness of the New Zealand tradable sector.

Figure 1:
The macroeconomic balance approach[5]



Note: (R1 denotes actual exchange rate, R* the equilibrium, and UCUR1 the underlying current account balance)

The second step is to 'cyclically adjust' the present level of the current account, to give the present level of the *underlying* current account (denoted UCUR1 in the figure above). As discussed in section 4.2, this is done by adjusting the present current account for the effect of the current domestic and foreign output gaps on imports and exports respectively, as well as the lagged effects of exchange rate changes which have already occurred. The underlying level of the current account can be thought of as the level the current account would be at now if both the New Zealand and world economies were operating at potential and all pass-through of exchange rate effects was complete. This step depends on assumptions about the elasticities of export and import volumes and prices to changes in the exchange rate. It also depends on assumptions about the elasticity of exports to the world cyclical position, and the elasticity of imports to the domestic cyclical position. These assumptions are discussed in section 3.

[5] Chart is taken from Isard and Mussa (1998, figure 2.2).

The third (and final) step is to calculate the level of the exchange rate that would cause the actual current account deficit to be exactly offset by the desired capital account surplus. In essence, this involves calculating the slope of the 'underlying current account' (UCA) line in figure 1. The slope of the line is negative, because as the exchange rate appreciates, net exports will tend to fall, worsening the underlying current account position.[6] The slope of the UCA line determines the responsiveness of net exports to the exchange rate. For example, if the slope of the UCA line is very steep, then a comparatively large movement in the exchange rate is required to close a given sized gap between the present underlying current account, and the desired capital account. Conversely, a flat UCA line suggests that net exports are relatively responsive to given changes in the exchange rate.

The equilibrium exchange rate is thus a function of the slope of the UCA line and the gap between the present underlying current account and the desired capital account. For example, if the present cyclically adjusted current account deficit (UCUR1) is smaller than the desired capital inflow (as in figure 1), the exchange rate would have to appreciate from present levels to reach an equilibrium: in figure 1, it would have to rise from R1 to R*.

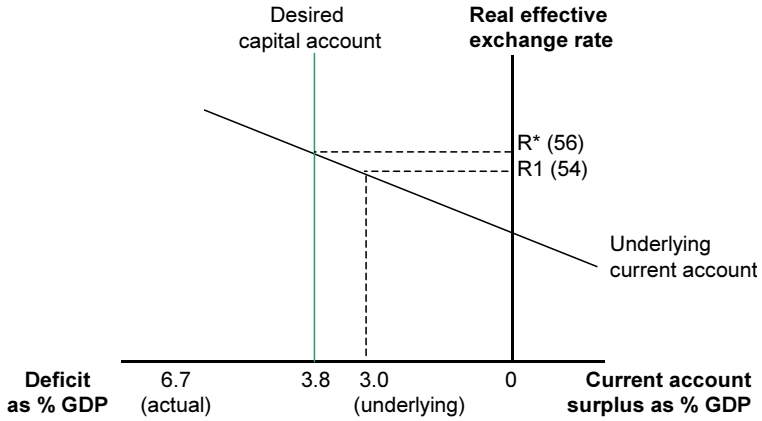
The equilibrium exchange rate R* can be interpreted as the medium term level of the exchange rate that seems justified by the fundamentals. It may be out of line with longer run fundamentals such as purchasing power parity, in which case the transition from the medium to the long term will involve further adjustment. In this paper, we determine R* in section 4.3.

Before explaining the more detailed analysis underpinning our MB estimate of R*, we anticipate our conclusions by outlining our key results graphically. Figure 2, based on figure 1, shows our estimates of the actual and underlying current account balances, the desired capital account, R1 and R* for the December quarter of 1999. At that time the TWI was around 54 (R1) and the current account deficit

[6] Because we are concerned with the long-run equilibrium for the currency, we are interested here in the eventual response to a permanent shift in the currency. In other words, while shorter run behaviour such as the J-curve may influence the actual level of the current account, it does not affect the underlying level of the current account and therefore is not relevant to our analysis.

was nearly 7 per cent of GDP. The underlying current account, once all cyclical and lagged exchange rate effects were removed, was around 3 per cent of GDP, nearly 5 percentage points better than the actual current account deficit. We assume that the desired capital account was around 3.8 per cent. The elasticities of exports and imports to the exchange rate that we posit imply that the underlying current account deficit would worsen to equal the desired capital account at 3.8 per cent if the exchange rate appreciated around 2 per cent, to about 56. This is our baseline MB estimate of exchange rate 'equilibrium' at the end of 1999.

Figure 2:
The macroeconomic balance approach: 1999 estimates



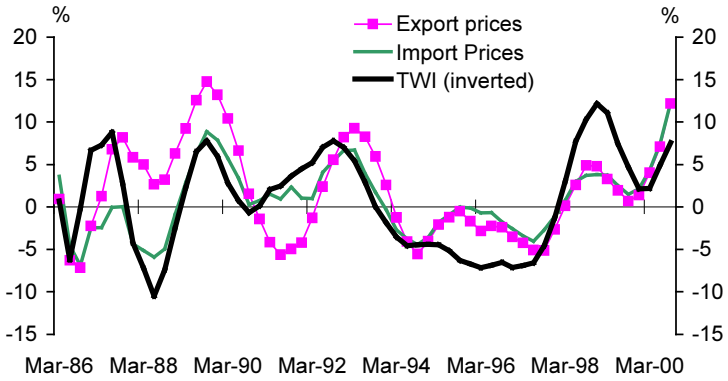
3 Parameterising the MB model: Elasticity assumptions, alternatives, and implications

The MB model depends heavily on assumptions about a number of elasticity parameters that describe how New Zealand exports and imports react to other variables. In this section, we document the assumptions we have made about the parameters, why we have chosen those assumptions, and we outline the assumptions underpinning the alternative scenarios discussed in section 4.4. Finally, we discuss the implications of our assumptions for empirical observation of the trade balance, an area that we think may merit further work.

Our judgement is that some of the parameter assumptions in the IF model are not so appropriate for the New Zealand economy. For example, the IF model assumes that export prices remain fixed when the exchange rate moves (a zero elasticity), and that exchange rate fluctuations are immediately, and fully, passed through into import prices (an elasticity of 1).[7] However, casual observation of New Zealand data suggests that there is not a one-to-one relationship between changes in the TWI and import prices. Nor does there appear to be zero correlation between the TWI and export prices (see figure 3 over page). Instead, we observe that NZD denominated import and export prices both react to exchange rate fluctuations, with the 'pass-through' appearing to be less than complete and reasonably lagged.

[7] All the elasticities in the text and tables are expressed as absolute values.

Figure 3:
Annual average percentage change in export and import prices and the TWI



Lining up export and import prices on a chart obviously does not provide conclusive proof of our assertions about pass-through. However, there are also strong theoretical grounds for expecting New Zealand export prices to respond to the exchange rate, and for expecting import price pass-through to be incomplete, and lagged. Significant proportions of New Zealand exports are relatively homogenous commodities whose prices are determined on world markets. This makes the price expressed in New Zealand dollars responsive to exchange rate fluctuations. Even New Zealand's manufactured exports are typically sold into markets where New Zealand producers are small relative to the size of local producers and producers from third countries trading in that market.[8] Again, this will tend to force New Zealand producers to accept the prevailing foreign currency price (see Hargreaves and White (1999)), for more discussion of price determination in world markets). There is also empirical evidence of significant pricing to market behaviour by New Zealand importers (see Winkelmann (1996)).

Because of this evidence, our baseline calibration of the IF model uses alternative elasticity assumptions to those in the standard IF

[8] For example, New Zealand exporters accounted for approximately 1.4 per cent of manufactured exports (HS groups 84-96) to Australia on average between 1994 and 1996.

model. Since New Zealand import prices seem to react less than one-for-one with TWI changes, while New Zealand export prices also react significantly to TWI fluctuations, we assume import and export price elasticities of 0.7 and 0.6 (rather than 1.0 and 0.0 respectively). That is, if the TWI depreciated by 1 per cent, we assume that export prices would eventually rise by 0.6 per cent and import prices would eventually rise by 0.7 per cent. This makes the trade balance much more responsive to fluctuations in the exchange rate than under the IF assumptions, as explained later in this section.

We have also lengthened the lags with which import and export prices respond to the exchange rate. Whereas IF assume that the full import price pass-through occurs within the current year, we assume that only 60 per cent of the final pass-through will occur in the current year, with 20 per cent occurring in each of the two subsequent years. We use the same lag structure (60/20/20) to describe the impact of the exchange rate on export prices.

The final adjustment we make to the IF assumptions is for the elasticity of export volumes with respect to the exchange rate. For industrial countries IF assume an export volume elasticity of 0.7. For New Zealand we use the developing country assumption of 0.5. This recognises the essentially commodity based nature of our exports, and the time lags involved in increasing agricultural production.

Table 1 below summarises the full set of parameters and assumptions used in our baseline analysis. With the exception of the export and import price elasticities discussed above, we follow IF by adopting the parameters in Bayoumi and Faruqee (1998) that seem reasonable based on surveys of relevant empirical analysis.

Table 1:
Parameterisation of the MB model and source of parameters

Elasticity of:	Notation	Absolute value	Justification
Exports to world output gap	$\|\varepsilon\|_{X,Ygap*}$	1.5	Used in Isard and Faruqee (ed) (1998) (IF), based on Goldstein and Khan (1985).
Imports to domestic output gap	$\|\varepsilon\|_{M,Ygap}$	1.5	Used in IF, based on Goldstein and Khan (1985).
Export volumes to exchange rate	$\|\varepsilon\|_{X,E}$	0.5	Used in IF, based on Reinhart (1995), for *developing* countries. The commodity nature of NZ exports makes the 'developing' country assumption appropriate (developed country assumption in IF is 0.7).
Import volumes to exchange rate	$\|\varepsilon\|_{M,E}$	0.9	Used in IF, based on Masson, Symansky and Meredith (1990), for developed countries.
Export prices to exchange rate	$\|\varepsilon\|_{PX,E}$	0.6	Small open economies like New Zealand are price takers, so exchange rate swings should impact on domestically denominated export prices. IF assume 0.
Import prices to exchange rate	$\|\varepsilon\|_{PM,E}$	0.7	Empirically, pass-through in New Zealand appears to be quite slow and possibly even incomplete (perhaps because of pricing to market). IF assume 1.0.

Table 2 summarises the lags with which volumes and prices respond to the exchange rate. For export and import volumes we use the same assumptions as the IMF.[9] For export and import prices, we use alternative assumptions, as discussed above.

Table 2:
Lags used for exchange rate effects in the MB model
(Proportion of total effect occurring each year)

Variable	Y0	Y1	Y2	Y3	Y4	Justification
Export volumes to exchange rate	0.3	0.35	0.15	0.1	0.1	Current IMF assumption (slightly slower than that published in IF).[10]
Import volumes to exchange rate	0.3	0.35	0.15	0.1	0.1	Current IMF assumption (slightly slower than that published in IF).
Export prices to exchange rate	0.6	0.2	0.2			Assumed (in absence of better information) to equal import price lags.
Import prices to exchange rate	0.6	0.2	0.2			IF assume instantaneous pass-through, but this seems unreasonable in NZ context.

Note: Y0, Y1, Y2, Y3, and Y4 denote the proportion of the total effect occurring in the current year, first, second, third and fourth subsequent years respectively.

In order to investigate the sensitivity of the model conclusions to the assumptions, in section 4.4 we conduct a sensitivity analysis, re-parameterising the model twice to create alternatives where the trade balance is more or less responsive to the exchange rate. Table 3 summarises the assumptions used in each of the alternative scenarios, as well as the assumptions in the baseline scenario (from tables 1 and 2).

[9] The lags published in IF are slightly slower than those summarised in table 2. Updated lags were obtained from personal communication with Peter Isard.

[10] The IMF lags published in IF were 60% in Y0, 25% in Y1 and 15% in Y2.

Table 3:
Comparison of model assumptions used in different scenarios

		Unresponsive scenario (IMF assumptions)	Baseline scenario	Responsive scenario
X to Ygap*	$\|\varepsilon\|_{X,Ygap*}$	1.5	1.5	1.5
M to Ygap	$\|\varepsilon\|_{M,Ygap}$	1.5	1.5	1.5
X to ER	$\|\varepsilon\|_{X,E}$	0.71	0.5	0.9
M to ER	$\|\varepsilon\|_{M,E}$	0.92	0.9	1.0
P_X to ER	$\|\varepsilon\|_{PX,E}$	0	0.6	0.8
P_M to ER	$\|\varepsilon\|_{PM,E}$	1.0	0.7	0.5
X & M lags (proportion of total effect occurring each year)				
Y0		0.3	0.3	0.4
Y1		0.35	0.35	0.3
Y2		0.15	0.15	0.3
Y3		0.1	0.1	
Y4		0.1	0.1	
P_X & P_M lags (proportion of total effect occurring each year)				
Y0		1.0	0.6	0.6
Y1			0.2	0.2
Y2			0.2	0.2

The 'less responsive' scenario is based on the original IMF elasticities as published in IF. Most notable is that export price pass-through is set to zero, while import price pass-through is set to one (and assumed to occur instantaneously). This makes the trade balance less responsive to the exchange rate because the responsiveness of the trade balance is a function of the elasticity of export and import prices and volumes to the exchange rate. In the appendix, we show that the following equation describes the responsiveness:

$$\frac{dTB/dE}{Y} = \frac{-PX.X}{Y}\left(|\varepsilon|_{X,E} + |\varepsilon|_{M,E} + |\varepsilon|_{PX,E} - |\varepsilon|_{PM,E}\right) \quad (1)$$

where the $|\varepsilon|$ terms denote the absolute value of the elasticity of export and import prices and volumes to the exchange rate, TB denotes the trade balance, E denotes the exchange rate (normalised to

one), PX.X denotes nominal exports, and Y denotes nominal output. This equation assumes the trade balance is initially at zero, but in the model we allow for the actual trade balance.

The intuition here is that an appreciation (rise) in the exchange rate causes export volumes to fall, import volumes to rise, export prices to fall, and import prices to fall. The first three effects worsen the trade balance, while the last improves it (which is why the import price elasticity is negatively signed). Plugging in our *baseline scenario* elasticities for these four determinants of the trade balance (0.5, 0.9, 0.6 and 0.7 respectively) and New Zealand's trade/GDP ratio (which is approximately 0.3) we get an elasticity of the trade balance to the exchange rate of approximately -0.3(0.5+0.9+0.6-0.7) = -0.4. That is, a 1 per cent depreciation in the exchange rate is assumed to improve the trade balance by about 0.4 per cent of GDP. This is our baseline scenario.

Using the *IMF assumptions*, however, we get -0.3(.7+.9+0-1)[11] or an elasticity of about -0.2: a 1 per cent depreciation in the exchange rate improves the trade balance by about 0.2 per cent of GDP.

Finally, to create the *responsive* scenario in section 4.4, we make the four elasticities 0.9, 1.0, 0.8 and 0.5. This gives us an elasticity of the trade balance to GDP of -0.3(.9+1.0+0.8-0.5), or about -0.7: a 1 per cent depreciation in the exchange rate improves the trade balance by about 0.7 per cent of GDP. In the responsive scenario we also shorten the lags with which export and import volumes respond to the exchange rate. As a result the final impact of the exchange rate on the trade balance is achieved more rapidly (see table 3).

How plausible is our baseline assumption of 0.4 for the implied elasticity of the trade balance to the exchange rate? One perspective might be that it is not very realistic on the grounds that while the New Zealand dollar has been through swings of around 40 per cent in the last 5 years, the trade balance has only moved in a range of about 4 per cent (between -1 and 3 per cent of GDP).

[11] Notice that with the IMF assumptions we have recovered the simple Marshall Lerner condition: a depreciation will improve the balance of trade if export and import volume elasticities (0.5 and 0.9 in the baseline example) sum to more than 1. The simple Marshall Lerner condition depends on an assumption of mark-up pricing, which makes domestic export prices invariant with the exchange rates, while import prices respond completely and instantly.

However, this criticism neglects two important points. First, these are long-run elasticities: the currency is expected to affect the trade balance only gradually. If we approximate this by taking a two-year moving average of the exchange rate, the swings over the 1990s only have an amplitude of around 20 per cent, which partly explains the relative stability of the trade balance.

Second, the implied elasticity of the trade balance to the exchange rate is calculated under the assumption that everything else remains equal. Thus, this elasticity may not apply if the exchange rate is moving in response to shifts in other determinants of net exports. For example, consider the case in which world export prices fall and the exchange rate depreciates in response. In this case, the observed elasticity of the trade balance to the exchange rate may be near zero, because the positive impact of the depreciation will be offset by the negative impact of the world export price shift.

In other words, in some circumstances, the impact of an exchange rate shift on the trade balance may be disguised by other factors. Hence, if (as seems plausible) an econometric analysis concluded that the observed long run elasticity of the balance of trade to the exchange rate was lower than 0.4, there are two possible explanations. The first is that our elasticity assumptions are incorrect, and the true New Zealand elasticities are closer to the IMF (IF) assumptions. Alternatively, it might be the case that the exchange rate moves to offset other shocks and thus acts as a buffer to the economy.

4 Using the macroeconomic balance model

4.1 Step one: Determining the desired equilibrium level of capital flows

The desired equilibrium level of capital flows has a simple relationship to the equilibrium net foreign asset position. A condition of long run balanced growth is that all behavioural variables grow at a constant rate. Thus, in equilibrium, the ratio of net foreign assets (NFA) to nominal GDP must be stable:

$$\%\Delta NFA = \%\Delta GDP \qquad (2)$$

In addition we know that the percentage change in NFA for any period must equal the net outflow of capital from New Zealand over that period, as a per cent of NFA (abstracting from revaluation effects).[12] That is, the change in NFA should equal the inverse of the capital account balance. Also since $\%\Delta GDP$ is equal to the rate of inflation plus the rate of real output growth, we have that in equilibrium:

$$\frac{-CA}{NFA} = (\%\Delta Y + \%\Delta P)$$

or

$$\frac{-CA}{GDP} = (\%\Delta Y + \%\Delta P)\frac{NFA}{GDP} \qquad (3)$$

where CA/GDP is the capital account balance as a ratio to GDP, NFA/GDP is net foreign assets as a ratio to GDP, $\%\Delta Y$ is real growth and $\%\Delta P$ is inflation.

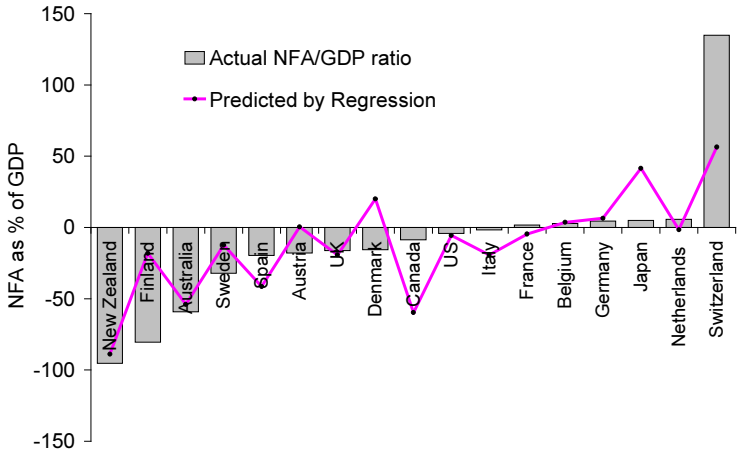
Using equation 3 we can calculate the equilibrium capital account balance as a function of the equilibrium net foreign asset position. For example, if we expect an equilibrium NFA/GDP ratio of -0.95,[13]

[12] Because this is an equilibrium relationship and revaluation effects should not occur in equilibrium, this is a reasonable abstraction. However, revaluation effects mean that historical measures of the current account deficit do not always bear a close resemblance to the change in net foreign assets.

long-run potential output growth of 2.5 per cent, and long-run inflation of 1.5 per cent, then the capital account surplus (and current account deficit) will be 3.8 per cent of GDP in equilibrium.

Figure 4 shows the net foreign asset positions of a number of countries, including New Zealand. When expressed as a per cent of GDP, New Zealand easily has the highest ratio of net foreign liabilities (NFL) in the sample. Given this, can we justify the assumption that the NFA/GDP ratio will stabilise around -0.95 or should we expect the ratio to rise (become less negative)?

Figure 4:
Net foreign assets/liabilities for selected countries[14] and predicted values



To answer this question, we need to consider the factors that cause some countries to become debtors and others creditors. Two key factors that may cause capital to enter a country are the availability of complementary factors of production, and the relative wealth of

[13] This is very close to the assumption currently embedded in the Reserve Bank's forecasting and policy system model (FPS).

[14] For most countries the NFA data is for the year ended March 1999. The exceptions are: Italy, France & Switzerland (year ended March 1998) and the Netherlands (year ended March 1997).

the country. How will these affect the NFA/GDP ratio? A country which has a large labour force can make better use of a capital stock of given size than a country with a smaller labour force. Similarly, a country with a lot of natural resources can make better use of a given quantity of capital than a country with very few natural resources, as the capital can be employed in utilising the natural resources. Finally, a wealthy country is likely to diversify its wealth by investing in the capital stocks of other countries, while relatively poor countries are likely to import capital.

We used regression analysis to see if these variables can explain the variation in NFA positions across the 17 countries shown in figure 4. The regression explained national NFA as a proportion of GDP (NFA/GDP) as a function of natural resources per capita (NR/CAP) and GNP per capita (GNP/CAP). It explained about half the variation in NFA/GDP across countries (see figure 4)[15] and for New Zealand, predicted a large net foreign liability position of almost 90 per cent of GDP (not far from the actual ratio of around 95 per cent). More generally it seems that 'commodity' countries with substantial natural resources (New Zealand, Australia, Canada, and some Scandinavian countries) are all importers of capital. The results of the equation are reported below:

Predicted NFA/GDP
$= -82.7 + 3.3\ \text{GNP/CAP} - 1.1\ \text{NR/CAP}$ (4)
(2.0) (2.5) (1.6)
t-statistics in parentheses.
Adjusted $R^2 = 0.54$, Standard error = 0.25.

This analysis provides some preliminary support for our assumption that New Zealand's NFA/GDP ratio will stabilise near current levels (approximately 90 per cent of GDP). However, the results should be interpreted cautiously for a number of reasons. First, the standard errors around the estimate for New Zealand's NFA/GDP are wide. A two standard deviation confidence interval spans a region from around -45 per cent of GDP to -145 per cent of GDP. Second, there are substantial uncertainties about the accuracy of our estimates of

[15] Data on NFA per capita is sourced from the IMF, GNP per capita from the World Bank's *World Development Indicators*, and Natural Resources per capita from a World Bank environmental economics analysis (Kunte, Hamilton, Dixon & Clemens (1998)).

natural resources per capita (which come from a World Bank analysis). The estimate for New Zealand (USD 51,000 per capita) looks high[16] relative to those of Canada and Australia (USD 35-37,000 per capita) and those of most other countries (which are generally less than USD 10,000 per capita). A more reasonable assumption might be to set New Zealand's NR/CAP variable roughly equal to that of Canada and Australia (ie 35,000), and re-estimate the regression. When we do this, the equation predicts a NFA position for New Zealand of about -75 per cent of GDP (which implies a 'desired' capital account/current account balance of about 3.0 per cent of GDP, down slightly from our central assumption of 3.8 per cent).

Moreover, the approach we have used above is reasonably novel. In general, analysis of the desired capital account (Faruqee and Debelle in Isard and Faruqee ed (1998) is an example) has been conducted using cross-sectional (panel) regressions of the *capital account* on explanatory ratios such as the Government deficit, demographic factors, GDP per capita and the output gap. This analysis is similar to that in our regression above, but it uses different explanatory variables and explains the capital account (a flow) rather than the net foreign asset position (a stock). New Zealand-specific results using this model are not available, but the factors in the model suggest that it would predict a significant capital account surplus (current account deficit). New Zealand's young population and low level of GDP per capita, relative to other industrialised nations, would create scope for capital inflows. It would be useful to investigate New Zealand-specific results from the cross-country models in Faruqee and Debelle (1998).

Table 4 summarises our alternative estimates of the desired capital account. Because there is significant uncertainty about the desired capital inflow, in section 4.4 we consider a range of estimates in our MB model. We adopt the value consistent with the equilibrium NFA position in the RBNZ's FPS model (3.8 per cent) as a central estimate with alternative scenarios using 3.0 and 4.6 per cent. The low-end

[16] This is partly because New Zealand's substantial national parks are valued 'as-if' they were employed as arable farmland (an opportunity cost based valuation). This probably overstates the ability of that land to be utilised in New Zealand's 'production function' and hence overstates the ability of that land to justify higher capital inflows.

assumption of around 3 per cent implies that New Zealand will, in equilibrium, have greatly reduced its stock of foreign debt. Using equation 3, it is easy to show that a 3 per cent desired capital account balance implies an equilibrium NFA position of around -75 per cent of GDP. In order to reduce our net foreign liabilities to this level, we would need to run current account deficits considerably smaller than 3 per cent for a prolonged period. This is difficult to imagine at present, after the deficits of the last decade, but is certainly not implausible.

Table 4:
Estimates of New Zealand's desired capital inflow

Prediction based on	Prediction
FPS (RBNZ model) NFA/GDP assumption	3.8%
Predicted NFA/GDP from (4)	3.5%
Predicted from (4) with altered NR/CAP figure	3.0%

To complicate matters, it is also likely that the market view of the sustainable, or 'desired', current account may change over time. For example, to some extent New Zealand was 'flavour of the month' in the early to mid-1990s, and this encouraged substantial capital inflows. Similarly, the recent fall in our exchange rate is consistent with financial markets being less willing to maintain large New Zealand asset positions.

Ideally, then, we would like to quantify the swings in sentiment toward New Zealand, using a time series approach to estimate the desired capital account balance with suitable proxies (or instruments) for financial market sentiment regarding New Zealand as explanatory variables. For example, the risk premium on some classes of New Zealand assets, or the composition of capital inflows (the decline in non-resident bond holdings and foreign direct investment) may help to explain the deterioration in the currency (through lowering the desired capital account balance). This is a potential area for further research.[17]

[17] The difficulty of modelling sentiment is probably a primary reason why most exchange rate equations can only explain a small proportion of exchange rate fluctuations.

4.2 Step two: cyclically adjusting the current account

As discussed in section 2, an important step in using the macroeconomic balance model is determining the *underlying* current account balance. This involves estimating what the present current account balance would be if all cyclical or temporary influences on it were removed, and the exchange rate remained at its present level.

Table 5 summarises the steps we take to calculate the underlying balance. First we remove from the raw current account balance the influences of droughts[18] (step 1 in table 5) and large one-off imported items[19] (step 2). Next, we adjust the investment income balance (IIB) by smoothing the 'implied return' (step 3) on our net foreign liabilities, and we also smooth migrants' transfers (step 4).[20] These adjustments are designed to give us a truer picture of where the current account would be in equilibrium. The adjustments either involve removing one-offs that are unrelated to the trend current account position, or smoothing very volatile components (such as the investment income balance). The current account balance after adjusting for these factors is known as the 'adjusted' current account balance.

[18] To remove droughts and other rural supply shocks, we smooth agricultural, fishing, and food processing export volumes using an HP filter.

[19] The value of the two frigate imports is removed from the raw import data.

[20] To smooth investment income, we apply a 7 per cent per annum rate of return to the existing stock of net foreign assets rather than using the actual investment income data. Seven per cent was chosen as the rate of return because it was roughly the average return paid over the 1990s. To smooth transfers, we use an HP filter.

Table 5:
Calculation of adjusted and underlying current account (in % of GDP)

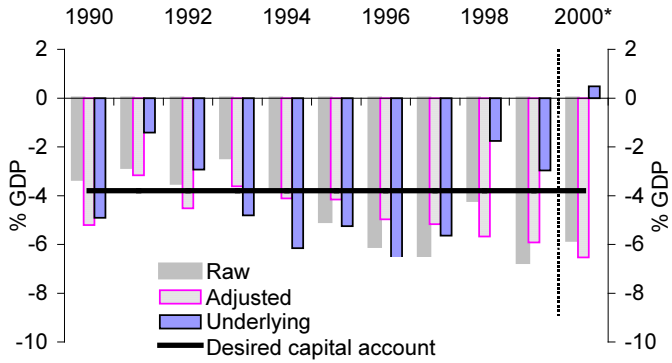
	Raw	(1) Export	(2) Imports	(3) IIB	(4) Transfers	Ad-justed	(5) Growth	(6) X Vol	(7) X Price	(8) M Vol	(9) M Price	Under-lying
1990	-3.3	-0.2	0.0	-1.7	0.0	-5.2	-0.6	1.0	1.0	0.0	-1.1	-4.9
1991	-2.8	-0.7	0.0	0.4	0.0	-3.2	-1.0	1.1	1.0	1.7	-1.1	-1.4
1992	-3.5	0.1	0.0	-1.2	0.1	-4.5	-1.0	1.0	0.7	1.7	-0.8	-2.9
1993	-2.4	0.3	0.0	-1.6	0.1	-3.6	0.2	-0.5	-0.6	-0.9	0.6	-4.8
1994	-3.8	-0.1	0.0	0.0	-0.1	-4.1	0.8	-1.1	-0.9	-1.8	0.9	-6.2
1995	-5.1	0.2	0.0	0.6	0.1	-4.2	0.8	-0.7	-0.5	-1.2	0.6	-5.3
1996	-6.1	-0.1	0.0	1.4	-0.3	-5.0	0.3	-1.2	-1.0	-2.1	1.2	-7.9
1997	-6.7	-0.3	0.6	1.2	0.1	-5.2	-0.2	-0.1	0.2	-0.1	-0.2	-5.6
1998	-4.2	0.2	0.0	-1.6	0.0	-5.7	-0.4	1.6	1.4	2.9	-1.6	-1.8
1999	-6.7	0.5	0.6	-0.4	0.1	-5.9	-0.1	1.1	1.2	2.1	-1.4	-3.0
2000[*]	*-5.8*	*-1.3*	*0.0*	*0.7*	*-0.1*	*-6.5*	*-0.2*	*2.8*	*2.2*	*4.6*	*-2.4*	*0.5*

* Data for the year 2000 is based on official Reserve Bank forecasts as published in the December 2000 Monetary Policy Statement.

The next step is to correct this 'adjusted' current account balance for the cyclical impact of the business cycle in New Zealand on imports, and that in our main trading partners (GDP-14) on exports (step 5). To do this we use the elasticities assumed in table 1 for the domestic and foreign output gap: a 1 per cent foreign output gap, for example, is assumed to improve exports by 1.5 per cent of GDP. Finally, we adjust for lagged exchange rate effects (steps 6 to 9). Steps 5 to 9 were performed using the calibrated model developed for this purpose by Bayoumi and Faruqee (1998). If the exchange rate had recently appreciated, the model would judge that the current account balance would deteriorate as the lagged effects of the exchange rate appreciation work their way through the economy. Thus the *underlying* current account deficit would be *larger* than the actual (or adjusted) current account deficit. The final result of all these adjustments is the *underlying* current account balance (shown in the final column of table 5).

Figure 5 charts three of the series from table 5 above: the actual (raw) current account balance, the adjusted current account balance, and the final underlying current account balance obtained from the Bayoumi and Faruqee model. The underlying current account is the current account balance the model predicts would occur if all cyclical influences were removed, and the exchange rate were to remain at the level at which it ended the year (technically, the December quarter average level).

Figure 5:
Current account balances: raw, adjusted and underlying

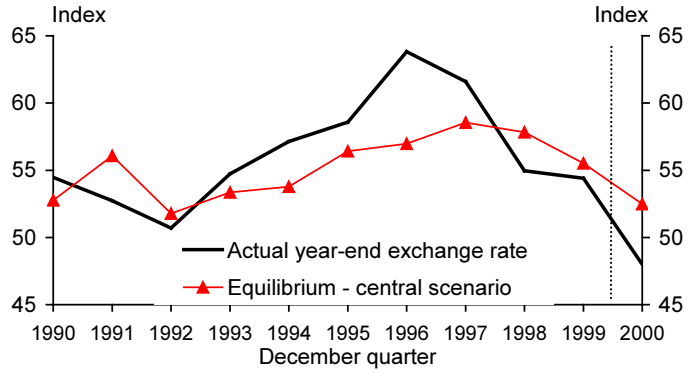


* Data for the year 2000 is based on official Reserve Bank forecasts as published in the December 2000 Monetary Policy Statement.

4.3 Step three: Macroeconomic balance estimates of fair value

In step 3 the desired capital account (from step 1) and the underlying current account (from step 2) are used to calculate the 'fair value', or *long run equilibrium* level of the New Zealand dollar. In step 1, we concluded that New Zealand's desired capital account probably lay between 3 and 5 per cent of GDP and we chose a central estimate of 3.8 per cent (with alternative scenario estimates of 4.6 and 3.0 per cent). Figure 5 and the final column of table 5 show the actual underlying current account we calculate for each of the last 10 years. Once we have these two pieces of information for each year, we calculate the equilibrium exchange rate (R* in figure 1) as the level of the exchange rate that would cause the underlying current account balance to equal the desired capital account balance. Figure 6 charts our resulting estimate of R*, together with the actual exchange rate since 1990. The figure plots December quarter values, and the December 2000 values are based on official Reserve Bank of New Zealand forecasts.

Figure 6:
New Zealand's exchange rate: actual and equilibrium (R*)[21]



The disequilibrium between R* and the actual exchange rate can be approximately related back to the gap between the underlying current account and the assumed desired level of the capital account balance. In years such as 1996, when the underlying current account deficit was larger than the desired capital account balance[22], our model suggests that the exchange rate at the end of that year must have been above its long run equilibrium level. Thus the model suggests that New Zealand's exchange rate at the end of 1996 was substantially overvalued, by around 10 per cent.

Since then, the actual exchange rate has depreciated considerably, and our measure of the equilibrium has also fallen. In contrast to 1996, 1999 was a year in which the underlying current account deficit was estimated to be 3.0 per cent of GDP - slightly *smaller* than 3.8 per cent. Thus, the model suggests that the exchange rate at the end of 1999 was approximately 2 per cent below equilibrium. Based on exchange rate data to date and Reserve Bank of New

[21] This figure uses December quarter average figures, and uses the IMF total competitiveness measure of the New Zealand exchange rate, rebased so that the value of the index is the same as the average level of the nominal TWI in the December 2000 quarter.

[22] Assumed in our baseline scenario to be 3.8 per cent.

Zealand forecasts for the current account in the year to December 2000, it seems likely that the disequilibrium in the New Zealand exchange rate has become greater. Using forecast data, we estimate that the exchange rate at the end of 2000 is undervalued by approximately 10 per cent.

How do we explain the fact that the 'equilibrium' estimate has varied over time, with a recent downward trend? Essentially the estimate of the 'equilibrium' real exchange rate moves in response to deviations between the estimated underlying current account deficit and the 'desired' (or sustainable) current account deficit. The extent of disequilibrium in the exchange rate, for a given disequilibrium between the underlying current account and the desired capital account, depends on the elasticity of the trade balance to the exchange rate. In the context of figure 1, this elasticity determines the slope of the underlying current account line.

Because we back out our estimate of equilibrium from the model's estimate of disequilibrium, when the current account balance deteriorates (or improves) differently to the model's predictions, the estimate of the 'equilibrium' exchange rate must be revised. Generally speaking, if an exchange rate depreciation is not followed by an improving current account balance, then the estimate of 'equilibrium' will be revised lower. Although the recent exchange rate depreciation has coincided with a very significant improvement in the projected underlying current account deficit for the year ended December 2000, the extent to which the exchange rate has depreciated—all else being equal—would have suggested an even *greater* improvement in the underlying current account balance. Thus, our preliminary projected estimate of *equilibrium* for the year ended December 2000 was revised down further, relative to our estimate for the end of 1999.

This example helps to explain the evolving profile of the equilibrium exchange rate depicted in figure 6. During the appreciation of the exchange rate between 1992 and 1996 the actual current account balance deteriorated by less than the model predicted, resulting in a gradual upward evolution of the equilibrium exchange rate. The reverse has happened since; the exchange rate depreciation after 1997 was not (at least initially) followed by as large an improvement

in the current account balance as expected. At the end of 1999, the underlying current account balance (-3.3 per cent) was higher than the desired value (-3.8 per cent), so the model suggests the currency was slightly undervalued (by 3 per cent, which corresponds to fair value (at the end of 1999) of 53 US cents, or 56 on a TWI basis).

Looking forward, the next revision to equilibrium could go in either direction. If the actual current account balance improves by more than anticipated then the equilibrium will be revised upwards. Alternatively, if the current account disappoints, then the equilibrium could be revised down further. In future we hope to extend this analysis in two ways. First, we would like to incorporate more forecast data to see how the equilibrium will evolve based on our forecasts. Second, we would like to undertake more sensitivity analysis of the lag structure with which the exchange rate is assumed to affect the trade balance.

According to our model, the fair value for the NZD has fluctuated in a range over the 1990s which corresponds to a TWI between around 52 and 59. This is a tighter range than that seen in the actual TWI, which has been in a range of around 46 to 68 over the same period when measured on the same basis. The fluctuation in fair value reflects the MB model's evolving judgement about what exchange rate is necessary to equate the current account deficit to the desired capital account.

4.4 Some sensitivity analysis

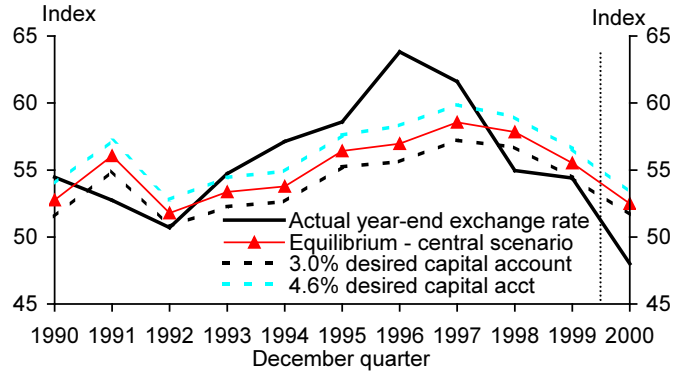
The macroeconomic balance model provides a framework for calculating the approximate fair value of the New Zealand dollar, based on a range of assumptions. In this section, we check the sensitivity of our results to the assumptions we make in two areas: the size of the desired capital account, and the elasticity of the trade balance with respect to the exchange rate.

Alternative assumptions about the desired capital account

As discussed in section 3.1, our central scenario assumes that the desired capital account is 3.8 per cent of GDP. In figure 7, we adjust our central estimate by +/- 0.8 percentage points, which gives 3.0 and 4.6 per cent, and recalculate equilibrium. This does not

significantly alter our fair value estimates - the range (shown by the dotted lines) around our central estimate for the equilibrium exchange rate is only about 5 per cent. Hence, we conclude that our results are not particularly sensitive to the desired capital account assumption.

Figure 7:
Equilibrium exchange rate under alternative assumptions about the Desired Capital Account



Intuitively, it makes sense that our results are not particularly sensitive to the assumptions about the desired capital account because, by recalibrating the price elasticities in the model, we have assumed that the trade balance reacts reasonably responsively to shifts in the exchange rate. In the context of figure 1 or 2, we have assumed that the underlying current account line is reasonably flat, so shifts in the desired capital account line do not greatly alter the equilibrium exchange rate. This contrasts with the results from macroeconomic balance style models for larger industrialised countries, using the standard IMF assumptions, where the underlying current shifts in the desired capital account can alter equilibrium significantly.[23]

[23] See for example Bayoumi, Clark, Symansky & Taylor (1994).

Alternative assumptions about the elasticity of the trade balance to the exchange rate

We find that our results are much more sensitive to the assumptions about the elasticity of the trade balance to the exchange rate. Based on the alternative assumptions summarised in table 3, the charts below show the central scenario estimate of equilibrium along with the alternative estimates we obtain using the different assumptions about the elasticity of the trade balance to the exchange rate.

Figure 8 illustrates that when the elasticity of the trade balance with respect to the exchange rate is reduced to the level assumed by the IMF in Isard and Faruqee (eds) (1998), the model produces quite volatile predictions for fair value of the New Zealand exchange rate. Intuitively this volatility stems from the unresponsiveness of the trade balance to the exchange rate. The exchange rate needs to move a long way to cause the current account deficit to shift towards the desired. In contrast, in the very responsive trade balance scenario depicted in figure 9, the fair value estimates do not change so much relative to the central scenario.

Figure 8:
Actual and equilibrium exchange rate: central scenario vs IMF assumption

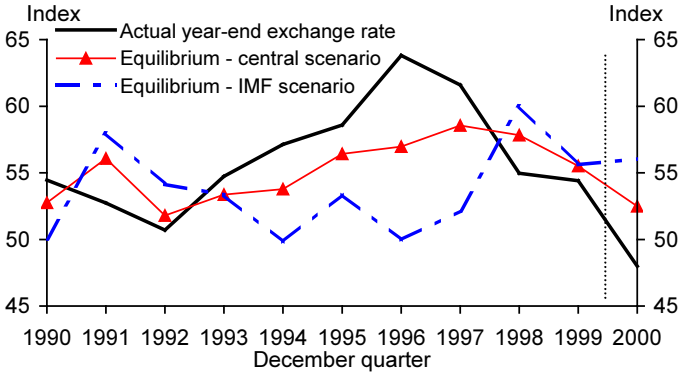
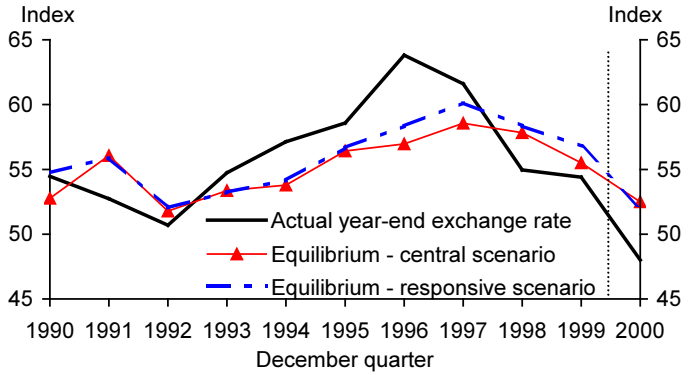


Figure 9:
Actual and equilibrium exchange rate: central scenario vs more elastic trade balance assumption



To summarise, our sensitivity analysis shows that our results are not highly sensitive to the desired capital account we have chosen. The elasticity of the trade balance to the exchange rate is a more crucial assumption. In particular, our sensitivity analysis has shown that our results become quite unstable if we select a significantly lower elasticity.

5 Conclusions

Using the macroeconomic balance model, we estimate the 'fair value' of the New Zealand dollar over the past 10 years. The model is calibrated in several ways to reflect the specific characteristics of the New Zealand economy. For example, we use elasticities that take into account the predominantly commodity-based nature of New Zealand's exports, as well as the incomplete pass-through of the exchange rate to import prices.

The estimate of fair value for the exchange rate is backed out from the model's estimate of disequilibrium between the underlying current account and the desired capital account. As a result, the model produces an evolving profile of the equilibrium exchange rate.

Over the 1990s the model estimates that the fair value for the TWI fluctuated between 52 and 59. At the end of 1999 our baseline scenario suggests that the long-run fair value equilibrium was around 56 on a TWI basis, implying that at that point the currency was approximately at fair value. Looking forward, the next revision to equilibrium could go in either direction, depending on a number of factors, but primarily on the future path of the current account balance.

While these results seem plausible, we emphasise a number of caveats. One important caveat to our assessment is the model's dependence on a large number of calibrated parameters and estimates of variables such as the 'desired' capital account. While we have shown that our baseline results are not too sensitive to one of the most uncertain variables (the desired capital account), the other assumptions ensure that our overall uncertainty is still substantial.

A second caveat is the fact that the methodology is based on the assumption that our current level of tradable sector competitiveness (our relative productivity, and the level of our terms of trade) will not change during the transition to equilibrium. If New Zealand's competitiveness is currently higher or lower than the level it is likely to settle at in the medium term, then our equilibrium exchange rate is also likely to change.

Finally, we acknowledge that modelling exchange rates and deriving accurate measures of equilibrium exchange rates is exceptionally difficult. While this paper takes one specific approach to obtain an estimate of equilibrium, it is useful, and indeed necessary, to evaluate this estimate in the context of a variety of different approaches and techniques. A forthcoming discussion paper will discuss alternative estimates based on the concept of Purchasing Power Parity (see Brook & Hargreaves (2001)).

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Appendix

This appendix proves the simple decomposition of the elasticity of the trade balance to the exchange rate discussed in the text.

We can write the trade balance as:

$$TB = PX.X - PM.M \tag{A1}$$

Where PX and PM are domestically denominated export and import prices, and X and M are export and import volumes.

Normalise the nominal exchange rate to one and differentiate A1 with respect to it:

$$dTB/dE = PX\frac{\partial X}{\partial E} + X\frac{\partial PX}{\partial E} - PM\frac{\partial M}{\partial E} - M\frac{\partial PM}{\partial E} \tag{A2}$$

Rearrange and add some E terms (since the exchange rate was normalised to one):

$$dTB/dE = PX.X\left(\frac{\partial X}{\partial E}\frac{E}{X} + \frac{\partial PX}{\partial E}\frac{E}{PX}\right) - PM.M\left(\frac{\partial M}{\partial E}\frac{E}{M} + \frac{\partial PM}{\partial E}\frac{E}{PM}\right) \tag{A3}$$

The terms inside each set of brackets are elasticities:

$$dTB/dE = PX.X\left(\varepsilon_{X,E} + \varepsilon_{PX,E}\right) - PM.M\left(\varepsilon_{M,E} + \varepsilon_{PM,E}\right) \tag{A4}$$

(-) (-) (+) (-)

Here we simplify the algebra by assuming the trade balance is initially in balance (ie PX.X = PM.M). This can easily be generalised and in the actual macroeconomic balance model we do not make this assumption. Since the elasticity of export volumes, export prices and import prices to the exchange rate will be negative, and the elasticity of import volumes to the exchange rate will be

positive, we can take absolute values of the elasticity terms and rearrange to get:

$$dTB/dE = -PX.X\left(|\varepsilon|_{X,E} + |\varepsilon|_{M,E} + |\varepsilon|_{PX,E} - |\varepsilon|_{PM,E}\right) \qquad \text{(A5)}$$

Dividing through by Y (output) gives the equation shown in the text:

$$\frac{dTB/dE}{Y} = \frac{-PX.X}{Y}\left(|\varepsilon|_{X,E} + |\varepsilon|_{M,E} + |\varepsilon|_{PX,E} - |\varepsilon|_{PM,E}\right) \qquad \text{(A6)}$$