Essays on the Current Account, Consumption Smoothing, and the Real Exchange Rate

by

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Abstract

The first two essays of this thesis are empirical studies of the behavior of the current account that test different aspects of the theory of consumption smoothing implied by standard intertemporal representative agent models. The first essay is titled, *The Response of the Current Account to Terms of Trade Shocks: A Panel Data Study.* This essay demonstrates that the response of the current account depends on the degree of persistence of shocks. The estimation procedure uses the fact that the persistence of the Terms of Trade varies greatly across countries. Countries with the least persistent TOT shocks exhibit a positive relationship between TOT shocks and the current account; countries with the most persistent TOT shocks exhibit a negative relationship.

The second essay is titled, *The Current Account, Consumption Smoothing and Credit Constraints.* I focus on the large and persistent Australian current account deficits from 1951 to 1995. The failure of the consumption smoothing hypothesis over the full sample is consistent with credit constraints. There was a significant increase in the degree of consumption tilting after capital market liberalisation in 1983. Also, the current account responds asymmetrically to positive and negative shocks to Net Cash Flows. That is, consumers smooth consumption optimally during times of high NCFs, but credit constraints prevent optimal smoothing during times of low NCFs.

The third essay is titled, *Effective Real Exchange Rates and Irrelevant Exchange Rate Regimes*; it is joint work with Rafic Naja. There is strong evidence that the short-term variance of the bilateral Real Exchange Rate is significantly higher under floating nominal exchange rate regimes than under fixed regimes. However, we show that the short-term variance of the effective RER displays no systematic difference across nominal exchange rate regimes. This result is based on 27 low inflation and stable growth rate countries from 1978 to 1992. Our study benefits from variation in the timing of regime switches across different countries. In part the result is due to the fact that effective RERs are an average of bilateral RERs.

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I dedicate my thesis to the memory of Alys Kent and Allan Poole.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

The first two essays of this thesis present empirical evidence on the implications of the standard intertemporal model of consumption smoothing. Variants of this model are the mainstay of current theoretical and empirical analysis of the behavior of the current account balance. One prediction of these models is that the response of the current account to a shock will depend on the persistence of this shock. The first essay tests this hypothesis by making use of the fact that the persistence of terms of trade shocks varies greatly across countries. The second essay provides a more general test of the consumption smoothing hypothesis. It focuses on the role of credit constraints in determining the behavior of the current account. A simple test of the existence of credit constraints is developed by allowing for an asymmetric response of the current account to good and bad shocks.

The third essay is joint work with Rafic Naja and is unrelated to the first two essays. In this essay we re-examine the link between nominal exchange rate regimes and the Real Exchange Rate (RER). In contrast to the existing literature, we focus on the behavior of the effective RER. Also, we make use of a newly compiled data set on nominal exchange rate regimes across a much larger set of countries.

The Response of the Current Account to Terms of Trade Shocks: A Panel Data Study

This essay uses a large panel data set to examine the dynamic relationship between the current account balance and the terms of trade. I develop a very simple representative agent model of intertemporal optimization with two goods. I use this model to illustrate an important hypothesis which is a common feature of models of this type. Namely, the response of the current account to a shock will depend on the degree of persistence of that shock. In particular, I show that a terms of trade shock can have a positive or negative effect on the current account, depending on both the direction and *duration* of the shock. There are two opposing effects to consider. The consumption smoothing effect implies a positive correlation between the current account balance and the terms of trade, while the investment effect implies a negative correlation. However, the consumption smoothing effect should dominate for more transitory shocks and the investment effect should dominate for more persistent shocks. Results are consistent with this standard theory. Countries with the least persistent terms of trade shocks exhibit a positive relationship between terms of trade shocks and the current account; countries with the most persistent terms of trade shocks exhibit a negative relationship. Results are robust to attempts to control for productivity shocks and changes in the government fiscal balance.

The empirical analysis begins by counting episodes of large terms of trade changes over a two year period and the associated change in the current account. The results show that many countries experience large positive and negative correlations between the terms of trade and the current account. This is consistent with the fact that shocks will be neither entirely temporary nor entirely permanent. To derive more specific results, I compare results for two sub-samples of countries. These groups are chosen to represent the two extremes at either end of the spectrum of terms of trade persistence. A comparison of the average number of positive and negative correlation episodes for these two groups is consistent with the theory. Specifically, those countries with the least persistent terms of trade have more episodes of positive correlation and less episodes of negative correlation (relative to countries with the most persistent terms of trade).

Panel data regressions demonstrate that the current account response is positively related to the terms of trade for countries with predominantly temporary terms of trade shocks and negatively related for countries with predominantly permanent terms of trade shocks. Moreover, the response of the current account for these two smaller country groups is shown to be significantly different from the response estimated across the full sample of countries.

The Current Account, Consumption Smoothing and Credit Constraints

This essay uses an empirical approach that was developed by others to test the permanent income theory of consumption and savings. The model is of an open economy with free capital mobility. The theory implies that the current account deficit will be equal to the net present value of expected future changes in Net Cash Flows (that is, GDP net of investment and government expenditure). For example, if the NCF is expected to be rising in the future this will lead to a current account deficit today in order to smooth consumption. The advantage of this theory is that it does not require an explicit formulation of the underlying process that generates changes in NCFs.

Australia provides an interesting case to test the theory of optimal consumption smoothing for a number of reasons. Australia has run a large and persistent current account deficit for most of the previous 50 years. There is an ongoing debate within Australia regarding both the sustainability and optimality of the current account deficit. Reasonable data is available for all of this period, which includes an interesting episode of particularly large changes in the current account and NCFs around the time of the Korean War. Until the early 1980's, Australia had a relatively closed capital market and a repressed domestic financial market. Thus, it seems likely that a significant proportion of the population was subject to some degree of credit constraints. The complete opening of the capital market in 1983 led to the doubling of the average level of the current account as a fraction of GDP and a rapid accumulation of net foreign liabilities.

The essay outlines a standard intertemporal model of an unconstrained representative agent. Theory implies that the current account can be decomposed into a non-stationary consumption tilting component and a stationary consumption smoothing component. A major focus of the paper is on the effect of the significant capital market opening and completion of financial deregulation that occurred in 1983. I show that this liberalisation did indeed lead to a significant increase in the degree of consumption tilting, which is consistent with increased access to credit. The hypothesis of consumption smoothing is rejected for the full sample period from 1950 to 1995, but not for the latter half of the sample which begins in 1974. Although, the result from the period 1974 to 1995 is indicative of a reduction of credit constraints, this can not be attributed exclusively to the liberalisation that occurred in 1983 (almost 10 years after 1974). Unfortunately, the sample period since liberalisation is too short for estimation purposes.

Using an alternative approach I am able to provide more convincing empirical evidence of credit constrained behavior. I illustrate how credit constraints imply an asymmetric response of the current account between good and bad times. By allowing for this asymmetry in the estimation process, I demonstrate that consumers are able to completely smooth consumption when net cash flows are high, but not when net cash flows are temporarily low.

Effective Real Exchange Rates and Irrelevant Exchange Rate Regimes

The third essay is joint work with Rafic Naja. We show that there is no systematic effect of the nominal exchange rate regime on the short-term variance of the effective Real Exchange Rate. This is in stark contrast to the existing literature in this area, which focuses on the behavior of bilateral RERs. Our finding for effective RERs, helps to explain why other researchers have been unable to find any systematic impact of the nominal exchange rate regime on macroeconomic variables other than the bilateral RER.

We use a newly compiled monthly data set on nominal exchange rate regimes across a set of 90 countries. This is gives us an advantage over previous studies which typically rely solely on the collapse of the Bretton Woods system to delineate between nominal exchange rate regimes. Instead, our data set has variation in the timing of regime switches across different countries, and it post-dates the Bretton Woods era.

We begin our analysis by presenting Mussa's classic result for industrialized countries during and after the Bretton Woods system. The variance of short-term changes in the *bilateral* RER is shown to be about 12 times higher under a flexible exchange rate regime than under a fixed exchange rate regime. However, using the same set of countries and the same regime classifications, we show that the short term variance of the *effective* RER is only about 2 times higher under a flexible exchange rate regime than a fixed regime.

However, using our more recent sample period, and a broader sample of countries, we show strong evidence that there is no systematic difference in variance of the effective RER across nominal exchange rate regimes. This result is based on a set of 27 low inflation and stable growth countries. Inflation and growth performance are used to exclude countries from the sample for which we would expect volatile RER behavior irrespective of the nominal exchange rate regime. Also, countries with high inflation experiences will likely to be unable to commit to a fixed exchange rate for an extended time.

In part, our findings may be related to the fact that a fixed exchange rate regime under Bretton Woods is likely to be very different from a fixed exchange rate regime post-Bretton Woods. That is, the variance of a country's effective RER under a fixed exchange rate regime, is likely to depend on the number of other major trading partners that are also in a fixed regime. Also, because the effective RER is an average of bilateral RERs, it is natural to expect that it will have a lower variance than any of its component bilateral RERs.

Chapter 2

The Response of the Current Account to Terms of Trade Shocks: A Panel Data Study

2.1 Introduction

A standard intertemporal representative agent model with a non-durable good and no investment predicts that a temporary positive shock to income will lead to an improvement in the current account. Similarly, if there are no borrowing constraints, a temporary negative shock will lead to a fall in the current account. Hence, this classical model of consumption smoothing predicts a positive correlation between temporary income shocks and the current account. Ghosh and Ostry (1992) provide some evidence that this is true for a few industrialized countries (in particular, the US). Tornell and Lane (1996) describe a political economy model that under certain conditions predicts a negative correlation between temporary income shocks and the current account. They provide evidence of a few cases of large temporary positive shocks to the terms of trade that lead to falls in the current account.

However, the effect of investment works in the opposite direction to the consumption smoothing effect. If there is a shock to productivity or to the terms of trade, there will be an incentive to alter the capital stock. The longer the duration of the shock, the greater the change in the capital stock. A purely transitory shock will have no investment effect. A permanent shock will have a strong investment effect. The response of investment to shocks feeds directly into the current account.

In periods following productivity or terms of trade shocks, the current account can move in the opposite direction to the shock if the investment effect dominates the consumption smoothing effect. This is more likely the longer the duration of the shock. The implications of this basic theory can be tested by using the fact that the persistence of shocks to the terms of trade varies greatly across countries.

This chapter provides evidence on the dynamic behavior of the current account for a very large sample of countries. The objectives of the chapter are as follows:

- To evaluate the frequency of the different types of dynamic responses of the current account across a large sample of countries.
- To determine if the investment effect dominates the consumption smoothing effect in countries which have more persistent terms of trade shocks.[1]

The chapter is organized as follows. Section 2.2 presents a summary of the basic model and a brief review of the literature. Both terms of trade and productivity shocks are considered. Productivity shocks are predicted to have a negative relationship with the current account because they are typically very persistent and, hence, involve only the effect of investment. However, terms of trade shocks display a range of persistence across countries and, therefore, could have either positive or negative effects on the current account.

Sec`'on 2.3 outlines and provides results from the first of two different but complimentary methodologies. The key to the first approach is to define and then identify various episodes. An episode will be a large shock to the terms of trade which is followed by some response of the current account - whether it is positively or negatively correlated, or

1 If investment involves significant fixed costs, then a large temporary shock to the terms of trade should have a different effect from a small temporary shock. I do not consider this possibility, but leave it for future research.

even uncorrelated. There are a number of problems which are addressed, including: the issue of stationarity of the data; the existence of trends in the data; and the window of time allowed for an episode. This approach allows the identification of episodes of negative correlation even within countries for which the consumption smoothing effect tends to dominate the investment effect more often than not. The other advantage of this approach is that it can include countries with only a short period of current account and terms of trade data.

Section 2.4 presents a regression analysis of panel data to estimate the responsiveness of the current account balance to the terms of trade. This approach can control for the effects of productivity shocks and allows for an unrestricted dynamic framework. The main objective of this section is to determine if and how the relationship varies across different groups of countries. Countries are separated into groups according to the degree of persistence of shocks to their terms of trade.

The implications of credit constraints and of government fiscal policy are briefly considered in Section 2.5 before some concluding remarks.

2.2 Theoretical Framework and Literature Review

This section begins with a description of a general classical model of the current account which emphasizes two important effects: the consumption smoothing effect and the investment effect. Later in this section, the implications of this model are compared with those of alternative models by way of a brief review of the existing literature.

2.2.1 A Simple Model of the Current Account and the Terms of Trade

The model is a small open economy facing a given world interest rate. The economy consists of a single infinitely lived representative agent. The agent is assumed to supply one unit of labor inelastically. The agent's problem is to choose the path of investment and consumption so as to maximize lifetime utility, which is given by

$$U = \sum_{t=0}^{\infty} \frac{u(c_t)}{(1+\delta)^t} \tag{2.1}$$

where c_t is consumption at time t, δ is the is the agent's rate of time preference $u(\circ)$ is a time separable utility function with the usual properties, that is, $u' > 0$ and $u'' < 0$. Uncertainty is unnecessary for the basic results and so it is not incorporated into the model.[2]

There are only two goods in this model, an import good and an export good. The agent consumes only the import good, and the export good is the only good produced domestically. The price of imports is normalized to one, and the price of exports is p_t. Hence, the terms of trade are also equal to p_t. Exports, y_t, are produced according to the following production function

$$y_t = A_t f(k_t) \tag{2.2}$$

where k is the level of the capital stock; also, $f' > 0$ and $f'' < 0$. The unit price of capital is fixed and equal to one (by the appropriate choice of units).

The law of motion of the capital stock is based on the assumption that investment in this period, i_t, only feeds into the capital stock next period:

$$k_{t+1} = k_t + i_t \tag{2.3}$$

This assumption captures the idea that it takes time for a shock this period to be observed and time for the capital stock to adjust (but it is not crucial to the results). The depreciation rate on capital is set to zero for simplicity.

The agent can borrow or lend on the world capital market at the fixed interest rate $r_t = r$ (denominated in units of imports). The agent's dynamic budget constraint is therefore

$$\Delta b_{t+1} = rb_t + p_t y_t - c_t - \Delta k_t \tag{2.4}$$

2 Uncertainty is discussed later in the chapter when it becomes relevant to the estimation methodology.

where b_t is the stock of net foreign assets at the beginning of time period t and Δ is the first difference operator. Equation (2.4) is also the definition of the current account balance which is the change in net foreign assets, Δb_t.[3]

The steady state optimal level of the capital stock when $p_t = p$ and $A_t = A$, for all t, is given by equating the marginal value product of capital to the world interest rate:

$$pAf'(k) = r \tag{2.5}$$

In this very simple model, shocks to the terms of trade have exactly the same effect as productivity shocks. Specifically, the elasticity of the capital stock with respect to the terms of trade is equal to the elasticity of the capital stock with respect to productivity

$$\frac{\partial k}{\partial p}.\frac{p}{k} = \frac{\partial k}{\partial A}.\frac{A}{k} = \frac{-f'}{kf''} > 0 \tag{2.6}$$

A more realistic model would have more than one sector producing goods. In the case of a positive terms of trade shock, the export sectors would expand and the import competing sectors would contract (non-traded sectors could go either way). In such a model, an increase in the terms of trade would have less of an impact on investment than an equal percentage increase in productivity (across all sectors). However, so long as a positive terms of trade shock leads to an aggregate increase in investment, the results that follow will still hold qualitatively.

In this model, the response of investment is dependent on the duration of the shocks. There is insufficient time to observe and then respond to a purely transitory unanticipated shock (that is, a shock that lasts for only one period). However, for more persistent shocks, investment will respond according to equation (2.5). The investment effect by itself leads to a negative correlation between the shock and the current account in the period that the shock is observed.

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3 Also there is the transversality condition, $\lim_{t \to \infty} \frac{b_t}{(1+r)^t} = 0$, which prevents the agent from building up

In reality, the response of investment may be delayed and more drawn out than is implied by this simple model.[4] This could be due to a number of factors that may exist in the real world, including: delayed learning about the true nature of a shock; quadratic costs of adjusting the capital stock; and time to install and remove capital equipment (see Glick and Rogoff 1995 and Obstfeld and Rogoff 1996).

The other choice variable in the agent's maximization problem, besides investment, is the level of consumption in each period. Consumption behavior is determined by the Euler equation of this problem:

$$\frac{u'(c_{t+1})}{u'(c_t)} = \frac{1+\delta}{1+r} \tag{2.7}$$

I assume that $\delta = r$ for expositional purposes. Given the assumption of strict concavity of the within period utility function, this implies a flat consumption path.[5] Consumption will be equal to the level of permanent income, namely

$$y_t^p = r\left[b_t + \sum_{j=t}^{\infty} \frac{p_j y_j}{(1+r)^{j-t}}\right] \tag{2.8}$$

The consumption smoothing effect is simply that consumption equals permanent income and, therefore, any differences between permanent and current income are reflected in the current account balance.[6]

The effect of a shock is best illustrated by a simple example. If $p_t = p$ and $A_t = A$ are constant, then permanent income will equal actual income and the current account will be

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debt to levels so high that it can only be financed by rolling over the debt by further borrowing.

4 Also, consumption may not adjust instantaneously to shocks, although I ignore this here by presuming that consumption responds more rapidly than investment.

5 With $\delta \neq r$ the consumption path has a trend. The current account will also exhibit a trend except for the special case where the path of A_t and p_t imply the same trend for both consumption and income. These possibilities are dealt with in the empirical section of this chapter by detrending all of the series.

6 Actual income is equal to the sum of interest income on net foreign assets and export income, $rb_t + p_t y_t$.

equal to zero. Starting from this initial steady state at time $t = 0$, consider a shock to either productivity and/or the terms of trade as follows

$$p_t A_t = \begin{cases} pA(1+\varepsilon) & for \quad t = 0, 1, \ldots, \tau \\ pA & for \quad t = \tau + 1, \tau + 2, \ldots \end{cases} \tag{2.9}$$

Consider a positive shock, $\varepsilon > 0$ (although the argument is symmetric for negative shocks).[7] There are three cases to consider depending on the persistence of the shock.

(i) The shock is **permanent,** $\tau = \infty$.

Investment increases today, but the capital stock does not reach its new level until the following period. Hence, current income rises today but by less than permanent income. The consumption smoothing effect leads to a current account deficit today. The investment effect also causes a current account deficit in the same period that the shock is realized. (A small current account surplus in all future periods ensures that the intertemporal budget constraint is satisfied.)

(ii) The shock is **purely temporary,** $\tau = 0$.

There is no investment effect because there is not enough time to react to the shock. Current income rises by more than permanent income and so the consumption smoothing effect implies a current account surplus at the time of the shock.

(iii) The shock is **temporary** but **persistent,** $0 < \tau < \infty$.

Now permanent income rises by less than current income.[8] The consumption smoothing effect leads to a current account surplus in all periods from $t = 0$ to τ.

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7 It is possible that a persistent large negative terms of trade shock could lead to significant investment in an industry which had so far been relatively minor - for example, the first oil shock could have led to significant investment (and hence current account deficits) to exploit previously untouched oil resources. However, this did not appear to be relevant for any of the countries with very persistent terms of trade shocks (see Section 2.4.3).

8 Although this need not be the case for a very persistent shock. In this case, at time $t = 0$, it could be that the one period delay in the capital stock adjustment means that current income is less than permanent income, in which case the story is much like in the case where $\tau = \infty$.

The magnitude of the consumption smoothing effect is decreasing with higher persistence, τ , because permanent income is closer to current income, the greater the persistence of the shock.

The investment effect leads to a current account deficit in the period that the shock occurs. The net effect of consumption smoothing and investment depends on the degree of persistence of the shock. For less persistent shocks, the consumption smoothing effect will dominate and there will be a positive correlation between the shock and the current account (in the period of the shock). For some degree of persistence, the two effects will cancel each other out. At higher degrees of persistence, the investment effect will dominate and there will be a contemporaneous negative correlation between the shock and the current account.

The key to this chapter is to use the differences in terms of trade persistence to identify two groups of countries, namely, those with more temporary shocks for which the consumption smoothing effect should dominate and those with very persistent shocks for which the investment effect should dominate.

2.2.2 Literature Review

Obstfeld and Rogoff (1995) provide an extensive review of the recent theoretical and empirical literature on the intertemporal approach to the current account. They discuss that the response of the current account to shocks depends on persistence, but they do not present any direct evidence regarding persistence.

There are a number of studies which test the consumption smoothing hypothesis directly, including Otto (1992), Ghosh (1995) and Ghosh and Ostry (1995). The theory used in these studies is consistent with that shown in Section 2.2.1 above. The current account is shown to depend on the future path of Net Cash Flows (GDP net of investment and government expenditure). However, the empirical analysis does not require an explicit formulation of the dynamic process that generates changes in NCFs. Therefore, this literature overlooks the role played by the degree of persistence in the underlying shocks. Chapter 3 contains a more detailed discussion of this alternative approach.

Ghosh and Ostry (1992) present a model which they use to test for consumption smoothing using quarterly data on the United States, Japan, the United Kingdom and Canada. Their model highlights the role of uncertainty in generating precautionary savings, and they find some support for this in the data.

Glick and Rogoff (1995) incorporate the investment decision explicitly in their structural estimation of a simple current account model. Their model only contains one good and so they restrict themselves to looking only at productivity shocks. They estimate their model using 30 years of annual data from the G7 countries. The exogenous shocks they examine are Solow residuals for the manufacturing sectors of these countries. They show that these productivity shocks are highly persistent (they cannot reject the null hypothesis of a unit root in the levels of the Solow residuals) and then estimate that there is a significant negative relationship between the first difference in the Solow residual and the first difference in the current account balance.[9] This result is consistent with both their model and mine. However, they have nothing to say about the effects of less persistent shocks.

Backus, Kehoe and Kydland (1994) describe the correlation between the terms of trade and the trade balance across industrialized countries that is consistent with the findings of this chapter. They model this fact as an endogenous response of the terms of trade to changes in investment following productivity shocks; they do not discuss the possibility of optimal tariffs (which is not an issue in this essay because I treat the terms of trade as exogenous).

Tornell and Lane (1996a and 1996b) show how a model of a dynamic game between competing fiscal claimants can explain negative correlations between the current account balance and very temporary shocks to the terms of trade for a small set of countries. This

9 The productivity shocks can be decomposed into the country specific shock and the common world shock. They find that this latter component has no effect on the current account which is consistent with theory.

possibility is discussed later in the essay as a possible alternative explanation of the results.

2.3 Counting Episodes

This section of the chapter provides a preliminary look at the data and identifies the relative frequency of episodes of positive and negative correlations between the current account and the terms of trade at frequencies of one or two years. The statistics provided below show that the current account does not always respond to the terms of trade in a standard consumption smoothing fashion. The methodology used to identify episodes of correlation between the current account and the terms of trade is complementary to the regression results of Section 2.4 because it does not suppose that changes in the terms of trade within a country are always either entirely temporary or entirely permanent.

2.3.1 Data Description

The data are from various sources - full details are provided in Appendix A.2. Series are annual from 1960 to 1994, although many countries have much shorter sample periods. I have included 128 countries in my sample. The countries are listed in Appendix A.1 at the end of the chapter. The two variables introduced in this section are the current account balance (as a proportion of GDP) and the terms of trade. The terms of trade is constructed from the ratio of export to import price indices when these are readily available, otherwise they are based on export and import unit value indices or on estimates provided by the World Bank. Despite the less than ideal data for some countries there is no reason to expect any systematic bias in the terms of trade series.

I leave a discussion of the important issue of stationarity of the data until the actual estimation of the econometric model. At this stage, it is sufficient to point out that many countries in the sample appear to have non-stationary terms of trade. This is dealt with in this section of the chapter by taking first differences of the current account and the terms of trade to remove trends and ensure that the comparison is between variables that are integrated of the same order (that is stationary, or I(0) variables).

The precise nature of these transformations are as follows:

- The terms of trade index for each country was transformed by demeaning the annual growth rate of the series; and

- The current account (as a percent to GDP) was transformed by demeaning the first difference of the series.

2.3.2 Episodic Approach

For each country I calculated two correlations: first, the contemporaneous correlation between the current account balance and the terms of trade, and second, the same correlation but with the terms of trade lagged by one year. The lagged correlation allows for the possibility of a delayed or slow response of the current account balance to changes in the terms of trade.[10] The average of these correlations across all countries in the sample are 0.21 and -0.15 respectively. For countries which had negative correlations (both contemporaneous and lagged), it is most often the lagged correlation that is larger in absolute value.

These results show that some countries do experience negative correlations between the current account balance and the terms of trade. However, even within countries that display a positive correlation, there may still be episodes within the sample period where the current account moves counter to the consumption smoothing theory during a shock to the terms of trade.

There are a total of 3043 observations in the sample. For each country, I calculated the sample standard deviations of the transformed current account balance and the terms of

10 If the net real trade balance does not react contemporaneously to a rise in the terms of trade, the current account will automatically rise; that is, a positive contemporaneous correlation will occur if there is no instantaneous response of trade volumes.

trade. For the terms of trade, absolute changes in excess of one standard deviation occur for 828 of the total observations; this is split half and half between positive and negative changes. The first set of results is based on the following question:

What happens to the current account balance in years when the terms of trade changes by more than one standard deviation? Within this set of observations there are six possibilities. These are shown in Table 2.1. The terms of trade changes are either positive or negative. The changes in the current account are either positive or negative (greater than one standard deviation) or small (the row labeled "Zero..." contains changes less than one standard deviation in absolute value). The two shaded boxes in the table represent negative correlations between the terms of trade and the current account balance.

Table 2.1: Number of Observations with Changes in the TOT and the CAC Greater than One Standard Deviation

	Positive TOT	Negative TOT	
Positive Current A/c	**74** (9%)	**35** (4%)	
Zero Current A/c	**310** (37%)	**282** (34%)	
Negative Current A/c	**38** (5%)	**89** (11%)	**Total**
			828

Almost 30 per cent of the large changes in the terms of trade are associated with large changes in the current account balance and not quite one third of these are negative correlations.

Table 2.1 only captures high frequency changes. The following extension allows the current account a longer time to respond to changes in the terms of trade.

First, observations which have two years of either consecutive rises or consecutive falls in the terms of trade are identified. This set of observations is further reduced by keeping only those observations for which the change in the terms of trade over the two years is larger in absolute value than one standard deviation. The response of the current account balance during each two year period is then recorded. Again there are six possibilities, as shown in Table 2.2 below. If the sum of the changes in the current account are more than one standard deviation in absolute value, the observations are recorded in either the row for positive or the row for negative current account changes; otherwise, the change in the current account is considered small and is included in the row for zero current account change. The negative correlations are shaded as before.

Table 2.2: Pairs of Consecutive Large Changes in the TOT Matched with Pairs of Large Changes in the CAC

	Positive TOT	Negative TOT	
Positive Current A/c	**108** (11%)	**60** (6%)	
Zero Current A/c	**311** (31%)	**339** (34%)	
Negative Current A/c	**54** (5%)	**138** (14%)	**Total**
			1010

The results are similar to the previous table. Many of the observations in Table 2.1 do not appear in Table 2.2. Therefore, it makes sense to combine the two tables into one. This is done in Table 2.3 below. (Note that in Table 2.2, each pair of years is counted once. In Table 2.3, each year of each pair is counted separately so as to compare to observations in Table 2.1.[11])

11 There is a problem of double counting for some years. That is, under Table 2.1, a given year might be classified as a negative correlation, whereas under Table 2.2, the same year is classified as a positive correlation. This problem was avoided by classifying such years as a zero correlation (this occurrence was very rare).

The results for each country are listed in Table A.1 (in Appendix A.1), which gives the breakdown according to the total number of episodes of positive, negative and zero correlation. Countries tend to have episodes of both negative and positive correlations, although there are a few with either only positive or only negative correlation episodes.

Table 2.3: Years with Large Changes in TOT matched with Large Changes in the Current Account

	Positive TOT	Negative TOT	
Positive Current A/c	237 (13%)	119 (6%)	
Zero Current A/c	537 (29%)	583 (31%)	
Negative Current A/c	121 (6%)	279 (15%)	**Total**
			1876

A test of independence is straightforward. The null hypothesis is that there is no relationship between changes in the terms of trade and changes in the current account. The chi-squared test statistic for this test is equal to 100 (with two degrees of freedom), which is a clear rejection of the null hypothesis.

To test if the frequency of negative correlations is significant, I would like to test the null hypothesis of perfect consumption smoothing (that is, no investment effect). However, it is not possible to conduct such a test based on these results because the null hypothesis implies that the frequency of negative correlations is zero. Any confidence interval around an actual cell frequency which is non-zero must be strictly greater than zero. Therefore, we would always reject a null hypothesis which has a zero frequency in a cell for which the point estimate is non-zero.

The most that can be said about Table 2.3 is that the point estimate of the probability of a 'large' negative correlation between the terms of trade and the current account (conditional on a "large" shock to the terms of trade) is 0.13. This is about half the probability of a 'large' positive correlation.

2.4 Panel Data Regressions

2.4.1 Methodology

Regression analysis of panel data was considered the best way to measure the statistical significance of the relationship between the current account and the terms of trade for a number of reasons. Firstly, coverage of such a wide range of countries restricts the analysis to about twenty two years of annual data, which was considered too small a sample for individual country regressions. Also, theory suggests that countries should be split into groups according to the persistence of the terms of trade shocks which would allow potentially different dynamic responses to be identified.

The approach was to run a single equation panel data regression of the following basic form:

$$\Delta CAC_{it} = \sum_{j=1}^{4}\alpha_j \, \Delta CAC_{it-j} + \sum_{j=0}^{4}\beta_j \, \Delta TOT^s_{it-j} + \sum_{j=0}^{4}\gamma_j \, \Delta GDP^s_{it-j} + u_{it} \tag{2.10}$$

where: ΔCAC_{it} is a transformation of the annual current account balance (as a percent of nominal GDP, for country i at time t) obtained by demeaning the first difference of the original series; ΔTOT^s is the shock or innovation (see below) to the annual growth rate of the terms of trade; and ΔGDP^s is the shock to the annual growth rate of real Gross Domestic Product. Exact details of the original series and their sources are provided in Appendix A.2.[12]

12 Because the changes in the terms of trade are often very large, the log difference is not a good approximation of the growth rate of this series. Therefore, growth rates of the terms of trade and real GDP were both calculated as year to year percentage changes.

There are some important issues related to the choice of this specification that need to be addressed, including the inclusion of real GDP, the nature of the transformations of the variables, the identification of shocks, the lag structure and the question of exogeneity.[13]

The theory discussed in Section 2.2 implies that changes in productivity are likely to be an important determinant of the current account. However, for many countries in this study, this data is unavailable or at best very unreliable. Real GDP growth is used as a proxy for productivity growth. I checked that this would not affect the results significantly by using the set of OECD countries[14] for which somewhat reliable estimates of the Solow residuals. Specifically, I ran the regressions first with the Solow residuals and then with real GDP growth in place of the Solow residuals. The results were very similar and suggested that this substitution would not bias the results for the full set of countries. I do not report the results for the OECD country regressions (they are available upon request).

The data were transformed so as to ensure that all variables were integrated of order zero, which was necessary for valid statistical inference. Tests of stationarity (discussed in detail later in this section) revealed that a large number of countries showed evidence of non-stationary terms of trade in levels, while others showed evidence of stationarity. The level of real GDP is likely to be non-stationary (even about a deterministic trend) for most countries.[15] Finally, even the current account balance shows evidence of trend behavior within the sample period for some countries. Differencing the current account along with

13 One extension considered but not presented here was to weight each terms of trade series by each country's degree of openness (exports plus imports as a per cent of GDP). This would help to control for the fact that the current account of a very closed country should respond less to a terms of trade shock than a very open country. However, this weighting scheme did not substantially alter the conclusions and only made the interpretation of the elasticities cumbersome.

14 Luxembourg is excluded from the results. This leaves 23 OECD countries in the sample.

15 Glick and Rogoff (1995) have shown that the Solow residuals of the G-7 countries follow a random walk in levels (based on manufacturing data). Therefore, shocks to productivity are permanent or, at the very least, very persistent.

the other variables avoids the problem of spurious regressions due to either stochastic or deterministic trends.[16]

Identifying Shocks

The main objective of this essay is to measure the response of the current account to *unexpected* changes in the terms of trade. The change in the terms of trade may contain a predictable component and therefore be an imperfect proxy for terms of trade shocks.[17, 18] Shocks or innovations to the terms of trade are constructed for each country as the estimated residual from the following regression:

$$\Delta TOT_{it} = c_i + \sum_{j=1}^{3} \theta_{ij} \Delta TOT_{it-j} + \upsilon_{it} \tag{2.11}$$

where: ΔTOT_{it} is the growth rate of the terms of trade in country i at time t, c_i is a constant term for country i. The terms of trade shock is $\Delta TOT_{it}^{s} = \hat{\upsilon}_{it}$. This specification uses three lags of the growth rate of the terms of trade to be consistent with the results of the Augmented Dickey Fuller tests conducted later on in this section. Shocks to the growth rate of real GDP are constructed in a similar fashion for consistency.[19]

This is a fixed effects model because the data has already been demeaned country by country. Hence, there is no need for a constant term in equation (2.10).

The lag structure of equation (2.10) was chosen for a number of reasons which are not apparent from the simple theory of Section 2.2. In particular, this structure allows for

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16 As mentioned before, this trend behavior could be due to differences between a countries' discount rate and the world interest rate and/or expectations of trends in productivity or the terms of trade.

17 Except in the case where the terms of trade follows a random walk, which appears to be the case for many countries with very persistent terms of trade shocks.

18 The use of the actual changes in the terms of trade and real GDP (as imperfect proxies for the shocks) in the estimation of equation (2.10) biases coefficient estimates towards zero but does not substantially alter the main findings (these results are not reported).

19 The sample size is not sufficient to allow the construction of ex-ante shocks by using recursive regressions (that is, the first regression in the recursion would require a sample that ends just prior to the start of the sample period used in the panel data regressions).

uncertainty and adjustment costs. If investment involves quadratic adjustment costs (as in Glick and Rogoff, 1995), the current account will adjust gradually to shocks. If investment involves fixed costs, then the current account adjustment could be delayed. This delay will in part depend on uncertainty - it may take time to observe shocks and determine their likely size and persistence. [20] The dynamics implied by uncertainty and adjustment costs may also be captured by lags of the current account on the right-hand-side of equation (2.10).

Another source of dynamics comes from the possibility of contracts leading to a degree of commitment in terms of the real level of imports and exports. These contracts, as well as the time it takes to observe and then react to a shock, imply an automatic positive correlation between the current account and the contemporaneous terms of trade. To the extent that this lack of response is not optimal, the current account will adjust in periods following the terms of trade shock.

When estimating equation (2.10), it is assumed that the terms of trade and productivity growth (proxied by real GDP growth) are both exogenous with respect to the current account. For the terms of trade, this assumption is certainly valid for most of the countries in the sample which are 'small' in the sense that they have little influence on world prices. The possible causation running from the current account to the terms of trade for a few large countries is ignored, other than to be careful that country groupings were not dominated by large countries. However, the joint influence of members of the Organisation of Petroleum Exporting Countries on oil prices is considered important and accounted for below.

The causality running from the current account to the productivity shocks is tenuous and likely to be indirect.[21] For developing countries in particular, the level of imports of new capital equipment will embody new technology and therefore affect the productivity level.

20 For example, in the early stages of the Gulf War of 1990/91, the oil price rose dramatically then fell back towards pre-war levels before the year was out.

21 A very indirect link would be through the potential for a large shock to the current account to induce changes in the real exchange rate that lead to changes in sectoral composition and, hence, aggregate productivity changes. [Thanks to Richard Eckaus for pointing out this link].

However, capital equipment is only a part of total imports of goods and services which in turn is only a component of the current account.

One extension that was considered was to weight each countries' terms of trade by its degree of openness (as measured by the ratio of exports and imports to GDP). This would control for the fact that the response to a terms of trade shock should be insignificant for a country that is almost closed. However, the use of weighted terms of trade series did not alter the main results of the essay and so were not reported in detail. Also, the two country groupings based on terms of trade persistence (see below) have similar distributions of openness.

Before discussing the crucial topic of the terms of trade persistence, I present the results for the full set of countries which provide a useful base line comparison for later country group results.

2.4.2 Results for the Full Set of Countries

The panel data regressions for the full set of countries were based on a set of 96 countries. Data limitations meant that many of the 128 countries used in Section 2.3 were excluded from the regression analysis. Countries which had all the necessary series over the years 1970 to 1992 (as marked in Table A.1) were included in the regression analysis. A few countries had missing current account data for one year of the sample, usually 1970 (see Appendix A.1). In order not to exclude these countries and not to exclude 1970 from the sample period, all of the data for these countries in the year missing the current account data were set equal to zero (which is equivalent to removing this country year by a dummy variable).[22]

22 Reducing the sample period for all countries to 1971 to 1992 would eliminate the 1974 oil shock if four lags of the current account are included on the right hand side of equation (2.10).

The estimation procedure was Feasible Generalized Least Squares, which was used to correct for heteroskedasticity across countries.[23] The estimates of both the full and the parsimonious model are reported in Table 2.4 below. The preferred model here and in the rest of the essay is the parsimonious model which is obtained by eliminating lags of variables with insignificant coefficients which is consistent with the Box Jenkins methodology.

23 Estimates of variance of the residuals used in FGLS were based on the fully specified model, not on the more parsimonious models reported below. However, any residual heteroskedasticity was corrected for by using the Newey-West estimates of the final covariance matrix.

Table 2.4: Panel Data FGLS - Full Sample of 96 Countries

- dependent variable - ΔCAC
- period of estimation - 1970 to 1992

Variable	Lag	Full Model	Parsimonious Model
		Coefficient (t-statistic*)	
ΔCAC	1	-0.265 (-10.42)	-0.259 (-10.21)
	2	-0.258 (-11.49)	-0.270 (-12.68)
	3	-0.137 (-6.16)	-0.153 (-7.15)
	4	-0.126 (-5.75)	-0.131 (-6.06)
ΔTOT^s	0	0.077 (12.12)	0.078 (12.26)
	1	-0.024 (-4.35)	-0.024 (-4.21)
	2	-0.010 (-1.91)	
	3	-0.006 (-1.25)	
	4	-0.019 (-3.01)	-0.018 (-3.75)
ΔGDP^s	0	-0.135 (-7.05)	-0.137 (-7.16)
	1	-0.074 (-4.95)	-0.076 (-5.10)
	2	-0.033 (-2.24)	-0.040 (-2.58)
	3	0.020 (1.36)	
	4	-0.031 (-2.26)	-0.036 (-2.59)
$\sum_{j}^{4} \Delta TOT^s_{t-j}$		0.016 (1.35)	0.036 (3.81)
$\sum_{j}^{4} \Delta GDP^s_{t-j}$		-0.253 (-6.48)	-0.288 (-8.45)
		No. Obs. 1824	No. Obs 1824
		$R^2 = 0.28$	$R^2 = 0.27$

* standard errors obtained by using the ROBUSTERRORS command in RATS with damp set to one and lags set to 4. This provides Newey-West estimates of the covariance matrix corrected for heteroskedasticity and for serial correlation of a moving average of order 4.

The results from the parsimonious model show that across the 96 countries, on average, a large positive shock to the terms of trade has a small but significant positive effect on the current account over a five year period following the shock. The year by year effects indicate that the current account rises in the same year as a positive shock to the terms of trade shock and then falls in following years. Productivity shocks (via the proxy of real GDP growth) have the expected negative effect on the current account in all years following the shock.

The next stage in the estimation is to run regression on two sets of countries, those with very persistent and those with very temporary terms of trade shocks.

2.4.3 Stationarity, Persistence and Trends in the Terms of Trade

The stationarity and persistence of the terms of trade are closely related and are crucial to both the methodology and the interpretation of the results. The Augmented Dickey-Fuller test is used to determine whether each terms of trade series is stationarity or non-stationarity, as well as to provide an estimate of the persistence of terms of trade shocks. The underlying model is assumed to be an autoregressive process for the logarithm[24] of the terms of trade with lag length, p, as follows:

$$(1-\phi_{i1}L-\phi_{i2}L^2-\ldots-\phi_{ip}L^p)\,tot_{it}=\varepsilon_{it} \tag{2.12}$$

where L is the lag operator and tot_{it} is the logarithm of the terms of trade for country i at time t. A natural measure of persistence for country i is

$$\rho_i \equiv \phi_{i1}+\phi_{i2}+\ldots+\phi_{ip} \tag{2.13}$$

From the Beveridge-Nelson decomposition, it follows that this model can be rewritten in the form of the ADF test

$$tot_{it}=\rho_i\,tot_{it-1}+\alpha_{i1}\Delta tot_{it-1}+\alpha_{i2}\Delta tot_{it-2}+\ldots+\alpha_{ip-1}\Delta tot_{it-p+1}+\varepsilon_{it} \tag{2.14}$$

where $\alpha_{ij}=-\sum_{k=j+1}^{p}\phi_{ik}$, $\quad 1\le j\le p-1$

24 The logarithm is not a good approximation for the growth rate as discussed in a previous footnote. However, in this case it is necessary to use the logarithm so as to follow the ADF procedure which requires the variable in levels and first differences.

The null hypothesis is that the terms of trade is integrated of order one, I(1): in other words, that $\rho_i = 1$. The standard form of the test also allows for a constant and a time trend in equation (2.14). The lag length, *p*, is chosen to give a parsimonious model while ensuring that the estimated residuals, $\hat{\varepsilon}_{it}$, show no sign of serial correlation. The tests are run on each country's terms of trade over the full length of data available for that country.

The objective is to choose two groups of countries according to the persistence of their terms of trade. One obvious criteria is stationary versus non-stationary terms of trade. However, the results of the ADF tests are not clear for all countries. In particular, results often depend on borderline decisions regarding the appropriateness of a deterministic trend, or whether to use 5 or 10 per cent critical values. In part, the problem is that these tests suffer from weak power which is particularly true for the small sample sizes.

Ideally, countries would be split into different groups according to ex-ante information regarding the behavior of their terms of trade, not ex-post information such as I am using. However, this is not possible because of the already limited sample size. Instead, I adopt an approach which identifies those countries with terms of trade which are at the extreme ends of the spectrum of terms of trade persistence. In this way, each grouping will contain countries that can be considered *most likely* to have either the most or the least persistent terms of trade shocks ex-ante.[25]

Least Persistent Terms of Trade Country Group

The critical criteria for inclusion in this grouping was a stationary terms of trade. I choose a group of 10 countries based on stationarity around a mean (using a 10 per cent significance level). Countries with trend stationary terms of trade were excluded because I felt that it would be hard for agents to differentiate between a trend and a preponderance of persistent shocks in one direction.[26]

25 The terms of trade may consist of both temporary and permanent components; however, the objective is to identify countries for which one of these components dominates the other.

26 A criteria based on stationarity around a mean, at a 5 per cent significance level, left too few countries in the sample. Other possibilities that were investigated included stationarity (including trend

The 10 countries included in the least persistent group include: Finland, Iceland, Israel, Jamaica, Jordan, the Republic of Korea, Mali, New Zealand, Panama and the United Kingdom. The average estimate of persistence for this group was 0.58.

Most Persistent Terms of Trade Country Group

The criterion for inclusion in the most persistent group was a non-stationary terms of trade with a point estimate of persistence above 0.85 under both of two different tests. The first was an ADF test including both a trend and a constant; the second was an ADF test with a constant but no trend. Both tests were done with lags, p, set equal to 3 and at the 5 per cent level of significance.[27] The point estimates of persistence from both of these tests are provided for all 128 countries in Table A.1. Some countries have terms of trade that display a high degree of persistence as measured by the ADF test, including both a trend and a constant but not with a constant alone (and vice versa). Hence, it was thought that countries meeting both of these tests would be most likely to have had ex-ante very persistent terms of trade.

The influence of the two oil price shocks is strongly evident in the terms of trade of many countries meeting these criteria. A further refinement was to exclude members of OPEC from this set because these countries influenced their terms of trade by restricting sales and production of oil and, presumably, investment in their oil industries.[28] Therefore, to the extent that the cartel was successful, OPEC members should have the consumption smoothing effect dominating the investment effect, whereas theory suggests the opposite for countries with highly persistent terms of trade shocks.

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stationarity) at a 5 per cent significance level with a point estimate of persistence, $\hat{\rho}_i$, below 0.55. Results for this group of 15 countries are consistent with those reported below. These 15 countries are: Australia, Bangladesh, Costa Rica, Finland, Jamaica, Jordan, Malawi, Mali, Morocco, Papua New Guinea, Portugal, Sudan, Thailand and Uruguay.

27 Three lags were sufficient for most countries to remove any serial correlation in the residuals of equation (2.14). Relaxing the criteria to be *either* p equals 3, 2 or 1 does not alter the results substantially from those presented below.

28 That is, the terms of trade is not exogenous for the case of OPEC countries.

The set of 11 countries satisfying the conditions for very persistent terms of trade are: Bolivia, Botswana, Canada, Italy, Kenya, South Africa, Spain, the Syrian Arab Republic, Tanzania, Trinidad and Tobago and the United States. It turns out that for this group the null hypothesis of a random walk in the terms of trade cannot be rejected.

2.4.4 Results based on Persistence of Terms of Trade Shocks

The theory outlined in Section 2.2 implies that more persistent terms of trade shocks will be negatively correlated with the current account while more temporary shocks will be positively correlated. Before presenting the evidence from the panel data regressions, it is worth reviewing the results from counting correlation episodes in Section 2.3 in the light of the two groups of countries above. Countries within the higher persistence group should have relatively more episodes of negative correlations than those of the low persistence group. The average number of positive, negative and zero correlation episodes per country within each group is shown in Table 2.5 below.

Table 2.5: TOT Persistence vrs Episodes of Correlation between ΔCAC and ΔTOT

	Average Number of Correlation Episodes per Country		
	Positive	Zero	Negative
Highly persistent TOT countries	3.9	7.4	3.6
Least persistent TOT countries	5.0	8.9	2.3

These results are broadly consistent with the theory that persistence is an important determinant of the dynamics of the current account with respect to terms of trade shocks. Countries with highly persistent terms of trade shocks have on average 57 per cent more negative correlations and 22 per cent less positive correlations than countries with the least persistent terms of trade shocks.

This finding is confirmed by the results of panel data regressions on the high and low persistent country groupings in Table 2.6 below.

Table 2.6: Panel Data FGLS - Highest Versus Lowest TOT Persistence

- dependent variable - ΔCAC
- period of estimation - 1970 to 1992

		11 Countries with Highest TOT Persistent		10 Countries with Lowest TOT Persistent	
		Full Model*	Parsimonious Model	Full Model*	Parsimonious Model*
Variable	Lag	Coefficient (t-statistic)			
ΔCAC	1	-0.198 (-2.47)	-0.161 (-2.57)	-0.322 (-3.91)	-0.307 (-4.17)
	2	-0.114 (-1.82)		-0.424 (-6.23)	-0.409 (-6.31)
	3	-0.202 (-3.62)	-0.184 (-2.98)	-0.186 (-3.04)	-0.180 (-3.45)
	4	-0.110 (-1.89)		-0.177 (-2.78)	-0.165 (-3.03)
ΔTOT^s	0	0.072 (2.71)	0.070 (3.96)	0.128 (2.75)	0.124 (2.86)
	1	-0.055 (-2.11)	-0.056 (-3.12)	0.024 (0.60)	
	2	-0.033 (-1.63)	-0.041 (-2.25)	0.005 (0.16)	
	3	-0.005 (-0.32)		-0.025 (-0.94)	
	4	-0.051 (-2.63)	-0.049 (-2.71)	0.019 (0.75)	
ΔGDP^s	0	-0.197 (-3.95)	-0.202 (-4.75)	-0.158 (-2.21)	-0.146 (-2.04)
	1	-0.002 (-0.04)		-0.190 (-2.80)	-0.185 (-2.67)
	2	-0.046 (-1.03)		-0.107 (-1.97)	-0.123 (-2.07)
	3	0.020 (0.53)		-0.162 (-2.13)	-0.159 (-2.19)
	4	0.012 (0.31)		-0.043 (-0.64)	
$\sum_{j=0}^{4} \Delta TOT^s_{t-j}$		-0.072 (-1.82)	-0.077 (-2.19)	0.150 (1.92)	0.124 (2.86)
$\sum_{j=0}^{4} \Delta GDP^s_{t-j}$		-0.213 (-1.92)	-0.202 (-4.75)	-0.662 (-3.56)	-0.612 (-4.19)
		No. Obs 209	No. Obs 209	No. Obs 190	No. Obs 190
		$R^2 = 0.34$	$R^2 = 0.31$	$R^2 = 0.30$	$R^2 = 0.30$

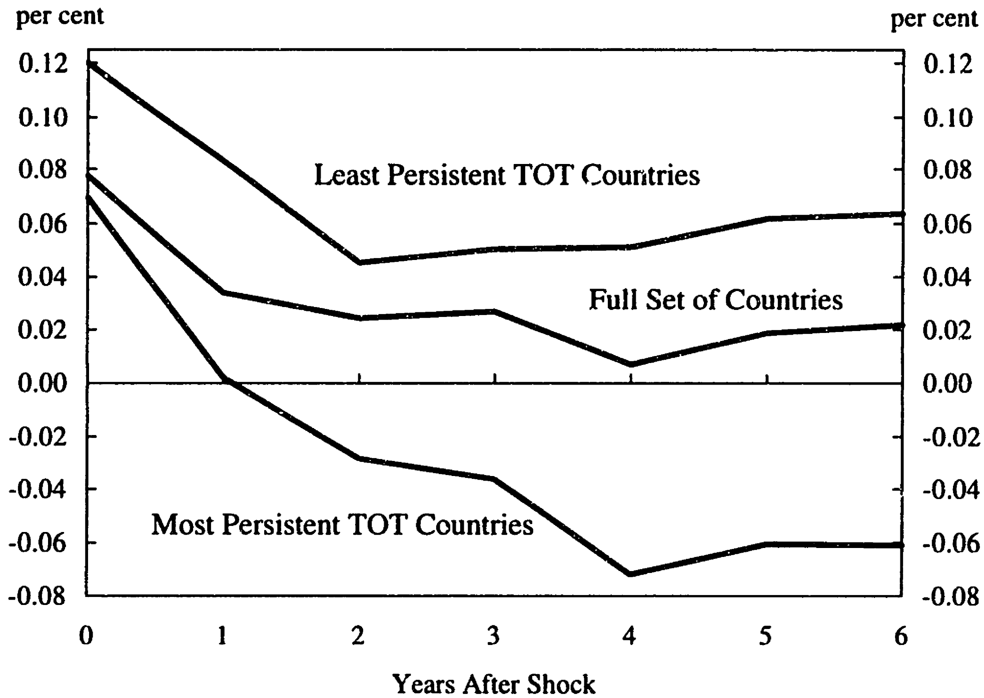
* standard errors corrected for heteroskedasticity and for serial correlation.

For countries with highly persistent terms of trade, the sum of coefficients on the terms of trade shocks is significantly negative (at the 5 per cent level). For countries which have the least persistent terms of trade, the coefficient on the contemporaneous terms of trade shock is positive and is the only significant lag in the regression. As expected, the effect of real growth (as a proxy for productivity shocks) is significantly negative and is much larger in absolute value than the effect of the terms of trade.

The impulse response functions show the cumulative effect of a 1 per cent shock to the terms of trade on the current account balance as estimated by each model. Figure 2.1 shows the impulse response functions from the three parsimonious models estimated above. The upper impulse response is based on the sample of 10 countries with the least persistent terms of trade, the middle impulse response is based on the full set of 96 countries, and the lower impulse response function is based on the sample of 11 countries with the most persistent terms of trade. In all three cases, the current account rises in the same year as a positive shock to the terms of trade, but this is reversed in subsequent years. The fact that the current account quickly moves towards a deficit in the case of countries for which the shock is persistent is consistent with a lagged investment effect dominating any consumption smoothing. However, for countries which experience predominantly temporary terms of trade shocks the consumption smoothing effect appears to dominate and the current account moves towards a surplus.[29] These findings were confirmed by constructing confidence intervals for the impulse response functions.

29 In the long-run, the current account should return to balance, but the estimation technique does not include enough lags to account for longer-run behavior. Adding more lags of the current account to the model provides tentative evidence that in all three cases the current account continues to move towards balance after more than four years after the shock.

Figure 2.1: Current Account Response to a One Per Cent Terms of Trade Shock



Bootstrap techniques were used to provide 95 per cent confidence intervals around each of the impulse response functions. The confidence intervals (shown in Figure A.1 in Appendix A) clearly show that after four years the response of the current account to a terms of trade shock is positive for the 10 countries with the least persistent terms of trade and negative for countries with the most persistent terms of trade. Furthermore, the confidence interval for the full set of 96 countries lies around zero and strictly between estimates for the two extreme persistence groupings after four years.

The standard deviation of the terms of trade shocks across countries is 13.5 and 9 per cent for the most and least persistent terms of trade country groups respectively. The current account response to positive shocks of this size after 4 years is a fall in the current account balance of almost one percentage point for the most persistent terms of trade countries and a rise in the current account of about half a percentage point for the least persistent group.

2.5 Concluding Remarks

I consider two alternative explanations for the findings above before providing a summary of the main results.

2.5.1 Tornell and Lane - Voracity Effect

Tornell and Lane (1996a and 1996b) present a model of competing fiscal claimants which under certain circumstances implies that a large positive shock to the terms of trade will lead to an increase in government expenditure sufficient to reduce the current account balance (the argument is symmetric for negative shocks). This voracity effect is an alternative explanation of the finding of a negative relationship between the terms of trade and the current account for some countries.

To control for this potential effect, I re-estimated the panel regression of equation (10) with government fiscal balance (as a per cent to GDP) included as a right-hand-side variable:

$$\Delta CAC_{it} = \sum_{j=1}^{4} \alpha_j \, \Delta CAC_{it-j} + \sum_{j=0}^{4} \beta_j \, \Delta TOT^{s}_{it-j} + \sum_{j=0}^{4} \gamma_j \, \Delta GDP^{s}_{it-j} + \sum_{j=0}^{1} \varphi_j \, \Delta GVT_{it-j} + u_{it} \tag{2.10'}$$

where: ΔGVT is the demeaned first difference of the government fiscal balance (as a per cent of GDP); see Appendix A.2 for more details. The government fiscal balance will have a direct effect on the current account balance according to the following identity:

$$CAC_t \equiv S_t - I_t + (T_t - G_t) \tag{2.15}$$

where S and I are private savings and investment, respectively, T is government revenue, and G is government expenditure. If private savings and investment decisions were independent of the government fiscal position, then $\varphi_0 = 1$ (and $\varphi_1 = 0$) in equation (2.10′). The lag of ΔGVT in equation (2.10′) accounts for the problem of government statistics being reported on a fiscal year basis which is often different from calendar years.[30]

An indirect effect of changes in the government fiscal position will exist if private savings and investment adjust to changes in the government fiscal position. Government expenditure may crowd out some private investment. An increase in the government deficit may lead to increased private savings in order to pay for expected future tax increases. These indirect effects work in the opposite direction to the direct effect of the government fiscal balance on the current account. If there is full crowding out and agents are perfectly Ricardian in their behavior, then $\varphi_0 = 0$, and $\varphi_1 = 0$ (if agents are slow to adjust, then $\varphi_0 + \varphi_1 = 0$).

I ignore the possible endogeneity problem by asserting that any response of the government fiscal balance to current account 'imbalances' is likely to be delayed in all but crisis situations. Such episodes are not likely to be the dominant effect across a longer time period and a large sample of countries such as used in this essay.[31]

As the results in Table A.2 (in Appendix A) show, there is a negative correlation between the terms of trade and the current account for countries with persistent terms of trade even after controlling for the government fiscal balance. The effect of the government fiscal balance has the expected sign (although it is significant only for the country group with less persistent terms of trade shocks). The sum of coefficients on government fiscal balance is closer to zero than to one, which suggests a strong indirect effect (that is, private agents offsetting the direct effect of a change in the government fiscal position).

30 Other lags of the government fiscal balance variable were not included in the regression because they were never close to being significant.

31 Endogeneity is not an issue in cases where the government deficit is so high as to imply a balance of payments crisis and, therefore, is reduced either because of the crisis or to avoid a potential crisis.

2.5.2 Credit Constraints

If consumers in a country face significant credit constraints, the consumption smoothing effect would be dampened in the case of negative terms of trade shocks. For such countries it is conceivable that the investment effect will dominate the consumption smoothing effect.[32] However, I argue that the two country groupings (based on terms of trade persistence) face similar degrees of credit constraints for consumers and, therefore, it is not likely that a story about credit constraints is driving the results that I have shown in Section 2.4.

I use the level of per capita GDP of a country to proxy the existence of credit constrained consumers. Table 2.7 below shows that the two country groups have very similar distributions of real per capita GDP (see Appendix A.2 for the exact description of the data). The significance of possible credit constraints seems constant across both high and low terms of trade persistence country groups.

Table 2.7: Distribution of Real GDP Per Capita Across Different Country Groups

	Real GDP per Capita, 1990 US dollars (country averages from 1960 to 1992)					
	Average across group	Min. within group	Max. within group	No. in group < 1000	No. in group < 4000	No. in group >10000
Highly persistent TOT countries	6236	485	15631	2	6	3
Least persistent TOT countries	6424	497	10959	1	5	4

32 The existence of credit constrained consumers does not imply that large firms are also credit constrained, so the response of investment will still be the same. For example, many investment projects could be funded by foreign direct investment.

2.5.3 Final Remarks

Theory implies that the response of the current account balance to shocks depends on the degree of persistence of these shocks. The consumption smoothing effect and the investment effect work in opposite directions. The greater the expected persistence of a shock, the more the investment effect will dominate. Therefore, in the years following a persistent shock, the current account will move in the opposite direction to the shock. The reverse is true for more temporary shocks. Terms of trade shocks are used to test this theory because they display a wide range of persistence across different countries.

A non-parametric approach to counting the effect of 2 year episodes of large terms of trade changes shows that many countries experience both positive and negative correlations between the terms of trade and the current account. This is consistent with the fact that shocks will be neither entirely temporary nor entirely permanent. A stronger finding than this was developed by using two smaller groups of countries which lie at the extreme ends of the spectrum of terms of trade persistence. Those countries with the least persistent terms of trade have more episodes of positive correlation and less of negative correlation between the current account and the terms of trade than do countries with the greatest terms of trade persistence.

Panel data regressions showed that the current account response is positively related to the terms of trade for countries with predominantly temporary terms of trade shocks and negatively related for countries with predominantly permanent terms of trade shocks. Moreover, the response of the current account for these two smaller country groups was shown to be significantly different from the response estimated across the full sample of countries.

These results were robust to the inclusion of changes in the government fiscal balance to control for possible voracity effects as in Tornell and Lane (1996a and 1996b). Also, the findings do not appear to be related to credit constraint stories because both of the country groupings based on terms of trade persistence have very similar distributions of per capita income (across countries).

Chapter 3

The Current Account, Consumption Smoothing, and Credit Constraints

3.1 Introduction

This chapter examines the extent to which the behavior of the Australian current account balance is consistent with a standard model of intertemporal consumption smoothing. Australia has a long history of large current account deficits. Figure 3.1 below shows that the current account deficit averaged almost 2.5 per cent of GDP from 1949 to 1983. Since the lifting of capital market restrictions in December of 1983, the deficit doubled to an average of almost 5 per cent of GDP from 1984 to 1995.

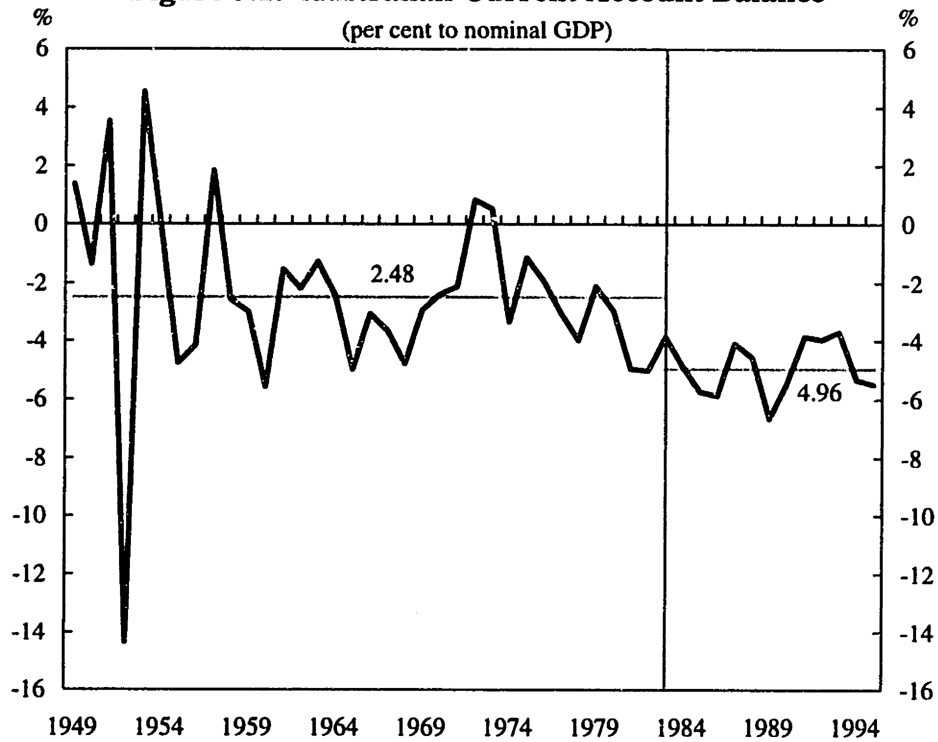
The Australian current account deficit has been large and persistent in comparison to other OECD countries. The 13 largest episodes of consecutive annual current account deficits for OCED countries from 1960 to 1995 are shown in Table B.1 in Appendix B.[1]

There has been an extensive debate regarding both the sustainability and optimality of the Australian current account deficit. Collins (1994) and Milbourne and Otto (1992) list the notable protagonists in this debate, including Arndt (1989), Johnson(1989), Moore (1989), Pitchford (1989a, 1989b), Sjaastad (1989) and Shields (1989). This chapter focuses on an empirical test of the question of optimality.

1 See also Figure B.1 in Appendix B for a comparison of current account data for the OECD.

Figure 3.1: Australian Current Account Balance

(per cent to nominal GDP)



There have been a number of empirical studies of the consumption smoothing model using current account data. The typical approach is based on methodology developed by Campbell(1987) and Campbell and Shiller (1987). These studies include Ghosh and Ostry (1992 and 1995), Ghosh (1995), and Otto (1992).[2] The standard permanent income theory of savings and consumption says that the optimal current account is negatively related to the expected future changes in Net Cash Flow (NCF is defined as GDP net of investment and government expenditure). Countries will run current account deficits (surpluses) when NCF is expected to rise (fall) in the future. Also, persistent current account deficits (surpluses) can occur if an agent's rate of time preference makes them more (less) impatient than the rest of the world.

This same methodology has been applied to the case of Australia. Milbourne and Otto (1992) use quarterly data to provide evidence that is inconsistent with consumption

2 For a summary of these and other related studies of the intertemporal model in an international setting, see Obstfeld and Rogoff (1995 and 1996).

smoothing. In contrast, Cashin and McDermott (1996) use annual data and show that the Australian data is consistent with consumption smoothing after, but not prior to, 1975.

The innovations of this essay are twofold. I take explicit account of the effect of the capital market opening that occurred in 1983.[3] There are two potential effects of this increased access to foreign credit: a long-term shift in the level of the consumption path through a more rapid accumulation of net foreign debt; and an increased ability of agents to smooth consumption in the shorter term in response to temporary changes in NCF.

The consumption smoothing model assumes that capital is freely mobile. Therefore, a number of authors have used this model as a test of the degree of capital mobility (for example, Ghosh 1995, and Ghosh and Ostry 1995). Cashin and McDermott (1996) suggest that the failure of the consumption smoothing model for Australia prior to 1975 is indicative of the existence of credit constraints. However, in their estimation they do not explicitly test for the existence of credit constrained behavior, nor do they test for a break point associated with the capital market opening in 1983.

The longer term effect of the capital market opening in Australia is easy to measure statistically, and in fact, it is fairly apparent from even a casual glance at the data. The doubling of the average deficit after 1983 (as a share of GDP) led to a rapid accumulation of net foreign debt, from about 6 per cent of GDP at the beginning of the 1980's to about 40 per cent in 1995. Net foreign liabilities increased from 23 per cent of GDP to 60 per cent over the same period.[4] Measuring the impact of liberalization on the ability to smooth short-term shocks is problematic because of insufficient annual data since capital

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3 The capital market was opened completely in December of 1983 at the same time as the move to a fully flexible nominal exchange rate regime (although there was limited access to foreign capital markets prior to this date). This was the culmination of a more general program of financial market liberalization which had begun some years earlier. These reforms included, amongst other things, significant banking deregulation and with it the removal of many lending and interest rate restrictions. For a discussion of the program of financial liberalization in Australia see Lowe (1995).

4 Source: Reserve Bank of Australia, *Bulletin*, various issues. Also, Collins (1994) shows that there was a shift in financing of deficits away from Direct Investment towards 'Other Capital' which includes resident official sector plus deposit money banks plus other sectors (pg. 290).

market opening in 1983.[5] An alternative approach to this problem is to test for asymmetric behavior of the current account to positive and negative shocks. The idea is that credit constrained consumers should be restricted in their ability to smooth consumption through times of low NCFs, but not through times of high NCFs. I am able to provide a stronger test for the existence of credit constraints by testing for this asymmetric behavior.

The second innovation of the essay is to account for the fact that shocks to Australian NCF that are correlated to shocks in the NCF of the rest of the world may have a limited effect on the current account. This point is emphasized by Glick and Rogoff (1995) who focus on productivity shocks in a structural model that emphasizes the investment decision. They show that only the country specific component of a productivity shock has an effect on the current account. The idea is that shocks that are common to the world lead not to adjustments in current account balances, but to changes in world interest rates. This is not entirely true in the case of Australia which is a net debtor country, particularly following the substantial increase in net foreign liabilities in the 1980's. Deviations of the world interest rate from its permanent level will create additional income effects and, therefore, some adjustment of the current account to shocks in the world NCF.[6]

The chapter is organized as follows. Section 3.2 presents a standard representative agent model of consumption smoothing and illustrates how this model can be tested against the data. The estimation proceeds in Section 3.3 in two stages. In the first stage, I remove the trend component of the current account that is due to 'consumption tilting' and measure the change in long-term behavior that occurred after the capital market opening in 1983. In the second stage of estimation, a Vector Auto Regressive (VAR) model is

5 Attempts to use quarterly data were unsuccessful inasmuch as the results for the full sample period using quarterly data were completely at odds with the results based on annual data. I believe this is largely due to the very high noise to signal ratio in the quarterly data and may explain the difference in the findings of Milbourne and Otto (1992) and Cashin and McDermott (1996).

6 In this essay, I assume fixed world interest rates for convenience, and, therefore, I do not directly address the issue of changes in world interest rates. Changes in interest rates are easily incorporated into the fundamental current account equation, as shown by Obstfeld and Rogoff (1995). However, incorporating a flexible interest rate into an empirical model is a more difficult prospect.

applied to the stationary component of the current account and changes in NCF to test for evidence of consumption smoothing. Then I extend the analysis by re-estimating the VAR model using an estimate of changes in the NCF that are uncorrelated with changes in the world's NCF.

In Section 3.4 I account for the effect that credit constraints may have had on consumption smoothing, particularly prior to capital market opening in 1983. First, I divide the sample period into two parts to try to isolate more of the latter period after liberalization. This is fairly unsatisfactory because of the limited sample size after 1983. As an alternative to this approach, I allow for asymmetric consumption smoothing during good and bad times as predicted by a simple story of credit constraints. Finally, conclusions are drawn in Section 3.5.

3.2 Theoretical Framework

The theory described in this section is very similar to that presented in Obstfeld and Rogoff (1995 and 1996). In contrast to many applied studies, I specify an iso-elastic utility function and assume a world of no uncertainty. Many previous studies have assumed a quadratic utility function in a world of uncertainty.[7] In either case, the role of precautionary savings is ignored and the empirical approach is very similar.[8] Because I assume that the paths of exogenous variables are known with certainty, I motivate the empirical analysis by asserting that there are errors in measuring the key variables.

The iso-elastic utility function is preferable to quadratic utility, particularly in a long-run setting when the consumption path is not flat. The quadratic utility function is problematic because it implies a strict upper bound on the level of consumption and it

7 For example, Ghosh (1995), Ghosh and Ostry (1995), Cashin and McDermott (1996), and Glick and Rogoff (1995).

8 Ghosh and Ostry (1992) try to measure the effect of uncertainty directly. The result is intuitively appealing: higher uncertainty means higher precautionary savings and, thus, a higher current account balance. However, they ignore their specification of the utility function when removing the effect of consumption tilting from the current account by proceeding in a manner similar to that shown here.

does not rule out negative levels of consumption. As Obstfeld and Rogoff (1995) stress, the assumption of quadratic utility should be thought of as a convenient approximation. In the same way, the assumption of certainty is also an approximation; in the case of an iso-elastic utility function, certainty is used to obtain a closed form solution.[9]

The model is of a small open economy populated by a single, infinitely lived representative agent. I use an iso-elastic time separable utility function and assume no uncertainty. The agent chooses a path of consumption and investment to maximize lifetime utility:

$$U_t = \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{1-1/\sigma} - 1}{1 - 1/\sigma} \tag{3.1}$$

where C_t is consumption at time t, β is the agent's discount rate, and $1/\sigma$ is the agent's intertemporal elasticity of substitution.

The agent can borrow or save through a single asset with a return equal to the fixed world interest rate, r. The budget constraint defines the current account balance:

$$CA_t \equiv B_{t+1} - B_t = Y_t + rB_t - C_t - G_t - I_t \tag{3.2}$$

where B_t is the stock of assets held over from time $t-1$, Y_t is output, G_t is government spending (determined exogenously) and I_t is investment. Labor is supplied inelastically, and output is produced according to the production function:

$$Y_t = A_t F(K_t) \tag{3.3}$$

where A_t is total factor productivity (determined exogenously) and K_t is the stock of physical capital (assuming no depreciation, $I_t \equiv K_{t+1} - K_t$). The assumption of a small open economy means that the capital stock is determined by the condition that equates the marginal product of capital to the fixed world interest rate.

9 The case of no uncertainty rules out unanticipated shocks which are obviously an important part of the real world. However, the empirical approach that I use for the analysis of consumption smoothing

$r = A_t F'(K_t)$

Assuming that $F' > 0$ and $F'' < 0$, ensures that there will be a unique solution for the optimal capital stock. Output and investment can be expressed as functions of total factor productivity, and both are determined independently of the path of consumption. Investment at time t, is a function of total factor productivity at time $t+1$ and the level of the capital stock at time t.

The optimal consumption profile is given by the Euler equation of this maximization problem:

$$C_{t+1} = C_t \, \beta^{\sigma} (1+r)^{\sigma} \tag{3.4}$$

If $\beta = 1/(1+r)$, then the consumption path will be flat and, as shown below, the current account will contain no consumption tilting component. However, for $\beta < 1/(1+r)$, the consumption path will be tilted downwards (and vice versa for $\beta > 1/(1+r)$). The current account will display trend behavior in the presence of consumption tilting (because consumption typically has a trend).

The model is solved by determining the optimal level of consumption. This is done by combining the Euler equation with the budget constraint and applying the transversality condition.[10] As I show below, optimal consumption is proportional to wealth. In turn, wealth is driven by the exogenously determined paths of total factor productivity and government expenditure. (Obviously, the solution is greatly simplified by assuming a constant world interest rate, r.)

For convenience, the permanent level of a variable is defined as its annuity value, for example:

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behavior, is identical to the approach based on models of uncertainty and quadratic utility.

10 That is, $\lim_{T\to\infty}\left(\frac{1}{1+r}\right)^T B_{t+T+1} = 0$.

$$\tilde{Y}_t \equiv \frac{r}{1+r}\sum_{s=t}^{\infty}\left(\frac{1}{1+r}\right)^{s-t} Y_s \tag{3.5}$$

Define the net cash flow (excluding interest payments on debt) as follows:

$$Z_t \equiv Y_t - G_t - I_t \tag{3.6}$$

The level of wealth can then be defined as

$$W_t \equiv (1+r)B_t + \sum_{s=t}^{\infty}\left(\frac{1}{1+r}\right)^{s-t} (Z_s) \tag{3.7}$$

The optimal level of consumption is proportional to the level of wealth in the following manner:[11]

$$C_t = \left(\frac{r+\upsilon}{1+r}\right) W_t \qquad \text{where} \qquad \upsilon \equiv 1-\beta^{\sigma}(1+r)^{\sigma} \tag{3.8}$$

The optimal current account is obtained by substituting (3.8) into the budget constraint.

$$CA_t = (Z_t - \tilde{Z}_t) - \frac{\upsilon}{r+\upsilon} W_t \tag{3.9}$$

This is the fundamental current account equation. The first term says that output above its permanent level leads to a current account surplus and investment or government spending above their permanent levels lead to a current account deficit. In other words, the net foreign asset position adjusts in a way that enables smooth consumption in the face of temporary disturbances to NCF.[12]

The second term in (3.9) captures consumption tilting that occurs when the rate of time preference (equal to $(1-\beta)/\beta$) is different from the world interest rate (that is, when

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11 For this solution to exist it is necessary for $\beta^{\sigma}(1+r)^{\sigma-1} < 1$ (for a discussion of this point, see Obstfeld and Rogoff 1996, page 71).

12 This first term also captures the potential for income growth to influence the level of the current account balance.

$\upsilon \neq 0$). A country that is more impatient than the rest of the world will be running current account deficits in proportion to their level of wealth. The consumption-tilting component of the current account, CA_t^T, is defined as the level of the current account that would occur when all variables are at their permanent level. Using the fact that consumption is proportional to wealth, as in equation (3.8), CA_t^T, can be written as follows:

$$CA_t^T \equiv -\frac{\upsilon}{r+\upsilon} W_t = \lambda C_t \qquad \text{where} \qquad \lambda \equiv -\frac{\upsilon(1+r)}{(r+\upsilon)^2} \tag{3.10}$$

The estimation of this model proceeds by decomposing the current account into two components.[13] First, the trend behavior of the current account is removed by estimating the extent of any consumption tilting. Then the stationary component of the current account is tested for evidence of consumption smoothing. The assumptions used in the model are best thought of as a way of approximating these two key features of the current account behavior. As already mentioned, I ignore the third feature of the current account, namely, precautionary saving.

Current Account Trends and Consumption Tilting

In the Section 3.3 below, I make use of the time series properties of the variables to separate the consumption tilting component from the actual current account. The level of consumption is typically a non-stationary variable. Therefore, if the consumption tilting component of the current account is non-zero, equation (3.10) implies a cointegrating relationship between the current account and consumption (which will also be non-stationary in this case).

I assert that both the current account and consumption are both measured imperfectly. Therefore, it makes sense to run the following cointegrating regression:

13 Sachs (1982) describes these two components as being due to the *time-preference* motive and the *consumption-smoothing* motive. The time-preference or consumption tilting motive occurs when the rate of time preference differs from the world interest rate. The consumption-smoothing motive occurs

$$CA_t = \lambda C_t + \varepsilon_t \tag{3.11}$$

If indeed this is a cointegrating relationship, the error term, ε_t, will be a stationary variable. Furthermore, λ can be estimated consistently even if consumption is correlated with ε_t. The estimate of the consumption tilting component of the current account is

$$CA_t^T = \hat{\lambda} C_t \tag{3.12}$$

Consumption Smoothing Current Account

The estimate of the consumption-smoothing component of the current account, CA_t^S, can be obtained as the residual

$$CA_t^S = CA_t - CA_t^T \tag{3.13}$$

The consumption smoothing component of the current account is equal to the first term in the fundamental current account equation (3.9).[14]

$$CA_t^S = Z_t - \tilde{Z}_t \tag{3.14}$$

The NCF, Z_t, is typically a non-stationary variable and yet CA_t^S is stationary by construction. To facilitate estimation, it is helpful to rewrite this expression in a form that involves only stationary variables.

$$CA_t^S = -\sum_{s=t+1}^{\infty}\left(\frac{1}{1+r}\right)^{s-t} \Delta Z_s \tag{3.15}$$

This shows that the consumption smoothing component of the current account will be in deficit when the net present value of future changes in the NCF is positive. In other

when there is a temporary change in the level of income, investment or government spending, which because of consumption smoothing, will lead to a *temporary* current account imbalance.

14 The consumption smoothing component of the current account is exactly equivalent to the current account in the case when the rate of time preference equals the world interest rate (that is, when $\upsilon = 0$) and, hence, the consumption tilting component is equal to zero.

words, the deficit allows the agent to smooth consumption through a period of temporarily low NCF.

The interpretation of this expression for the optimal current account has been the source of some confusion in the literature. For example, Otto(1992), Ghosh (1995) and Ghosh and Ostry (1995) all give the impression that a permanent unanticipated shock can not have an effect on the current account. Their problem is that they interpret shocks as occurring directly to the individual components of the NCF, namely, output, investment and government expenditure. However, only government expenditure is treated as exogenous. Changes in output and investment are driven by shocks to productivity in this model. To illustrate why these authors are wrong, assume that the investment response is gradual because of quadratic adjustment costs. A permanent, unanticipated increase in productivity will lead to a current account deficit initially because of anticipated future increases in the NCF; following the increase in productivity, investment will temporarily drive down NCFs.

To test the consumption smoothing hypothesis that is explicit in equation (3.15), I need to derive an estimate of the net present value of future changes in the NCF. To do this I estimate the following Vector Auto Regression (VAR), which is a valid representation of the process generating CA_t^S and ΔZ_t so long as they are both stationary variables.[15]

$$\begin{bmatrix} \Delta Z_t \\ CA_t^S \end{bmatrix} = \begin{bmatrix} \psi_{11} & \psi_{12} \\ \psi_{21} & \psi_{22} \end{bmatrix} \begin{bmatrix} \Delta Z_{t-1} \\ CA_{t-1}^S \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{3.16}$$

Once again, the estimation procedure is justified by asserting that both CA_t^S and ΔZ_t are subject to measurement error. From an empirical standpoint, it would be natural to use current and lagged values of changes in NCF to predict future changes in NCF. However, the consumption smoothing hypothesis embodied in (3.15) implies that the current account is a sufficient predictor of future changes in NCFs.

15 This model is easily generalized to incorporate higher order VARs as is done in Section 3.3.

A weak test of the consumption smoothing hypothesis is to determine if the current account Granger causes changes in the NCF as implied by equation (3.15). The VAR provides a convenient way of performing this test.

An estimate of future expected changes in the net cash flow can be constructed from the VAR estimate as follows.

$$E_t \Delta Z_s = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} \psi_{11} & \psi_{12} \\ \psi_{21} & \psi_{22} \end{bmatrix}^{s-t} \begin{bmatrix} \Delta Z_t \\ CA_t^S \end{bmatrix} \tag{3.17}$$

Let Ψ be the matrix $[\psi_{ij}]$ and $\mathbf{I}$ be a two by two identity matrix. The optimal consumption smoothing current account can be estimated by substituting equation (3.17) into equation (3.15).[16] The result is

$$\hat{CA}_t^S = -\begin{bmatrix} 1 & 0 \end{bmatrix} \left(\frac{1}{1+r} \Psi \right) \left(\mathbf{I} - \frac{1}{1+r} \Psi \right)^{-1} \begin{bmatrix} \Delta Z_t \\ CA_t^S \end{bmatrix} \equiv \begin{bmatrix} \Phi_{\Delta Z} & \Phi_{CA} \end{bmatrix} \begin{bmatrix} \Delta Z_t \\ CA_t^S \end{bmatrix} \tag{3.18}$$

From (3.18) we can see that a more precise test of the consumption smoothing model is the joint test of $\Phi_{\Delta Z} = 0$ and $\Phi_{CA} = 1$.

16 Both CA_t^S and ΔZ_t need to be stationary in order that (3.18) is well defined.

3.3 Empirical Results

3.3.1 Data

Data are annual series from 1949 to 1995 of the current account, the national accounts and the population, from the International Monetary Fund, *International Financial Statistics* (IFS on CDROM).

To be consistent with the theoretical model, all series are converted into per capita terms. Also, all nominal series (including the current account) are converted into real terms by using the GDP deflator.[17] For the NCF, I use real GDP minus total investment and government spending. The first difference of NCF and the level of the current account are shown in Figure 3.2 below. An apparent trend in the current account is obvious and suggests the existence of consumption tilting. Also, in line with the theory implied by equations (3.14) and (3.15), it appears as if there is some correspondence between the two series. That is, when net cash flows appear to be temporarily below their permanent level, the current account moves further into deficit, and vice versa, when cash flows are temporarily high.

The series were checked for the presence of a unit root using the Augmented Dickey Fuller test (ADF). The results, reported in Table 3.1, confirm that the current account, consumption and NCF are all non-stationary variables and that the change in NCF is a stationary variable.[18]

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17 There are two problems with the current account data. The first is that the preferred measure of the current account should incorporate changes in net foreign asset position due to capital gains and losses. The second is the that the net income deficit is based on nominal interest flows rather than real interest flows. This overstates Australia's real current account deficit which has been running a net income deficit over this entire period. This bias will be increasing over time since net foreign debt has steadily been increasing; although it will be offset somewhat by the fall in world inflation rates since the mid 1980's.

18 Milbourne and Otto (1992) conclude that the current account is stationary. However, their finding is border line and uses quarterly data over a shorter sample period. Furthermore, their finding is at odds with the observed trend behavior of the current account and the fact that consumption is clearly a non-stationary variable.

Figure 3.2: Australian Current Account and First Difference of NCF

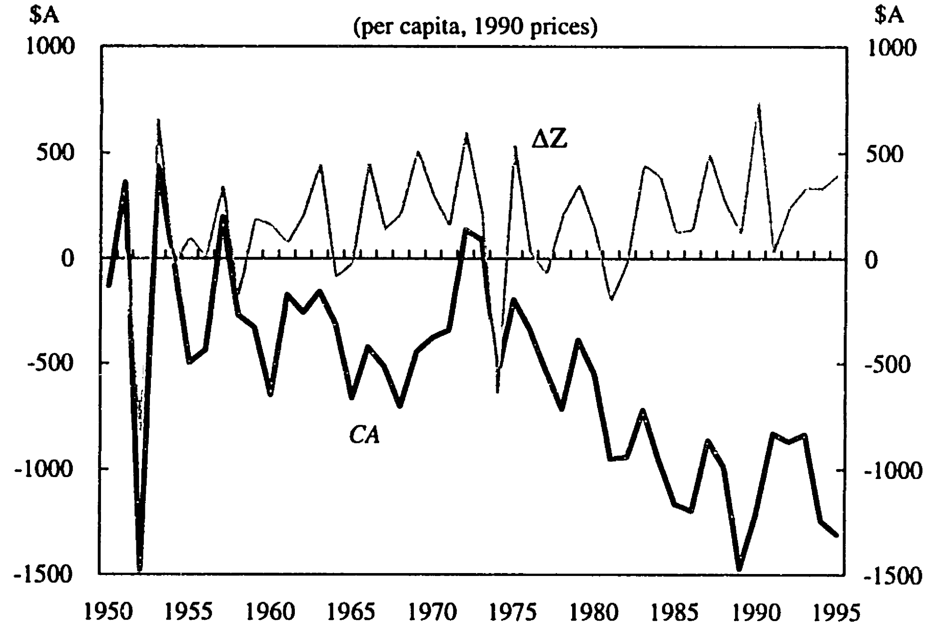


Table 3.1: Unit Root Tests -- Augmented Dickey Fuller Statistics

Variable	Lag, q		ADF(q)	LM(4)
Current Account, CA	3	Constant	-1.79	4.75
	3	Constant & Trend	-0.64	4.45
Consumption, C	3	Constant	0.29	6.50
	3	Constant & Trend	3.02	6.42
Net Cash Flow, Z	1	Constant	-2.78	8.39
	1	Constant & Trend	1.34	6.46
Changes in NCF, ΔZ	0	Constant & Trend	-8.85*	8.60
	0	Constant	-8.15*	8.02

Notes: Critical values are from Fuller (1976). A * indicates rejection of the null hypothesis of a unit root at the 5 per cent significance level. The number of lags, q, of differences of the variable is minimized without introducing serial correlation to the residuals. LM(4) is the Lagrange multiplier for a joint test of first to fourth order autocorrelation in the residuals. It has a Chi squared distribution with 4 degrees of freedom; the 5 per cent critical value is 9.49.

3.3.2 Consumption Tilting -- Cointegration Analysis

In order to break the current account into its consumption tilting and consumption smoothing components, it is necessary to obtain an estimate of the consumption tilting coefficient λ in equation (3.10). Because of the obvious negative trend in the current account, the expectation is that λ will be negative (that is, Australia's rate of time preference appears to be above the world interest rate). The existence of a unit root in both consumption and the current account means that it is appropriate to test for the following cointegrating relationship.

$$CA_t = \lambda C_t + \delta(D_t C_t) + \sum_{i=-1}^{1} \gamma_i \Delta C_{t-i} + u_t \qquad (3.19)$$

where D_t is a dummy variable that is zero from 1951 to 1983 and one from 1984 to 1995.[19] The inclusion of the second terms allows for a break in the trend at 1983. This is consistent with the capital market opening and with the fact that the mean ratio of the current account to GDP approximately doubled after 1983. Before the capital market opening, it is likely that consumers were not able to borrow as much as they desired. In this case, the degree of consumption tilting will have increased after 1983; that is, δ, will be negative.

The results of the estimation are summarized in Table 3.2. Reported t-statistics have been adjusted so that the standard t tables are applicable.[20] No constant term was included in the regression because it was found to be insignificant, which is consistent with the theory outlined in Section 3.2.

19 The leads and lags of the first difference of consumption are included on the right-hand-side of the regression to help account for serial correlation in the residuals. This procedure is suggested in Stock and Watson (1993). See Hamilton (1994) for a review of this and other related tests for cointegrating relationships.

20 The OLS t-statistics are multiplied by the factor (s^2/η^2); $s^2 = (T-5)^{-1} \sum_{t=1}^{T} \hat{u}_t^2$ and $\eta = \hat{\sigma}/(1-\hat{\phi}_1-\hat{\phi}_2)$, where $\hat{\sigma}$ is a consistent estimate of the standard deviation of residuals from a AR(2) regression of $\hat{u}$ with AR coefficients ϕ_1 and ϕ_2.

Table 3.2: Cointegration Tests -- OLS regression of Equation (19)

	λ	δ	ADF for residuals
Coefficient	-0.039	-0.034	-5.30*
t-statistic	-5.10	-5.78	

Notes: Critical values for the ADF statistic are from Fuller (1976). A * indicates rejection of the null hypothesis of no cointegration at the 5 per cent significance level.

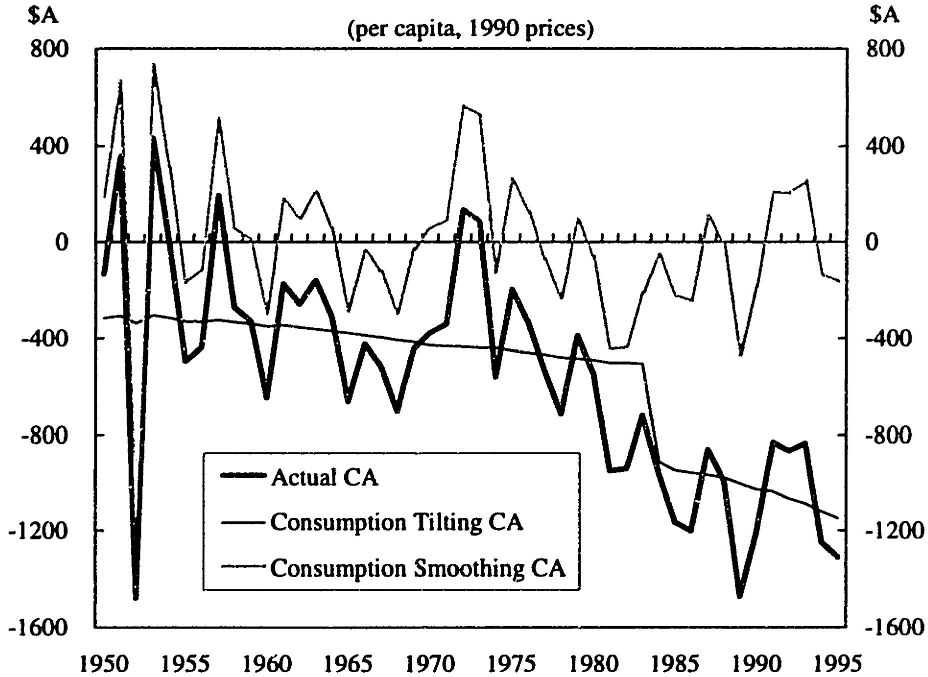
Clearly, the current account and consumption are cointegrated and the estimate of λ is less than zero. This is broadly consistent with Cashin and McDermott (1996).[21] Furthermore, δ is significantly less than zero, which confirms that the degree of consumption tilting increased after financial liberalization in 1983. This is strong evidence in support of the existence of binding credit constraints in the period prior to 1983 (so long as the reasonable assumption of unchanged consumer preferences is maintained).

The actual current account is separated into its stationary and non-stationary components in Figure 3.3 below.[22]

21 The approach of Cashin and McDermott (and others) is to test for a cointegrating relationship between consumption and the sum of NCF and interest on net foreign assets (rB_t). It is easy to show that this is equivalent to my methodology by using the current account identity to rewrite their cointegrating relationship. The only difference is that they are forced to use a fairly poor estimate of net interest income, whereas I am not.

22 The stationary component of the current account is obtained as the estimated residuals from the following OLS regression: $CA_t - \hat{\lambda} C_t - \hat{\delta} D_t C_t = \mu + \varepsilon_t$. The left hand side of this expression has a non-zero mean because of the inclusion of leads and lags of consumption changes in the right hand side of equation (3.19). The non-stationary consumption tilting component of the current account is simply $\hat{\lambda} C_t + \hat{\delta} D_t C_t - \hat{\mu}$.

Figure 3.3: Current Account Tilting and Smoothing Components



Using estimates of the sum of λ and δ, it is possible to back out a rough estimate of the Australian rate of time preference, $(1-\beta)/\beta$. Deaton (1992) provides a summary of estimates of the intertemporal elasticity of substitution ($1/\sigma$) that range from 0.35 to 0.75. Using an interest rate of 4 per cent implies that the rate of time preference is between 0.04004 and 0.04009.[23] That is, the consumption tilting behavior implies rates of time preference only marginally above the world interest rate.

3.3.3 Consumption Smoothing -- VAR Estimation Results

The evidence of credit constraints shown above also implies that agents would be unable to optimally smooth consumption in the face of transitory shocks to NCF. However, I ignore this possibility until Section 3.4.

By construction, the consumption smoothing component of the current account is a stationary variable (because it is the residual from a cointegrating equation). Because

23 For an interest rate of 2 per cent the estimate is between 0.02001 and 0.02002. For an interest rate of 6 per cent the estimate is between 0.06009 and 0.0602.

both CA^S and the first difference of the NCF, ΔZ, are both stationary, it is possible to estimate the VAR shown in equation (3.16). The results are presented in Appendix B.

Table B.2 in Appendix B shows the results for the VAR(1), VAR(2) and VAR(3) models.[24] The VAR(1) results are consistent with those from the VAR(2) and VAR(3). Summary statistics in Table B.3 show that the current account does Granger cause the change in the NCF, but that the change in the NCF does not Granger cause the current account. This is weak evidence in favor of the consumption smoothing hypothesis.

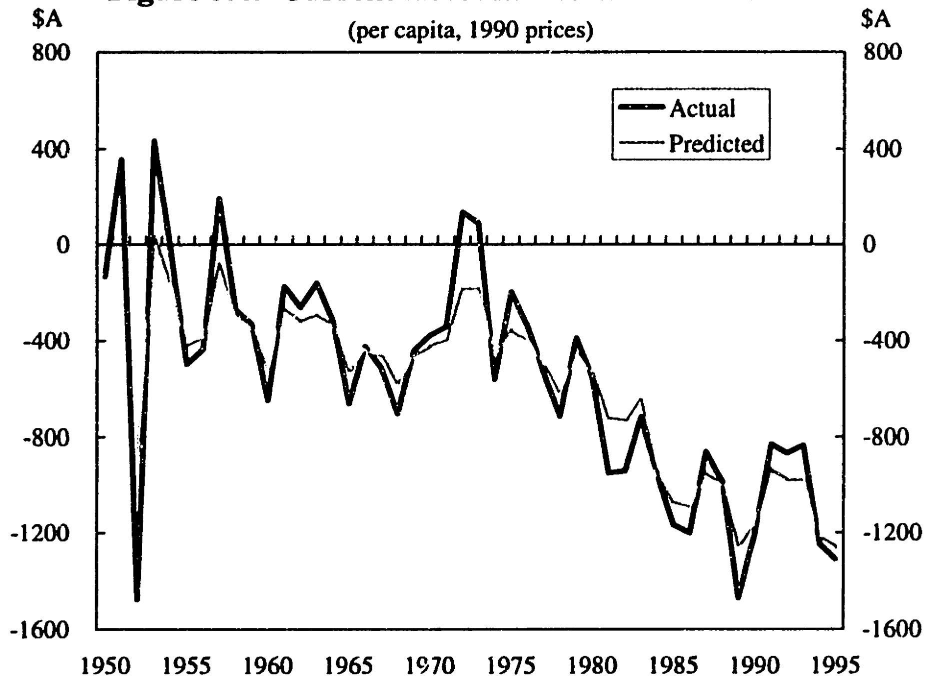
The estimates of the vector Φ are shown in Table B.4.[25] The strict test of consumption smoothing hypothesis is that the elements of this vector should be zero except for the element that applies to CA_t^S, which should be one. The consumption smoothing hypothesis fails the Wald test of this joint hypothesis. Figure 3.4 shows a comparison of the actual current account and the model estimate of the current account. This estimate is obtained by recombining the consumption tilting component and the consumption smoothing component implied by Φ.

24 Higher order VARs were estimated to ensure that results were not affected by potential serial correlation.

25 The estimates shown are based on a real interest rate of 4 per cent. Results were robust to using either a 2 or a 6 per cent real interest rate.

Figure 3.4: Current Account Actual and Predicted

(per capita, 1990 prices)



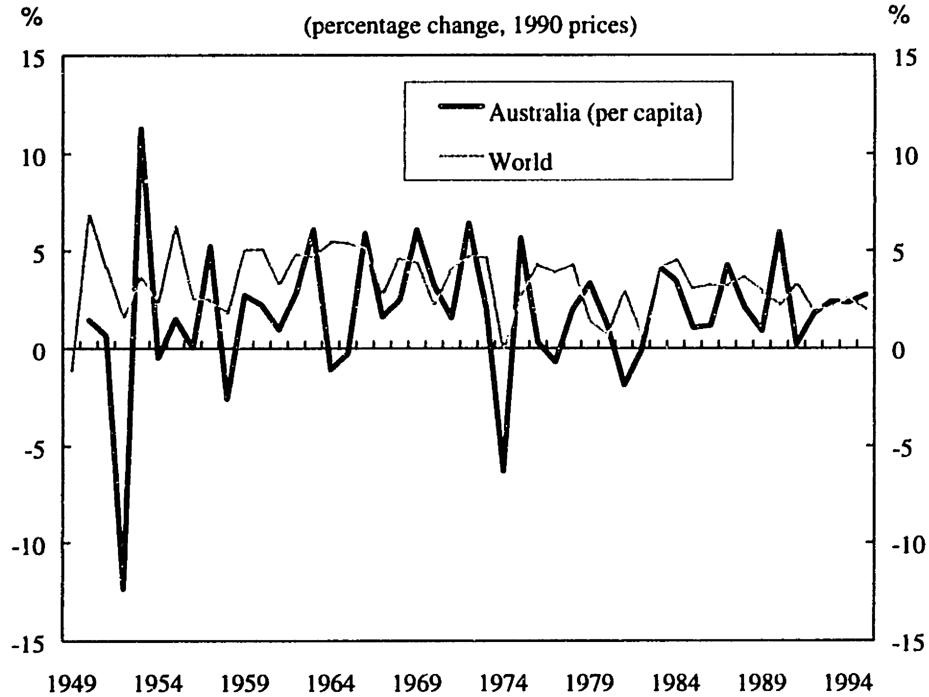
3.3.4 Separating World Shocks from Changes in NCF

Theory predicts that a shock that is common to the whole world can affect investment but will have a much smaller affect the current account (interest rates adjust to ensure that world savings equal world investment). Glick and Rogoff (1995) show that this is true for the group of G7 countries: they model the investment decision explicitly and consider shocks to manufacturing productivity. Figure 3.5 below compares percentage changes in the Australian NCF with changes in the World NCF.[26]

26 I define the world as the United States, Germany, Japan, France, Italy, the United Kingdom, Canada, Sweden and Belgium. Together these countries account for between 77 and 70 per cent of total world GDP over the sample period. Shares of world output are based on the list of countries in the World Bank Tables, using nominal GNP in US dollars.

Figure 3.5: Changes in Net Cash Flow - Australia and the World

(percentage change, 1990 prices)



The idiosyncratic changes in the Australian NCF, ΔZ_t^I, are constructed as the estimated residuals from the following regression:

$$\Delta Z_t = \alpha + \delta \, \Delta Z_t^W + \varepsilon_t \tag{3.20}$$

where ΔZ_t and ΔZ_t^W are changes in the Australian and the World NCFs respectively. Obstfeld and Rogoff (1995) show that under certain conditions, ΔZ_t can be replaced by ΔZ_t^I in equation (3.15).[27] The results of the estimation of the VARs using the idiosyncratic component of the NCF are shown in Tables B.5, B.6 and B.7 in Appendix B.

27 These conditions include a zero net foreign asset position. Otherwise, changes in the world interest rate will have a differential income effect on net debtors and net creditors, thereby leading to some adjustment of these countries' current accounts. Glick and Rogoff (1995) demonstrate that this effect is small for the set of G7 countries. In the case of Australia, this effect is likely to be more significant only in the latter part of the sample, following the more rapid accumulation of net foreign liabilities after 1983.

Most of the results are similar to those using the actual changes in the NCF, reported in Section 3.3. This is hardly surprising given that changes in the world NCF explain only a small fraction of changes in the Australian NCF.[28]

The current account is shown to Granger cause changes in the idiosyncratic NCF, but not vice versa. The restriction on the vector Φ fails in the case of the VAR(1) and VAR(2) estimates, but not in the case of the VAR(3) estimates. This apparent contradiction may in part be due to the fact that the VAR(3) estimates necessarily exclude the earlier two years of the sample. These two years contain very important information because both the current account and the NCF both show a large amount of variation in the early 1950's. Therefore, on balance, the consumption smoothing hypothesis is rejected over the full sample period.

3.4 Capital Market Opening and Credit Constraints

The aim of this section of the chapter is to determine whether or not credit constraints are responsible for the rejection of the consumption smoothing hypothesis over the full sample period. I have already shown that there was a significant increase in the degree of consumption tilting after 1983, which is consistent with a reduction in the extent of credit constraints. However, I have not accounted for the effect of credit constraints on the behavior of the consumption smoothing component of the current account. I approach the problem in two different ways.

3.4.1 Restricted Sample Periods

Ideally, I would like to test the performance of the model over the period with no capital market restrictions. However, this latter part of the sample period is too small to estimate

28 The adjusted R^2 from the OLS regression of equation (3.20) is only 0.05.

the VAR. Instead, I split the sample in half and re-estimate the VAR over the two sample periods, 1951 to 1973 and 1974 to 1995.[29]

The results of the estimation are shown for the VAR(1) model in Tables B.8, B.9 and B.10 in Appendix B (the results for the VAR(2) and VAR(3) models are not shown but are essentially equivalent).[30] In both sub-samples, the current account Granger causes changes in the NCF, but only in the latter sub-sample does the change in the NCF fail to Granger cause the current account. In other words, for the earlier sub-sample, knowing the history of changes in the NCF helps to improve predictions of the current account. This contradicts the consumption smoothing hypothesis implicit in equation (3.15).

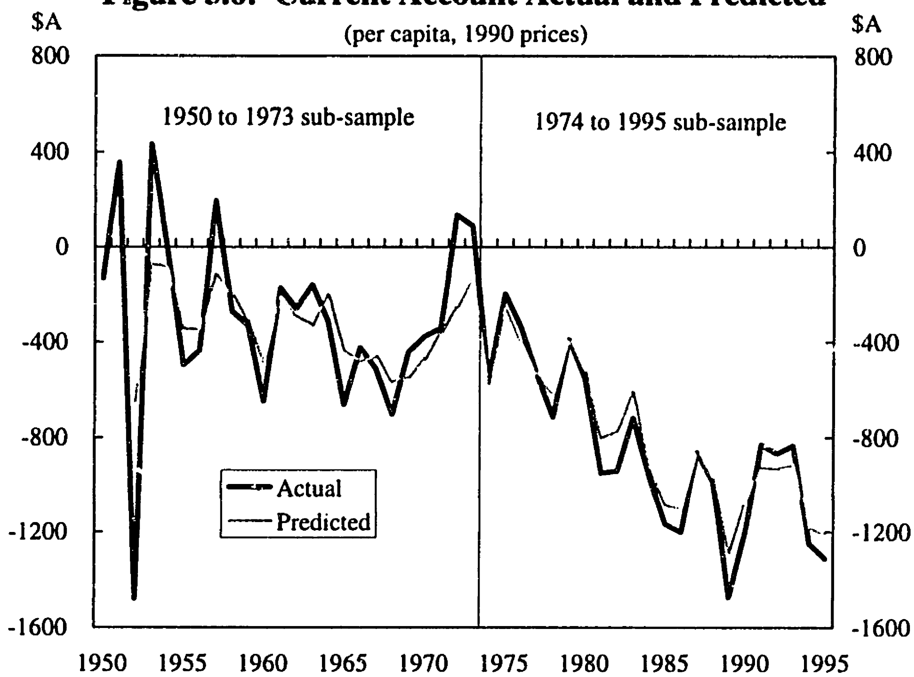
The strict test of the consumption smoothing hypothesis (that is, the restriction on the vector Φ), is rejected for the earlier sub-sample, but is accepted for the latter sub-sample. Figure 3.6 compares the predicted current account and the actual current account over the two sub-samples. This evidence is only weakly indicative of the effect of the capital market opening, and of credit constraints more generally, because the latter sub-sample still contains many years prior to the capital market opening.

29 The results for the complete sample prior to capital market liberalization, 1950 to 1983, are generally the same as for the shorter sample 1950 to 1973.

30 For Section 3.4 I maintain the use of the idiosyncratic component of the NCF.

Figure 3.6: Current Account Actual and Predicted

(per capita, 1990 prices)



3.4.2 Credit Constraints -- Testing for Asymmetric Behavior

In a world without credit constraints, consumers are able to respond to good and bad shocks to NCF in a symmetric fashion. However, this is no longer true in a world with credit constraints. A consumer who is strictly credit constrained will be unable to smooth consumption in response to a temporary reduction in their NCF. However, the same consumer will be able to smooth consumption in response to a temporary increase in their NCF.[31]

The objective is to determine to what extent, if any, credit rationing influences the current account through its effect on consumption smoothing behavior. I assume that, even during times when the capital market remained relatively closed, consumers were able to save during periods of temporarily high NCFs. The objective is to test for an asymmetric response of the current account during periods of temporarily high and low NCFs. I

31 This result needs some qualification. In the case when a consumer is currently credit constrained, would like to increase consumption and is expecting an easing of credit restrictions in the near future. In this case, the consumer may have an incentive to consume all of a temporary increase in their NCF if it is small enough.

proceed by breaking up the consumption smoothing current account series into two separate series as follows:

$$CA_t^{SP} = D_t^P \, CA_t^S \qquad \text{where} \qquad D_t^P = \begin{cases} 1 & if \quad CA_t^S > 0 \\ 0 & if \quad CA_t^S \leq 0 \end{cases}$$

$$CA_t^{SN} = D_t^N \, CA_t^S \qquad \text{where} \qquad D_t^N = \begin{cases} 1 & if \quad CA_t^S < 0 \\ 0 & if \quad CA_t^S \geq 0 \end{cases} \tag{3.21}$$

In other words, CA_t^{SP} takes the value of CA_t^S (the consumption smoothing current account), whenever CA_t^S is positive, and CA_t^{SP} is zero otherwise. [The variable CA_t^{SN} is defined in a similar fashion but with the signs reversed. Also, I define ΔZ_t^{IP} and ΔZ_t^{IN} in the same manner.]

To the extent that credit constraints are not absolutely binding for all agents, CA_t^{SP} will still indicate times of temporarily high NCF. Similarly, CA_t^{SN} will indicate times when NCF is temporarily low. Therefore, I still expect both CA_t^{SP} and CA_t^{SN} to Granger cause changes in NCF. However, I expect that credit constraints will greatly limit the ability of consumers to smooth through bad times, with little, if any impact on the degree of smoothing through good times. This means that CA_t^{SP} will be a very good predictor of future changes in NCF, but that CA_t^{SN} will not. To test this I run the following VAR(1):

$$\begin{bmatrix} \Delta Z_t^{IP} \\ \Delta Z_t^{IN} \\ CA_t^{SP} \\ CA_t^{SN} \end{bmatrix} = \Psi \begin{bmatrix} \Delta Z_{t-1}^{IP} \\ \Delta Z_{t-1}^{IN} \\ CA_{t-1}^{SP} \\ CA_{t-1}^{SN} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} \tag{3.16'}$$

The results for the VAR(1) are shown in Tables B.11 and B.12 in Appendix B. The Granger causality tests are consistent with the asymmetric affects of credit constraints. In particular, CA_t^{SP} and CA_t^{SN} jointly Granger cause both ΔZ_t^{IP} and ΔZ_t^{IN} (at the 5 per cent significance level). However, ΔZ_t^{IP} and ΔZ_t^{IN} do not Granger cause CA_t^{SP}, but jointly they do Granger cause CA_t^{SN} (at the 10 per cent significance level). In other words, lagged changes in the NCF are significant explanators of CA_t^{SN} even when controlling for lagged levels of CA_t^{SN}, which should not be the case if consumers are able to optimally smooth through bad times. These results are similar (if not somewhat stronger) over the sub-sample from 1951 to 1983.

Using a similar argument to that of Section 3.2, CA_t^S can be expressed as a non-linear function of the VAR parameter estimates.

$$\begin{aligned} \hat{CA}_t^S &= -\begin{bmatrix}1 & 1 & 0 & 0\end{bmatrix}\left(\frac{1}{1+r}\Psi\right)\left(I-\frac{1}{1+r}\Psi\right)^{-1}\begin{bmatrix}\Delta Z_t^{IP}\\ \Delta Z_t^{IN}\\ CA_t^{SP}\\ CA_t^{SN}\end{bmatrix} \\ &\equiv \begin{bmatrix}\Phi_{\Delta Z^P} & \Phi_{\Delta Z^N} & \Phi_{CA^P} & \Phi_{CA^N}\end{bmatrix}\begin{bmatrix}\Delta Z_t^{IP}\\ \Delta Z_t^{IN}\\ CA_t^{SP}\\ CA_t^{SN}\end{bmatrix} \end{aligned} \qquad (3.18')$$

The hypothesis of consumption smoothing and no credit constraints is equivalent to $\Phi_{\Delta Z^P} = \Phi_{\Delta Z^N} = 0$ *and* $\Phi_{CA^P} = \Phi_{CA^N} = 1$. The alternative hypothesis is that credit constraints imply an asymmetric consumption smoothing response. More specifically, the alternative hypothesis is $\Phi_{\Delta Z^P} \neq \Phi_{\Delta Z^N} \neq 0$, $\Phi_{CA^P} = 1$ *and* $\Phi_{CA^N} \neq 1$. Results from the VAR(1) estimate reject the pure consumption smoothing hypothesis, in favor of the asymmetric alternative (see Table 3.3 below).

Table 3.3: Tests of the Asymmetric Consumption Smoothing

	VAR(1): 1951-95	VAR(1): 1951-83
$\Phi_{\Delta Z^P}$	0.14 (0.20)	-0.24 (0.24)
$\Phi_{\Delta Z^N}$	-0.62 (0.36)	-0.24 (0.30)
Φ_{CA^P}	1.10 (0.42)	1.09 (0.37)
Φ_{CA^N}	0.31 (0.24)	0.20 (0.23)
Wald Statistic	48.38*	63.68*

Notes: * indicates rejection of the joint null hypothesis at a 5 per cent significance level.

3.5 Concluding Remarks

This essay has demonstrated that the behavior of Australia's current account from 1951 to 1995 is inconsistent with a standard representative agent model of intertemporal consumption smoothing. The main innovation was to take explicit account of the effect of credit constraints. Credit constraints were important during the period prior to the early 1980's when Australia had a repressed domestic banking sector and a relatively closed capital market. The failure of the standard consumption smoothing hypothesis for Australia was shown to be consistent with the existence of credit constraints.

A simple model with no uncertainty and an iso-elastic utility function was used to illustrate two important features of the current account behavior: consumption tilting and consumption smoothing. I made use the time series properties of the data to remove the non-stationary consumption tilting component which arises because Australians are more impatient than the rest of the world. There is evidence of a significant increase in the degree of consumption tilting after 1983. This is consistent with a reduction in the extent of credit constraints after the capital market was fully opened in late 1983.

Under the null hypothesis, the consumption smoothing current account deficit is equal to the net present value of future changes in Net Cash Flow. Estimates of VAR models proved that the current account Granger causes the change in the NCF but not vise versa; although, this is only weak evidence in support of the null hypothesis. The strict version of the null hypothesis was rejected using a non-linear transformation of the VAR parameter estimates from the period 1951 to 1995. Even so, the null hypothesis was accepted over the recent half of this sample period. This is consistent with reduced credit constraints after 1983, but is in no way conclusive evidence.

One implication of credit constrained behavior is an asymmetric response to temporarily high NCFs and temporarily low NCFs. Even in a credit constrained environment, agents are still able to save in order to smooth consumption when NCFs are high. However, credit constrained consumers will be unable to optimally smooth consumption when NCFs are low. In order to account for these asymmetries in the estimation process, both the current account and the change in the NCF were split into two series -- one with all of the positive observation of the series (and zeros elsewhere), and the other with the remaining negative observations (and zeros elsewhere). There was strong evidence of an asymmetric response that is entirely consistent with consumption smoothing in an environment of credit constraints.

Removing the effect of world shocks from changes in the Australian NCF did not alter the results significantly. This was not entirely surprising, because changes in the world NCF have little explanatory power for changes in the Australian NCF.

Chapter 4

Effective Real Exchange Rates and Irrelevant Exchange Rate Regimes

4.1 Introduction

Many studies have explored the hypothesis of sluggish price adjustments by examining the behavior of Real Exchange Rates (RERs) across different nominal exchange rate regimes. The broad class of models that incorporate the assumption of price sluggishness imply that the RER should exhibit less short-term variance under fixed rather than flexible nominal exchange rate regimes. In other words, RERs should move relatively slowly under fixed nominal exchange rates regimes (except for changes in official parities or realignments), and under floating exchange rate regimes the RER and the nominal exchange rate should show a high degree of correlation (in accordance with the nominal rate behaving like an asset price).

The fact that RERs exhibit substantially higher variance under floating nominal exchange rate regimes than under fixed exchange rate regimes has been well documented in the literature.[1] However, to the best of our knowledge, all of these studies[2] are based on the analysis of bilateral RERs, whereas, as Black (1986) suggested, a meaningful comparison would be based on effective RERs. The effective RER is more relevant than the bilateral

1 See Frankel and Rose (1995) for a summary of the literature on this topic.

2 Including the seminal piece by Mussa (1986), Eichengreen (1988), Baxter and Stockman (1989) and Flood and Rose (1993).

RER for questions that relate to the effect of the nominal exchange rate regime on other real macroeconomic variables. We re-examine the evidence using effective RERs across a large sample of countries.

A country's effective RER is a trade weighted average across all of its bilateral RERs. This means that the variance of the effective RER will be lower than the variance of most of its component bilateral RERs. This possibility would help to resolve a somewhat puzzling result that follows from the existing literature in this area:

> *Baxter and Stockman (1989) have shown that the nominal exchange rate regime has no significant systematic impact on key macroeconomic variables. However, the higher volatility of bilateral RERs under flexible exchange rate regimes compared to fixed exchange rate regimes is a well established fact. Resolving these two findings is puzzling if we accept that there should be a link between the RER and other real macroeconomic variables.*

One potential resolution of this puzzle is as follows. If the effect of averaging bilateral RERs reduces the variance of the effective RER sufficiently, then it might be feasible that the nominal exchange rate regime has little impact on the volatility of *effective* RERs and, therefore, little effect on the volatility of other macroeconomic variables.

The chapter proceeds as follows. In Section 4.2 we use Mussa's sample of 16 industrialized countries and his definitions of exchange rate regimes to examine the volatility of the RER under fixed and floating regimes. We show how the use of effective RERs in place of bilateral RERs has an important impact on the results.

We provide a brief description of our data in Section 4.3 which also provides a discussion of the problematic task of classifying countries' exchange rate regimes.

We present results for the effective RER across a much broader sample of countries in Section 4.4. In contrast to existing studies that rely heavily on the breakup of the Bretton Woods system to delineate between exchange regimes, our data set contains regime experiences which are less correlated across time, in part because our monthly data starts after 1978 and in part because of the larger number of countries included in the sample.[3]

To make a valid determination of the effect of the nominal exchange rate regime, it is necessary to compare the behavior of the RER across countries which have similar characteristics. In other words, we do not want a comparison across extreme types of economies for which we would naturally expect very different RER behavior irrespective of the nominal exchange rate regime. In Section 4.4 we choose to select a subset of countries based on their inflation experience and on the variability of their growth rates. Both of these criteria are likely to influence the underlying behavior of the RER. Countries with high and variable inflation or variable rates of growth also tend to exhibit a very wide range of RER volatility across all nominal exchange rate regimes. Therefore, we choose to concentrate our efforts on countries with both low inflation and stable growth rates.

Section 4.5 concludes with some remarks concerning the interpretation of our results.

4.2 Re-Examining Existing Evidence

Before proceeding with the analysis of the volatility of the effective RER, we show that the results of previous studies are driven largely by their reliance on bilateral RERs. We choose to focus on Mussa's seminal paper by recreating his results, using his sample of countries and his nominal exchange rate classification scheme, first for bilateral RERs and then for the effective RERs.

Mussa analyses the behavior of bilateral RERs (versus the US dollar) of 15 industrialized countries. His main result is that the variance of the quarterly changes in the bilateral RERs was on average almost 14 times higher under floating exchange rate regimes than under fixed exchange rate regimes. We replicate Mussa's methodology using monthly

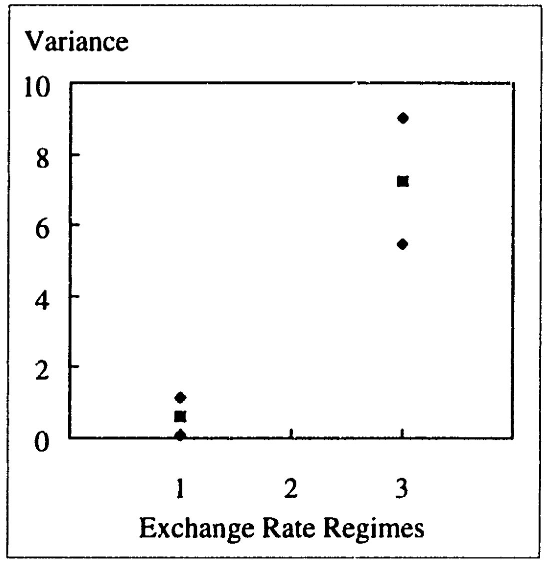
3 The existing findings could be due to very different behavior of the US RER pre- and post-Bretton Woods, but with no substantial change in the behavior of other countries' RERs. O'Connell (1986) makes this point when talking about the time series properties of bilateral RERs versus effective RERs.

bilateral RERs (see Appendix C.2 for details of the data and regimes).[4] Figure 4.1 below, shows the results for the bilateral RERs over the period January 1960 to December 1990; we label the fixed exchange rate regime as regime 1 and the floating exchange rate regime as regime 3.[5]

Figure 4.1: Average Variance of Monthly Bilateral RER Changes

- Mussa's Sample of 14 Industrialized Countries
- Bilateral RER based on US dollar and the CPI
- up to Dec-90

Reg.	Mean	95% Confidence Interval		No Obs.
1	0.60	0.08	1.13	13
2				
3	7.25	5.46	9.03	14



Confidence intervals for the average variance across countries within each regime are constructed as follows. We assume independence across countries and use estimates of the standard error of each country's variance to obtain a standard error for the average variance across countries. Figure 4.1 clearly shows that the variance of bilateral RER changes is significantly lower under regime 1 than regime 3; the ratio of the average variance is 1 to 12 respectively.[6]

4 The bilateral RERs are based on Consumer Price Indices. Nominal exchange rates are monthly averages throughout this chapter. We did not include Luxembourg in our sample.

5 The original sample period was from 1957 to 1984. Our effective RERs start in 1960, and we found it was straightforward to extend Mussa's regime classification scheme up to December 1990. Beyond that, it becomes ambiguous for many European countries which dabbled with fixed exchange rates for a time (especially Sweden, the United Kingdom and Italy).

6 The ratio of the average variance is lower than Mussa's result due to slightly different sample periods, the use of monthly instead of quarterly data, the inclusion of Ireland's experience under regime 3 and the exclusion of Canada's experience with regime 3 prior to 1962.

The assumption of independence across countries is most likely to be violated in the case where countries' experiences of each regime occur contemporaneously and where countries are likely to have experienced similar macroeconomic shocks. This is of particular concern in this sample of industrialized (mostly European) countries. To partially address this issue, we also conducted F-tests of the ratio of the variances across regimes within each country. For bilateral RERs in this sample, all F-tests (not reported here) conclusively indicated a greater variance under regime 3 than regime 1 for every country in the sample.

We now replicate the above methodology using effective RERs. The results are shown in Figure C.1 in Appendix C, which uses the same set of countries and the same nominal exchange rate regime classifications as in Figure 4.1 (a description of the data is provided in Section 4.3 and in Appendix C.2). The effective RER changes show greater variance under regime 3 than regime 1, but this difference is not significant at the 5 per cent level. The ratio of the average standard deviation is now 1 to 1.9 which is a lot lower than for the case of bilateral RERs.

The issue of the classification of the nominal exchange rate regimes is more difficult in the case of effective RERs than in the case of bilateral RERs. To illustrate, consider the case of Austria. The Austrian shilling was fixed against the US dollar under Bretton Woods and then flexible against the US dollar post-Bretton Woods. This would be a natural way of classifying the nominal exchange rate regime for the purposes of examining the behavior of the Austrian bilateral RER (relative to the US). However, for the purposes of analyzing the effective RER, it is natural to classify the nominal exchange rate regime as fixed both during and after Bretton Woods – that is, fixed first against the US dollar and later fixed against the German Deutsche mark.[7] Mussa attempted to account for this by considering more than one bilateral RER for a given country. When we look at effective RERs, we reclassified countries' exchange rate regimes according to whether or not the country was fixing its exchange rate against any major currency and

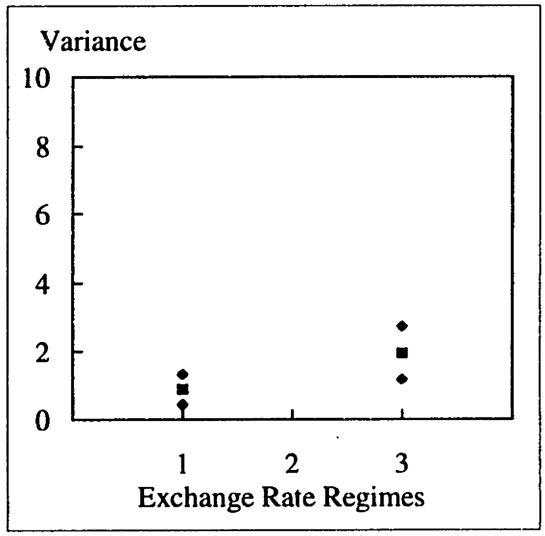
7 The question of transitions between regimes is avoided here, as in Mussa, by excluding observations around the time of the breakdown of Bretton Woods. This issue is discussed in more detail in Section 4.4.

not just against the US dollar. Also, we added the US to the sample of countries. The results of these refinements are shown in Figure 4.2 below. As before, the average variance of the monthly RER changes is higher under regime 3 than regime 1, but this difference is not significant at the 5 per cent level.

Figure 4.2: Average Variance of Monthly Effective RER Changes

- Mussa's Sample of 15 Industrialized Countries
- Multilateral RER
- Up to Dec-90
- Includes United States
- Austria in Reg. 1 full sample
- Ireland in Reg. 1 till Dec-78

Reg.	Mean	95% Confidence Interval		No Obs.
1	0.88	0.44	1.32	15
2				
3	1.95	1.16	2.74	14



However, F-tests for each country show that except for Denmark, France and the Netherlands, the variance of the monthly changes in the effective RER is significantly higher under regime 3 than regime 1.

The results of this section of the essay have shown that existing evidence that the variance of the changes in the RER is dramatically higher under a flexible exchange rate regime is no longer convincing when we consider effective RERs. The ratio of the variance of the RER under fixed versus flexible regimes is about 1 to 12 for bilateral RERs, but the ration is only about 1 to 2 for effective RERs.

As we mentioned above, a major problem with this sample of 16 industrialized countries is that most of the changes in the exchange rate regimes all occur at the same time (around the collapse of the Bretton Woods system). This is troubling because it is not clear that a finding of different behavior of the RER is due to a change in nominal exchange rate regimes or other contemporaneous changes in the world economy.[8]

We address many of these concerns by examining the behavior of the effective RER across a much larger set of countries. This has the added advantage that the changes in nominal exchange rate regimes are not strongly correlated over time. Before presenting the results of our analysis, we discuss the data in some detail in Section 4.3 below.

4.3 Data

Our initial data set consists of 92 countries with monthly data on the effective RER, the nominal exchange rate regimes and inflation rates over the time period 1978-1994. Also, we use annual data on real GDP to calculate the variance of real GDP growth rates.

4.3.1 Nominal Exchange Rate Regimes

We build our data set on nominal exchange rate regimes from the monthly issues (October 1978 - November 1996) of the International Monetary Fund, *International Financial Statistics* (IFS) and from the *Annual Report on Exchange Arrangements and Exchange Restrictions* of the IMF (1978-1983).

The raw data on regimes classifies countries in each month according to one of over 25 possible descriptions of the exchange rate arrangements.[9] We simplify this classification scheme by aggregating categories into three broad groupings. Regime 1 is a fixed exchange rate including pegs to single currencies and pegs to the SDR or other baskets. Regime 2 allows for some flexibility in the nominal rate and includes countries in the

8 The paper by Flood and Rose addresses this issue, as do Baxter and Stockman who show that other real macroeconomic variables are independent of regimes, and, therefore, we do not have to be too concerned with all changes being centered on end of Bretton Woods system. Still, we have problem of endogeneity.

9 These are also an integral part of monetary and other policies which have a direct bearing on exchange rate management.

EMS, pegs which are adjusted frequently (according to a set of indicators) and managed floating rates. Regime 3 consists of freely floating exchange rates (exact details are provided in Appendix 2). In practice, the classification scheme expresses relative degrees of flexibility rather than precisely delineating between alternative regimes.

Our classification scheme is similar to that used by the IMF. It differs from Mussa by differentiating between regime 2 and 3 which he had combined into a single group. The other differences are in part due to our focus on effective RERs. For example, as already mentioned, in our classification scheme, Austria is in regime 1 until 1990, during which time it was fixed to a major currency.

The main concern about our classification scheme for regimes is the accuracy of the initial classification by the IMF. Member countries of the IMF are required to submit information regarding their exchange rate arrangements, although this information is not always very accurate. The IMF investigates any countries that appear to be providing misleading information and shifts these countries to the appropriate categories. This issue is discussed in more detail in Section 4.4.

Ideally, the classification of the nominal exchange rate regime would be based on a country having in place a broad set of policies which are consistent with a given regime. However, on occasion, a country will classify itself into a given regime but run policies which are inconsistent with this regime. For example, a country with very high inflation that attempts to be in regime 1, but does nothing to control inflation, is unlikely to be able to hold a fixed peg for any length of time. Therefore, such a country will display a highly variable RER simply because the peg has to be continuously adjusted. Such a country is really not a genuine regime 1 country. We address this problem by examining a subset of countries with low and stable inflation and stable growth rates that are most likely to be accurately classified in terms of their exchange rate regimes.

4.3.2 Effective RERs and Other Data

We use the Goldfajn-Valdes (1996) data set on monthly effective RER's that is available from January 1960 to December 1994. In the construction of the RERs, they use the Wholesale Price Index when available; otherwise they use the Consumer Price Index.

Inflation rates are calculated from the monthly average CPI (or the WPI when the CPI is unavailable) from the *IFS*. Growth rates of real GDP were taken from the Summers and Heston database in the Mark 5.6 version of the Penn World Tables.

4.4 New Evidence

In what follows we examine the variance of the monthly percentage changes in the effective RER across countries and nominal exchange rate regimes. We do this for the period November 1978 to December 1994. We make refinements to the analysis as we proceed, the most important being to look at the results for countries with common inflation and growth experiences over the period. This is critical because we want to ensure that our findings are not driven by the wide range of RER behavior that we would expect across a large and diverse set of countries irrespective of their exchange rate regime.

For each country we separate monthly percentage changes in the RER according to the regime under which these changes occurred. Then, for each country within each regime, we calculate the variances of these changes. Each variance for each regime constitutes an 'observation' (countries that have experienced only one regime contribute only one observation). We then construct confidence intervals for the variances within each regime across all countries that experienced that regime. Figure C.2 shows the results for the full set of countries. Although the mean variance is higher under regime 3 than regime 1 and 2, this difference is not significant.

Regime Switching

Regime switches often involve large changes in both the nominal exchange rate and the RER. These transitions are problematic because it is not clear whether changes in the RER are associated with the new or the old regime (or simply because the regime is in transition). Indeed, a large depreciation may take place at the onset of a flexible regime but may be none other than a correction of a significant overvaluation from the fixed exchange rate regime. We control for this problem by deleting the last three months at the end of an old regime and the first three months at the beginning of a new regime.[10] Figure C.3 shows the results corrected for regime switching. The behavior of the RER is still independent of regimes; however, the confidence interval for regime 3 has fallen and narrowed substantially (which is consistent with the example discussed just above). All of the results that follow in this chapter are based on this correction for regime switching.[11]

High versus Low Inflation Countries

We divide the sample of countries between those with low inflation and those with high inflation. (We use a cutoff rate of 10 per cent per annum averaged over the sample from 1978 to 1994.) This will help to account for systematic differences across country types that might be relevant to the behavior of the RER but not necessarily related to the nominal exchange rate regime.[12] The results shown in Figures C.4 and C.5 confirm our

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10 This problem has typically been corrected for in other work by excluding the period from 1971 to early 1973, following the collapse of the Bretton Woods system.

11 Although we do not consider it in this essay, the behavior of the RER at the time of regime switches is often dramatic and is one way in which the nominal exchange rate regime may in fact have important implications for the RER and the economy in general.

12 This is also a useful distinction because we expect that the regime classification scheme is likely to be most accurate for low inflation and more developed economies. For example, a country can be classified as regime 1, but the government and monetary authorities might be setting other policies which are totally inconsistent with regime 1 (such as causing very high inflation through financing large deficits by printing money). Also, for reasons that we do not fully understand, many developing countries (which also have high inflation) report their regimes as floating when they clearly are not. For these reasons, we think that the regime classification is most accurate for low inflation (and stable growth) economies.

suspicion that high inflation countries have much higher variability in their RERs. We concentrate the rest of our analysis on the set of low inflation countries.

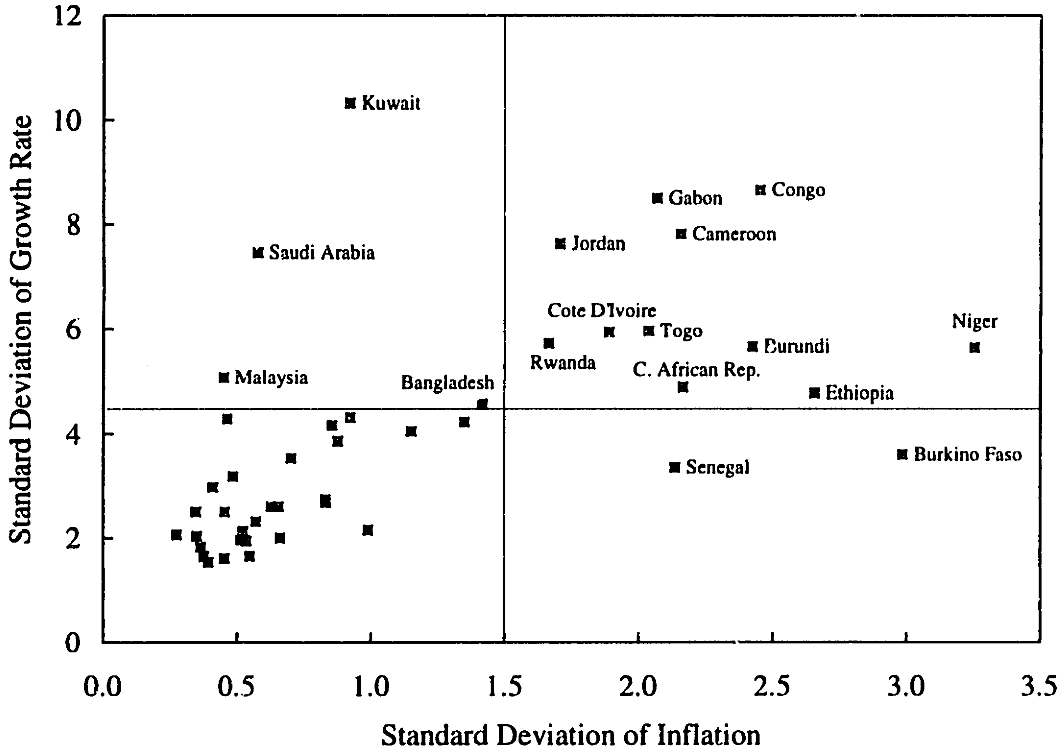
For this set of low inflation countries, regimes 2 and 3 display lower average RER variance than regime 1. This apparently perverse result occurs because many countries that have only experienced regime 1 have low but highly variable inflation (and highly variable growth rates), which naturally increases the variance of the RER for these countries.[13]

Low Inflation and Stable Growth Rate Countries

Figure 4.3 (below) shows a scatter plot of the standard deviation of both the inflation and the growth rates for the set of low inflation countries. We chose to exclude from our sample of low inflation countries all of those countries shown in the upper and right quadrants of Figure 4.3 (that is, countries with a standard deviation of growth greater than 4.5 per cent as well as Burkino Faso and Senegal).

13 This volatility must reflect greater instability both in terms of external shocks, such as the terms of trade, and internal shocks such as changes in domestic policy settings. Most of these countries are members of the CFA African Franc Zone, which experienced a very substantial real and nominal devaluation in January 1994 (see Savvides, 1996).

Figure 4.3: Variability of Inflation and Growth for Low Inflation Countries



The results of the effective RER variance for 27 low and stable inflation and stable growth countries are shown in Figure 4.4 below. There is no significant difference across regimes in the average standard deviation of the percentage change in the RER.[14] The ratio of the average variance in regime 1 compared to regime 3 is 1 to 1.6.

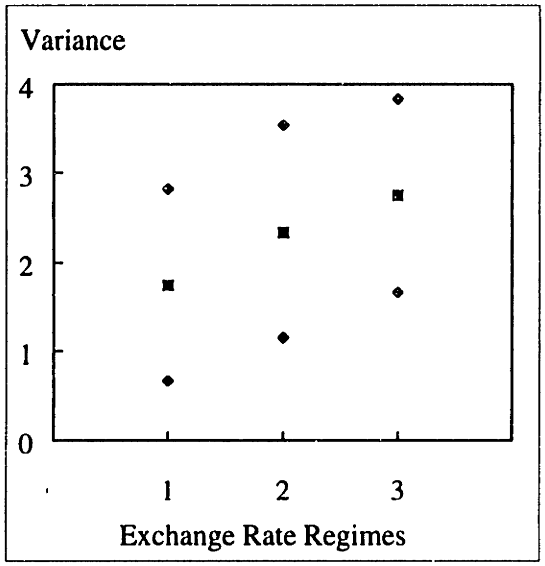
14 We excluded 3 observations that were based on a country being within a given regime for less than one year. Including these observations does not change the results in any important way.

Figure 4.4: Average Variance of Monthly Effective RER Changes

- 27 Low Inflation and Stable Growth Countries

- Inflation less than 10 per cent per annum
- Std. dev. of growth less than 4.5 per cent
- Excluding Burkino Faso and Senegal

Reg.	Mean	95% Confidence Interval		No Obs.
1	1.74	0.67	2.82	10
2	2.34	1.15	3.54	22
3	2.75	1.66	3.84	11



The results shown in Figure 4.8 are supported by individual F-tests on the 16 countries in this sample that experienced more than one regime over the period. The results are shown in Table 4.1 below. Less than one-third of the countries had significantly more variable effective RERs under more flexible exchange rate regimes. Two countries actually displayed a significantly lower variance under more flexible regimes.

Table 4.1: F-Tests for Differences in Variances of Effective RERs across Regimes

	Country	Regime 1 Variance	Regime 2 Variance	Regime 3 Variance	F-Test	Direction †
1	Australia		1.60	6.48	4.04*	+
2	Canada		1.14	0.95	1.19	0
3	Finland	1.26		3.42	2.72*	+
4	India		4.94	1.08	4.58*	-
5	Italy		0.66	2.72	4.15*	+
6	Japan		6.74	4.95	1.36	0
7	Korea	1.15	1.61		1.40	0
8	Morocco	1.54	2.38		1.55*	+
9	Norway	0.92		0.51	1.80*	-
10	Pakistan	2.94	2.91		1.01	0
11	Singapore	0.66	0.68		1.03	0
12	Spain		1.71	1.01	1.69	0
13	Sweden	1.89		3.65	1.94*	+
14	Thailand	1.85	2.42		1.31	0
15	United Kingdom		3.68	3.68	1.00	0
16	United States		2.37	1.79	1.33	0

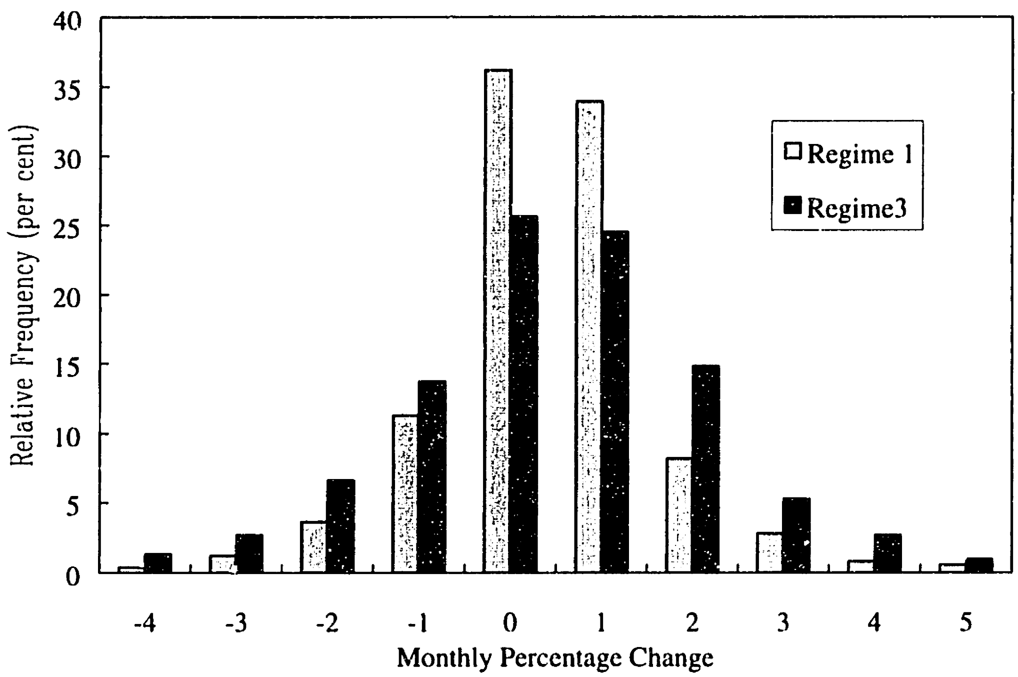
† A positive sign indicates that the variance is significantly higher for the more flexible exchange rate regime. A negative sign indicates the exact opposite result. A zero indicates no significant difference in the variance across regimes.

* Significant at the 5 per cent level.

4.5 Concluding Remarks

The results of Section 4.4 show that there is no significant difference between exchange rate regimes in terms of the variance of changes in the effective RER. One possible explanation is that the variance of the effective RER is high under regime 1 only because of large but infrequent changes in nominal parities. If this were true, then we would expect to see very fat tails in the distribution of the monthly percentage changes in the effective RER for regime 1 but not for regime 3. Figure 4.5 (below) shows that this is not the case: the distribution of monthly changes in the effective RERs is similar across regimes, with no fat tails.

Figure 4.5: Histogram of Monthly Percentage Changes in Effective RER



The results of F-tests on Mussa's sample of countries and his definitions of exchange rate regimes showed that the variance of the effective RER was significantly higher under the more flexible exchange rate regime for 11 of the 14 countries considered. In contrast, our sample of countries and definitions of regimes showed strong evidence that there was no systematic increase in variance of the effective RER for more flexible exchange rate regimes. One possible explanation is that the variance of the effective RER under fixed exchange rate arrangements depends on the extent to which major trading partners are also in a fixed exchange rate regime. In other words, regime 1 during Bretton Woods is quite likely to result in lower variance of the effective RER than regime 1 post-Bretton Woods. However, as our data set stands, there are almost no countries which are in regime 1 both during and after Bretton Woods and are fixed to a single currency. The few that we clearly can identify as remaining fixed post-Bretton Woods also simultaneously went from fixed to the US dollar to fixed to a basket of currencies – and experienced a fall in their effective RER volatility post-Bretton Woods.[15]

One potential bias in our estimates of RER volatility comes about because we have excluded regime transitions. If anything, we feel that we have underestimated the volatility of the RER under regime 1 because most of the changes in RERs at regime transitions are probably due to regime 1. This could be tested for as follows: if in going from regime 1 to 3 the RER fluctuates significantly but does not alter its level very much, then it would seem like these effects are due to regime 3. But if transition leads to a significant one-off change in the level of the RER, it is likely that this is due to regime 1's old fixed rate being inappropriate.

Before concluding, we want to mention an alternative interpretation of our findings. It may be that countries choose nominal exchange rate regimes in order to minimize RER volatility. That is, the choice of nominal exchange rate regimes is endogenous and this is exactly why we find no apparent effect of the nominal regime on effective RER volatility.

The results of our analysis suggest that there is no significant difference in the behavior of the effective RER across different nominal exchange rate regimes. Earlier findings show that bilateral RERs are more volatile under floating exchange rate regimes. This difference is not inconsistent because the effective RER for a given country typically has lower variance than most of its component bilateral RERs. Our result is significant because it would explain why it is that there is no apparent effect of the nominal exchange rate regime on real macroeconomic variables, apart from the bilateral RER.

15 To investigate this issue more carefully would require an extension of our regime classification back to at least 1973.

From the perspective of an agent that is predominantly concerned with a given bilateral RER (say a firm which trades almost exclusively with one country), then it would seem that price adjustments are sluggish, and this is why they observe higher volatility of the bilateral RER under flexible exchange rate regimes. However, from a macroeconomic perspective, it would appear that because the effective RER shows no systematic difference in behavior across different nominal exchange rate regimes, then prices are flexible.

Appendix A

Further Results and Data for Chapter 2

A.1 Further Results

A.1.1 Correlation Episodes and TOT Persistence

Table A.1: Summary of Country Correlation Episodes and TOT Persistence

Country	Correlation of CAC_t with		Episodes from Table 2.3 Correlations			Data exists	ADF $\hat{\rho}_i$, $(p = 3)$	
	TOT_t	TOT_{t-1}	positive	zero	negative	'70-'92	Trend & Constant	Constant Only
Average/Sum	0.21	-0.15	516	1120	240		0.68	0.84
Algeria	0.57	-0.44	5	2	0	yes	0.89	0.92
Antigua & Barbuda	0.04	-0.28	1	16	2		0.64	0.67
Argentina	-0.12	0.13	9	10	6	yes	0.75	0.97
Australia	0.13	-0.40	3	6	5	yes	0.47	0.98
Austria	0.24	-0.17	6	11	0	yes	0.75	0.91
Bahamas, The	-0.06	0.62	2	14	4		0.79	0.78
Bahrain	0.13	0.20	3	9	3		0.78	0.78
Bangladesh	0.16	0.07	1	15	3	'71-'92	0.31	0.86
Barbados	0.28	-0.21	3	6	2	yes	0.64	0.92
Belgium	0.49	-0.21	9	3	0	yes	0.76	0.94
Bolivia	0.44	-0.49	4	9	0	yes	0.97	0.86
Botswana	0.00	-0.09	0	4	3	'71-'92	0.91	0.86
Brazil	0.13	0.02	9	10	2	yes	0.54	0.77
Bulgaria	0.87	-0.19	3	0	0			
Burkina Faso	0.31	-0.02	5	11	1	yes	0.68	0.94
Burundi	0.59	-0.04	7	10	0	'71-'92	0.54	0.87

Cameroon	0.37	-0.31	8	8	0	'71-'92	0.73	0.74
Canada	-0.03	-0.27	3	11	5	yes	0.85	0.94
Cape Verde	0.44	-0.36	4	11	0		0.63	0.91
Centrl. African Rep.	0.12	-0.21	4	6	1	yes	0.71	0.71
Chad	0.08	0.06	3	13	1	yes	0.61	0.93
Chile	0.49	-0.19	7	11	1	yes	0.79	0.95
China	0.24	0.00	6	13	0	'71-'92	0.69	0.71
Colombia	0.22	-0.06	4	5	2	yes	0.89	0.83
Costa Rica	0.35	-0.31	6	15	2	yes	0.07	0.91
Cote d'Ivoire	0.39	-0.38	7	9	2	yes	0.81	0.79
Cyprus	-0.06	-0.11	5	12	3	yes	0.79	0.99
Denmark	0.29	-0.31	5	6	1	yes	0.80	0.86
Dominica	-0.27	-0.19	0	10	4		0.78	0.91
Dominican Republic	0.33	0.02	5	8	2	yes	0.30	0.59
Ecuador	0.18	-0.26	4	3	0	yes	0.88	0.92
Egypt, Arab Rep.	-0.15	-0.22	2	5	3	yes	0.66	0.78
El Salvador	0.47	-0.41	5	8	0	yes	0.79	1.02
Equatorial Guinea	0.06	-0.09	5	10	0		0.10	0.11
Ethiopia	-0.14	-0.03	3	9	2	yes	0.60	0.93
Fiji	0.40	-0.37	2	8	2	yes	0.69	0.84
Finland	-0.31	-0.05	2	9	10	yes	0.64	0.63
France	0.58	-0.46	6	3	0	yes	0.75	0.75
Gabon	0.67	-0.28	4	3	0	yes	0.83	0.91
Gambia, The	0.29	-0.10	4	14	2	'71-'92	0.52	0.86
Germany	0.15	-0.06	5	8	2	yes	0.74	0.75
Ghana	0.07	-0.02	2	11	4	yes	0.81	0.83
Greece	-0.22	0.23	3	14	3	yes	0.59	0.92
Grenada	0.05	-0.21	2	14	2		0.82	0.99
Guatemala	0.57	-0.54	5	10	0	yes	0.65	1.01
Guinea	0.31	-0.52	0	16	0		0.81	0.93
Guyana	0.38	-0.24	3	8	0	yes	0.49	0.81
Haiti	0.48	-0.15	9	8	1	yes	0.39	1.03
Honduras	-0.03	-0.02	2	9	8	yes	0.31	1.09
Hong Kong	0.40	-0.29	8	12	2		0.82	1.04
Hungary	-0.09	0.04	4	4	3		0.76	0.94
Iceland	0.09	-0.47	6	17	2	yes	0.70	0.73
India	0.09	0.02	5	8	3	yes	0.77	0.92
Indonesia	0.38	-0.48	5	1	1	yes	0.87	0.91
Iran, Islamic Rep.	0.55	-0.44	2	3	2	yes	0.85	0.91
Iraq	0.65	-0.32	1	6	0		0.84	0.92
Ireland	0.30	-0.52	5	9	0	yes	0.58	0.63
Israel	0.26	0.02	5	8	1	yes	0.64	0.63
Italy	0.58	-0.23	7	5	0	yes	0.88	0.87
Jamaica	0.20	-0.44	4	4	1	yes	0.38	0.44
Japan	0.39	-0.39	8	8	0	yes	0.89	0.84
Jordan	-0.04	0.11	2	5	2	yes	0.53	0.65

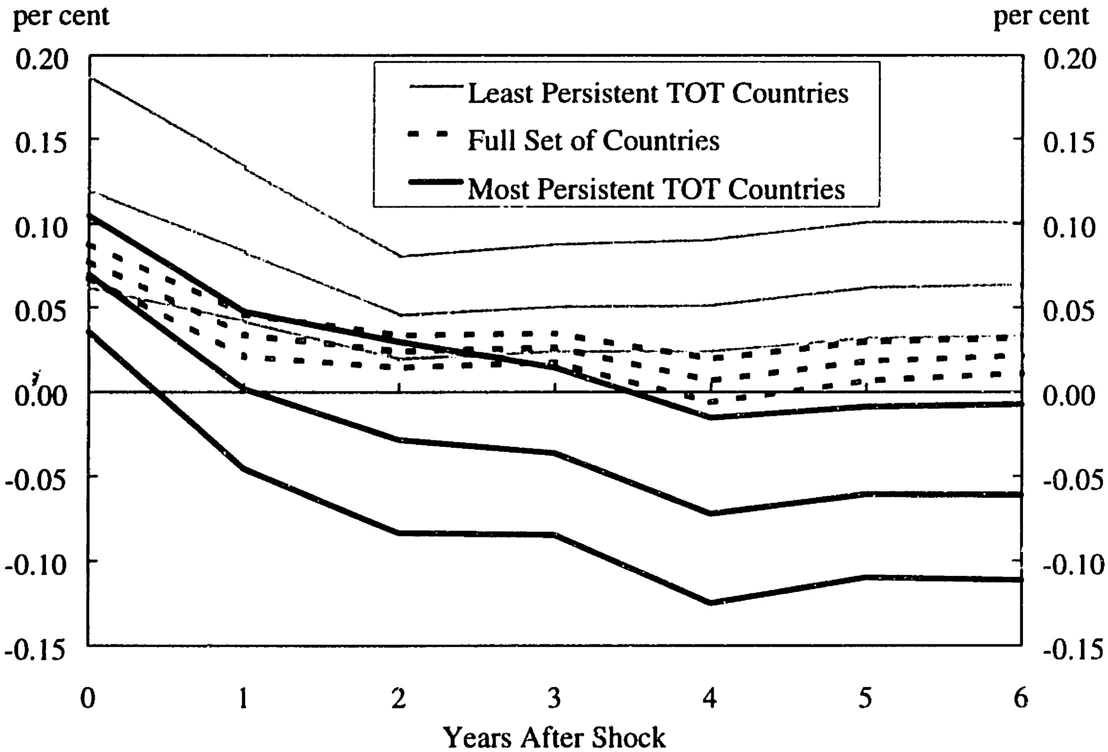
Kenya	0.21	-0.43	6	3	4	yes	0.93	0.94
Korea, Republic of	0.48	-0.19	10	3	3	yes	0.73	0.74
Kuwait	0.11	-0.15	0	7	0		0.86	0.92
Lebanon	0.23	0.49	0	11	0		0.63	0.87
Liberia	-0.14	-0.17	5	15	2		0.73	0.90
Libya	0.39	-0.44	4	1	2		0.85	0.91
Madagascar	0.05	0.29	0	14	4		0.67	0.85
Malawi	0.20	-0.39	5	14	1	yes	0.24	0.76
Malaysia	0.31	-0.68	0	15	0		0.75	0.77
Mali	0.26	0.24	7	12	2	yes	0.19	0.36
Malta	0.22	-0.11	5	7	5	yes	0.89	0.83
Mauritania	-0.29	-0.02	2	7	6	yes	0.80	0.95
Mauritius	0.46	-0.33	5	8	0	yes	0.64	0.64
Mexico	-0.03	-0.23	2	7	0	yes	0.82	0.84
Morocco	0.04	-0.60	1	1	4	yes	0.37	0.61
Mozambique	0.32	0.17	3	14	0		0.41	0.43
Namibia	0.15	0.32	2	13	0		0.38	0.83
Netherlands	0.22	-0.14	6	10	2	yes	0.82	0.90
Netherlands Antilles	0.61	0.47	2	21	0		0.86	0.87
New Zealand	0.20	-0.50	7	11	0	yes	0.61	0.75
Nicaragua	-0.11	-0.08	2	12	2	yes	0.71	0.98
Niger	-0.40	0.48	0	12	5	yes	0.63	0.94
Nigeria	0.55	-0.51	4	5	2	yes	0.90	0.91
Norway	0.59	0.00	8	6	0	yes	0.80	0.83
Oman	0.72	-0.52	2	2	0		0.87	0.87
Pakistan	-0.24	0.25	2	8	2	yes	0.72	1.00
Panama	-0.20	0.24	2	14	2	yes	0.84	0.81
Papua New Guinea	0.63	-0.05	9	12	0	'71-'92	0.10	0.80
Paraguay	0.58	0.18	4	17	0	yes	0.40	0.89
Peru	0.08	-0.33	5	18	5	yes	0.80	0.96
Philippines	-0.18	-0.33	2	9	3	yes	0.68	0.87
Poland	-0.14	0.84	2	12	1		0.36	0.55
Portugal	0.29	-0.42	9	8	2	'71-'92	0.22	0.95
Qatar	0.58	-0.53	3	3	0		0.83	0.91
Rwanda	0.16	-0.31	3	5	1	yes	0.78	0.87
St. Kitts and Nevis	0.23	0.49	4	15	0		0.84	0.83
St. Lucia	-0.10	-0.25	2	13	2		0.77	0.76
Saudi Arabia	0.72	-0.34	4	2	0	yes	0.84	0.92
Senegal	0.25	0.08	4	3	2	yes	0.72	0.77
Sierra Leone	0.13	-0.24	5	12	4	yes	0.04	0.98
Singapore	-0.10	0.12	6	4	2	yes	0.73	0.86
Solomon Islands	-0.42	-0.19	0	7	5		0.68	0.85
South Africa	-0.09	-0.29	7	10	6	yes	0.86	0.98
Spain	0.24	-0.37	6	12	6	yes	0.87	0.89
Sri Lanka	0.54	-0.24	9	6	0	yes	0.36	0.67
Sudan	0.34	0.11	2	8	0	yes	0.38	0.97

Swaziland	0.41	0.24	2	5	0		0.61	0.65
Sweden	0.28	-0.19	3	5	1	yes	0.82	0.83
Switzerland	0.12	-0.10	6	4	6	yes	1.10	0.81
Syrian Arab Rep.	-0.25	-0.24	0	7	3	'70-'91	0.85	0.93
Tanzania	0.12	-0.57	5	6	3	yes	0.93	1.09
Thailand	-0.31	0.12	0	13	2	yes	0.26	0.89
Tonga	-0.39	0.01	0	10	2		0.67	0.82
Trinidad & Tobago	0.49	-0.20	5	7	1	yes	0.85	0.87
Tunisia	0.12	-0.38	0	10	0	yes	0.80	0.90
Turkey	0.33	-0.06	4	9	2	yes	0.82	0.88
Uganda	0.24	-0.28	7	6	2	yes	0.74	0.82
United Arab Emrts.	0.87	-0.32	6	1	0		0.85	0.90
United Kingdom	0.53	0.06	5	6	0	yes	0.67	0.66
United States	0.01	-0.58	0	7	9	yes	0.85	0.93
Uruguay	0.18	-0.21	5	5	3	yes	0.53	0.78
Venezuela	0.58	-0.34	6	1	0	yes	0.82	0.89
Western Samoa	-0.06	-0.22	2	11	2		0.64	0.79
Zaire	-0.12	0.26	2	16	3		0.72	0.96
Zambia	0.72	-0.35	10	13	0	yes	0.72	0.91
Zimbabwe	-0.08	-0.19	3	15	3	'71-'92	0.53	0.95

A.1.2 Impulse Response Functions: Confidence Intervals

Confidence intervals around the impulse responses (discussed at the end of Section 2.4.4) were estimated by using a bootstrap technique. For each model estimated, new current account data was created by assuming the original model estimate to be true and generating errors from an independently identically distributed normal distribution with a mean of zero and a variance estimated from the original error estimates. New estimates of the model were generated using this new current account series, and from this a new impulse response function was constructed. This procedure was repeated one thousand times. A 95 per cent confidence interval was constructed by eliminating the upper 25 and lower 25 extreme impulse responses point by point along the impulse response function.[1]

Figure A.1: 95 Per Cent Confidence Interval for Current Account Impulse Response Function to a 1 per cent Terms of Trade Shock



1 The alternative is to construct a metric that estimates the distance of the impulse response functions from the initial estimate of the function and then eliminate extreme functions to create a confidence interval.

A.1.3 Panel Data Results Including Government Fiscal Balances

Table A.2: Panel Data FGLS - Highest Versus Lowest TOT Persistence

- dependent variable - ΔCAC
- period of estimation - 1970 to 1992

Variable	Lag	11 Countries with Highest TOT Persistent		9 Countries with Lowest TOT Persistent†	
		Full Model*	Parsimonious Model	Full Model*	Parsimonious Model*
		Coefficient (t-statistic)			
ΔCAC	1	-0.252 (-3.11)	-0.192 (-2.68)	-0.322 (-4.02)	-0.398 (-3.05)
	2	-0.138 (-2.14)		-0.379 (-5.49)	-0.428 (-5.86)
	3	-0.206 (-3.69)	-0.182 (-3.76)	-0.114 (-1.99)	-0.126 (-2.39)
	4	-0.096 (-1.61)		-0.167 (-2.61)	-0.166 (-2.82)
ΔTOT^s	0	0.061 (2.26)	0.060 (2.17)	0.137 (2.89)	0.134 (2.84)
	1	-0.049 (-1.88)	-0.053 (-2.13)	0.001 (0.01)	
	2	-0.037 (-1.83)	-0.043 (-2.48)	-0.001 (-0.04)	
	3	-0.009 (-0.53)		0.009 (0.19)	
	4	-0.055 (-2.75)	-0.047 (-2.14)	0.010 (0.33)	
ΔGDP^s	0	-0.199 (-3.90)	-0.205 (-4.05)	-0.161 (-2.12)	-0.161 (-2.14)
	1	-0.019 (-0.48)		-0.169 (-2.21)	-0.195 (-2.35)
	2	-0.028 (-0.64)		-0.108 (-1.94)	-0.201 (-2.03)
	3	0.020 (0.53)		-0.046 (-0.55)	
	4	0.028 (0.76)		0.030 (0.38)	
ΔGVT	0	0.112 (1.63)	0.10 (1.59)	0.189 (2.10)	0.229 (2.44)
	1	-0.008 (-0.12)		0.063 (0.71)	
$\sum_{j=0}^{4} \Delta TOT^s_{t-j}$		-0.087 (-2.16)	-0.083 (-2.57)	0.155 (1.76)	0.134 (2.84)
$\sum_{j=0}^{4} \Delta GDP^s_{t-j}$		-0.198 (-1.83)	-0.205 (-4.05)	-0.454 (-2.16)	-0.556 (-3.45)
$\sum_{j=0}^{1} \Delta GVT_{t-i}$		0.104 (0.87)	0.100 (1.59)	0.252 (1.88)	0.229 (2.44)
		No. Obs 209	No. Obs 209	No. Obs 171	No. Obs 171
		$R^2 = 0.38$	$R^2 = 0.35$	$R^2 = 0.47$	$R^2 = 0.39$

* standard errors corrected for heteroskedasticity and for serial correlation.

† Jamaica is excluded because it is missing a lot of GVT data.

A.2 Data

The data sources used in this chapter include: the IMF's International Financial Statistics (March and June 1996 CDROM versions); the World Bank's data bases (both the 1994 and the 1995 CDROM versions); the Summers and Heston database in the Mark 5.6 version of the Penn World Tables; and the OECD National Accounts and Yearbook of Employment Statistics. For each series I provide a brief discussion of the main issues and outline the rule used to construct the preferred measure from the various different data sources. This is followed by a detailed list of the exceptions to the rules and the reasons for these exceptions. It is beyond the scope of this essay to provide exact details on every component of the data (see the original sources for more information). It was often necessary to splice together data from different sources in order to get extensive coverage across countries and across time.

Current Account Balance

As a rule I used the IFS (line "78ald") for the current account balance (recorded in US dollars). When this data was missing, I used World Bank data (1995 CDROM, BN CAB FUND CD, current account balance after official transfers, US dollars, Balance of Payments basis). In the case of Belgium, I had to use some of the World Bank data on the 1994 CDROM, because it was unavailable in the WB95 data base. I used a linear interpolation for Mali in 1969.

Terms of Trade

There are two main sources for the terms of trade - the IFS (by combining unit values "74..." and "75..." or price indices "74..d" and "75..d") and the 1995 World Bank CDROM (terms of trade index, 1987=100, TT PRI MRCH XD). Prior to 1995, the World Bank published terms of trade series that had been estimated in house. In 1995, they began to use the UNCTAD's data base for the terms of trade.

The World Bank essentially uses the IFS data for the developed countries. However, prior to the 1995 CDROM, they constructed their own estimates for developing countries based mainly on commodity prices. The most obvious difference is the extra weight given to the price of oil for many of these countries because of the exclusion of the prices of manufactures and services. The oil shocks are more apparent in the World Bank 1994 data base than in the World Bank 1995 or the IFS data bases.

For the terms of trade I tried to use the WB95 data where possible. This was the preferred source because it generally provides better coverage historically and across a broader range of countries. The WB95 data are similar to the IFS for developed countries. The WB94 data base is not so useful because it will no longer be available in the future and for developing countries is based mainly on commodity prices, ignoring manufactures and services. The shortcoming of the WB95 (and the IFS) data is that it is based on data collected by individual countries and the data can be inconsistent - that is, some are based on unit values and others constructed from price indices.

Table A.3: Terms of Trade - exceptions to the rule of using WB95 data

Country	Main Data Source	Comments	Additional data spliced onto main source
Antigua & Barbuda	WB94	no other data available	
Austria	WB94	WB95 had no sign of any oil price shocks	60-64, 93 WB95
Bahamas, The	WB94	no other data available	
Bahrain	WB95		65-70 WB94
Belgium	WB94	WB95 had no sign of any oil price shocks	60-64, 93 WB95
Brazil	IFS	WB95 had rise in tot in first oil shock	60, 93-94 WB95
Burkina Faso	WB94	WB95 shows little evidence of first oil shock	60-64, 93 WB95
Cape Verde	WB94	WB95 has error - fixed terms of trade 80-93	
Dominica	WB94	no other data available	
El Salvador	WB94	WB95 inconsistent with both WB94 and IFS during late 70's	60-64, 93 WB95
Fiji	WB94	better coverage & WB95 shows little	

		evidence of oil shocks	
Grenada	WB94	no other data available	
Hong-Kong	WB95		65-67, 93 WB94
Hungary	IFS	better coverage (otherwise same as WB95)	65-69 WB94
Korea	IFS	WB95 did not show evidence of oil shocks	60-62 WB95
Malta	WB95		90-92 WB94
Namibia	WB94	no other data available	
Oman	WB94	better coverage (otherwise very similar to WB95)	93 WB95
Papua New Guinea	WB94	better coverage	93 WB95
Poland	WB94	better coverage	93-94 WB95
St. Kitts & Nevis	WB94	no other data available	
St. Lucia	WB94	no other data available	
Singapore	WB94	better coverage	93-94 WB
Solomon Islands	WB94	better coverage and WB95 shows little evidence of oil shocks	
Sudan	WB94	WB95 shows rise in tot in first oil shock	
Tonga	WB94	no other data available	
Turkey	WB94	better coverage (otherwise not too dissimilar)	93 WB95
Western Samoa	WB94	no other data available	

Trade Shares

Individual country trade shares are used to weight the terms of trade of each country. I used the measure of openness provided in the PWT5.6: variable 25, Openness, which is the ratio of the sum of imports and exports to GDP in national currencies. This measure displays quite of lot of short-term variance, which, amongst other things, is likely to be due to the influence of the business cycle. In order to avoid introducing this extra noise to the terms of trade, I took a nine year centered moving average of the trade shares before applying them to the terms of trade. [The moving average was truncated at the end points of the sample.] This still allowed for long term variation in countries' openness.

Ethiopian data was missing for 1991 and 1992 and was estimated by extrapolation of the average growth rate of the previous nine years.

Nominal GDP

Nominal GDP is needed to construct current account and government fiscal balances as a ratio to GDP.

Nominal GDP in local currency

The two sources used are the IFS (line "99b.." or "99b.c") and the World Bank (1995 CD ROM - GDP at market prices, local currency, *NY GDP MKTP CN*). Much of the WB95 data base, especially for developed countries, comes from the IFS,. As a rule the IFS was the preferred source, providing the best coverage historically and most reliable in terms of revisions. (Although, the two sources are very close for most countries.) The exceptions to the rule are explained in the table below.

Table A.4: Nominal GDP in local currency - exceptions to the rule of using IFS data

Country	Main Data Source	Comments	Additional data spliced onto main source
Algeria	IFS		94 WB95
Argentina	WB95	IFS had only one digit accuracy in 1960's	
Bahamas	WB95	only data available	
Bangladesh	WB95	better coverage	
Botswana	WB95	components incorrectly summed 88 & 89 in IFS	
Burkina Faso	WB95	only data available	
Cameroon	IFS		60-62 WB95
Cape Verde	WB95	better coverage (similar to IFS except 75 & 76)	
Chad	WB95	IFS implies implausible real growth in late 70's	
China	WB95	better coverage	
Cote d'Ivoire	WB95	better coverage (only difference is fall in 91 IFS)	
Dominica	IFS		60-73 WB95
Equatorial	WB95	better coverage	83-84 IFS

Guinea			
Fiji	WB95	better coverage	
Gabon	WB95	IFS in 86 too high (& far above IFS hard copy)	
Gambia, The	WB95	better coverage	
Ghana	WB95	better coverage (otherwise almost same as IFS)	
Guinea	WB95	only data available	
Hong-Kong	WB95	only data available	
Hungary	WB95	better coverage (otherwise similar to IFS)	
Iraq	WB95	only data available	
Jamaica	WB95	better coverage (otherwise similar to IFS)	
Kenya	WB95	better coverage	
Lebanon	WB95	only data available	
Liberia	IFS		60-63 WB95
Libya	WB95	only data available	
Madagascar	WB95	better coverage (similar to IFS except for 84)	
Maldives	WB95		78-84 IFS
Malta	WB95	only data available	
Mauritania	WB95	better coverage (otherwise similar to IFS)	
Morocco	WB95	better coverage (otherwise similar to IFS)	
Namibia	WB95	better coverage (otherwise similar to IFS)	
Niger	IFS		94 WB95
Oman	WB95	better coverage (otherwise similar to IFS)	
Papua New Guinea	IFS		60-63, 94 WB95
Poland	WB95	only data available	
St. Kitts & Nevis	IFS		60-74 WB95
St. Vincent & the Grenadines	IFS		60-74 WB95
Saudi Arabia	IFS		62 WB95
Senegal	IFS		94 WB95
Solomon Islands	WB95	better coverage (different for IFS in 72, 83, 87 & 89)	
Sudan	WB95	IFS implies extremely high real growth in 87	
Swaziland	IFS		60-65 WB95
Turkey	WB95	better coverage (otherwise similar to IFS)	
Vanuatu	IFS		79-81, 94 WB95
Western Samoa	WB95	no other data available	

Zaire	WB95	90-92 IFS
Zambia	IFS	94 WB95
Zimbabwe	IFS	60-62,91-94WB95

Exchange Rate

The current account balance is recorded in US dollars, so in order to construct the ratio of the current account to GDP, nominal GDP in local currencies has to be converted using the exchange rate. In some cases the official exchange rates published by the IMF in the IFS (line "rf") do not reflect the same international prices that are automatically incorporated into the current account data (almost all countries for which this is a problem are invoiced in US dollars for international transactions). To account for this, I use the World Bank's "Atlas" exchange rate series. These rates are generally based on the official IFS reported rates. Exceptions arise when multiple exchange rates are averaged or when official exchange rates are fixed far from free market levels (for more information refer to the World Tables publication).

I used the IFS exchange rates when the WB95 did not provide the data - primarily in the most recent years in the sample. The only problematic country was Uganda. The WB95 data base does not have the Ugandan exchange rate from 1969 to 1979. However, the official exchange rate (from the IFS) was clearly inappropriate for the late 1970's and early 1980's. This is obvious because the official rate implies implausibly large GDP growth rates (in US dollar terms). So for Uganda, I used the IFS official exchange rate, except for the years 1977-81 for which I took a linear interpolation of nominal GDP in US dollars.

Real GDP

Real GDP was taken mostly from the PWT5.6: variable 2, RGDPCH, real GDP per capita in constant dollars (Chain index, expressed in international prices, base 1985). This was converted to real GDP using the population variable. This data was supplemented by both the World Bank 1995 (NY GDP MKTP KD) and the IFS data (line

"99b.r" or "99b.p") - mostly to make series as current as possible. As a rule I used the PWT5.6 data supplemented by the WB95 data (notice that WB95 data is equivalent to IFS data for the developed countries). Exceptions to this rule are listed below.

Table A.5: Real GDP - exceptions to the rule of using PWT5.6 and WB95 data

Country	Main Data Source	Comments	Additional data spliced onto main source
Antigua and Barbuda	IFS	PWT5.6 unavailable and IFS gave better coverage	
Australia	PWT	IFS has better coverage than WB95	93 & 94 IFS
Austria	PWT	IFS has better coverage than WB95	93 & 94 IFS
Bahrain	PWT	IFS has better coverage than WB95	89-94 IFS
Belgium	PWT	IFS has better coverage than WB95	93 & 94 IFS
Bolivia	PWT	IFS closer to PWT5.6 earlier on than WB95	93 & 94 IFS
Canada	PWT	IFS has better coverage than WB95	93 & 94 IFS
Cyprus	PWT	IFS has better coverage than WB95	93 & 94 IFS
Denmark	PWT	IFS has better coverage than WB95	93 & 94 IFS
Dominica	WB95	only data available	
Equatorial Guinea	WB95	only data available	
Ethiopia	PWT	IFS closer to PWT5.6 earlier on, but WB95 only source in latter years	87-91 IFS, 92-94 WB95
Finland	PWT	IFS has better coverage than WB95	93 & 94 IFS
France	PWT	IFS has better coverage than WB95	93 & 94 IFS
Germany	PWT	IFS has better coverage than WB95	93 & 94 IFS
Greece	PWT	IFS has better coverage than WB95	93 & 94 IFS
Iceland	PWT	IFS has better coverage than WB95	93 & 94 IFS
Ireland	PWT	IFS has better coverage than WB95	93 & 94 IFS
Israel	PWT	IFS has better coverage than WB95	93 & 94 IFS
Jamaica	PWT	WB95 has 10% growth in 94 which was clearly wrong	92 & 93 IFS
Kenya	PWT	used change in growth rates for splicing	93 & 94 IFS
Libya	WB95	only data available	
Maldives	IFS	PWT5.6 unavailable and has better coverage than WB95	
Netherlands	PWT	IFS has better coverage than WB95	93 & 94 IFS
New Zealand	PWT	IFS has better coverage than WB95	93 & 94 IFS
Norway	PWT	IFS has better coverage than WB95	93 & 94 IFS
Portugal	PWT	PWT5.6 '90 had growth of 14% p.a. which seemed too high so replaced with WB95	

St. Lucia	IFS	PWT5.6 unavailable and has better coverage than WB95	
Saudi Arabia	PWT	IFS has better coverage than WB95	90-94 IFS
Sierra Leone	PWT	IFS closer to PWT5.6 than WB95 in latter years	93 & 94 IFS
Solomon Islands	PWT	PWT5.6 '88 had growth of 30% p.a. which seemed too high so replaced with WB95	
Spain	PWT	IFS has better coverage than WB95	93 & 94 IFS
Swaziland	PWT	IFS closer to PWT5.6 than WB95 in latter years	90-94 IFS
Sweden	PWT	IFS has better coverage than WB95	93 & 94 IFS
Switzerland	PWT	IFS has better coverage than WB95	93 & 94 IFS
Syrian Arab Republic	PWT	IFS has better coverage than WB95	92-94 IFS
Tanzania	PWT	IFS closer to PWT5.6 than WB95 in latter years	89-94 IFS
Tonga	WB95	only data available	
United Arab Emirates	PWT	IFS has better coverage than WB95	74-80 & 90-92 IFS
United Kingdom	PWT	IFS has better coverage than WB95	93 & 94 IFS
United States	PWT	IFS has better coverage than WB95	93 & 94 IFS

Government Fiscal Balance

The primary data source for the government fiscal balance is the IFS. I had to supplement this with data from the World Bank 1995 and 1994 CDROMs[2] and the hard copy of the IMF's Government Financial Statistics (GFS, 1995). Details are provided in the table below.

2 The WB94 data base contains some data on the government fiscal balance that is not in the WB95 data base; otherwise, they are very similar. The WB94 CDROM is used more often than the WB95 CDROM for this variable - but it should make little difference.

Table A.6: Government Surplus/Deficit - exceptions to the rule of using IFS data

Country	Main Data Source	Comments	Additional data spliced onto main source
Algeria	WB94	only data available	
Antigua and Barbuda	None	no data available	
Bangladesh	WB94	only data available	
Bolivia	IFS		94 GFS
Bulgaria	WB94	only data available	91, 93 & 94 GFS
Cameroon	IFS	IFS has missing data	84-88 WB94
Canada	IFS		92 GFS
Cape Verde	WB94	only data available	
Central African Rep.	WB94	only data available	
Chad	IFS	IFS has missing data	83-85 WB94
Cote d'Ivoire	WB94	only data available	
Dominica	WB94	only data available	
Dominican Republic	IFS		92 & 93 GFS
Equatorial Guinea		no data available	
Ethiopia	IFS		92 WB95
Gabon	IFS	77-78 & 88 are linear interpolations	86 & 87 WB94
Gambia, The	IFS		83-88 WB94
Grenada	WB94	only data available	
Guatemala	IFS		84 WB94
Guinea	WB94	80-81 & 84-85 are linear interpolations	89-92 IFS
Haiti	IFS	88-89 are linear interpolations	
Italy	IFS		92 WB94, 93-94 GFS
Jamaica	WB94	no other data available	
Kuwait	IFS		87-92 WB94
Lebanon		no data available	
Liberia	WB94	no other data available	
Libya		no data available	
Madagascar	IFS	71 is a linear interpolation	80-87 WB94
Mali	WB94	no other data available	
Mauritania	WB94	no other data available, 80-81 are linear interpolations	
Mozambique	WB94	no other data available	

New Zealand	IFS	89 is a linear interpolation	
Niger	WB94	no other data available	
Nigeria	IFS		75 WB94
Qatar		no data available	
Rwanda	IFS		81-88 WB94
St. Lucia	IFS		84 & 91 WB94
St. Vincent and the Grenadines	IFS		89 & 90 WB94
Saudi Arabia		no data available	
Senegal	WB94	no other data available	
South Africa	IFS		90 WB94
Sudan	WB94	no other data available	
Syrian Arab Republic	IFS		82-85 WB94
United Arab Emirates	IFS		85 & 86 WB95
Vanuatu	WB94	no other data available	
Western Samoa	WB94	84 is the only year for which data is available	
Zaire	IFS		83-87 WB94
Zambia	IFS	93 & 94 are linear interpolations (1995 data was available)	

Solow Residuals for OECD Countries

Solow residuals are constructed from a Cobb-Douglas production function:

$$\hat{A}_{it} = \hat{Y}_{it} - \delta\,\hat{L}_{it} - (1-\delta)\hat{K}_{it} \qquad \text{(A.1)}$$

where: $\hat{A}_{it}$ is the Solow residual for country i at time t, Y is real GDP, L is employment, K is the capital stock and δ is the share of labour in output. A 'hat' over a variable represents the percentage change on the previous year.

Employment data was kindly provided by Aart Kray and comes from Kray and Ventura (1996). The employment data comes originally from the OECD Yearbook of Employment Statistics and is the total civilian employment. The labour share of output data is originally from the OECD National Accounts (it is constructed as the ratio of

Compensation of Employees, MOCOM, to Gross Domestic Expenditure, MOGDPE, both in current local currency units).

Data on the capital stock is taken from the PWT5.6 - variable number 20, KAPW, non-residential capital stock per worker (1985 international prices). This is converted to the level of the capital stock by constructing a series of the number of workers from the real GDP per worker series (number 19, RGDPW) and real GDP (see above).

Appendix B

Further Results for Chapter 3

B.1 Further Results

B.1.1 Current Account Balances of OECD Countries

Table B.1: Largest Episodes of Consecutive Annual Current Account Deficits, OECD

Country	Episodes of Consecutive Deficits	Episode Length (years)	Cumulative Size of Episodes (per cent to GDP)
New Zealand	1973-94	22	127
Greece	1965-95	23	126
Ireland	1968-90	23	123
Australia	**1974-95**	**22**	**93**
Portugal	1974-84	11	77
Korea	1966-76	11	64
Norway	1970-79	10	56
Mexico	1967-82	16	54
Turkey	1974-87	14	46
Australia	**1960-71**	**12**	**37**
Canada	1983-95	23	37
Finland	1979-93	15	37
Iceland	1971-77	7	35

Figure B.1: Current Account (per cent to nominal GDP), OECD Countries

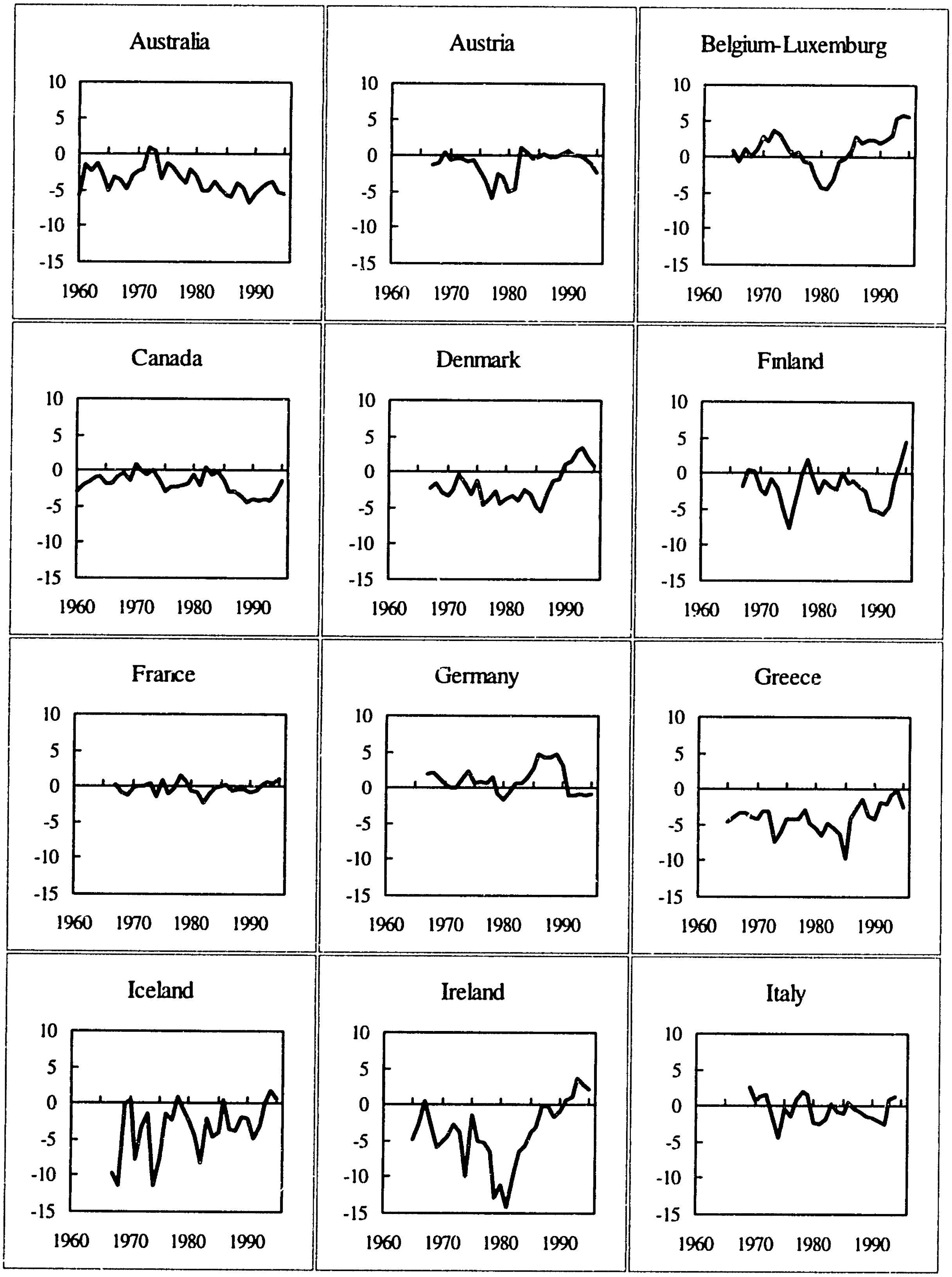
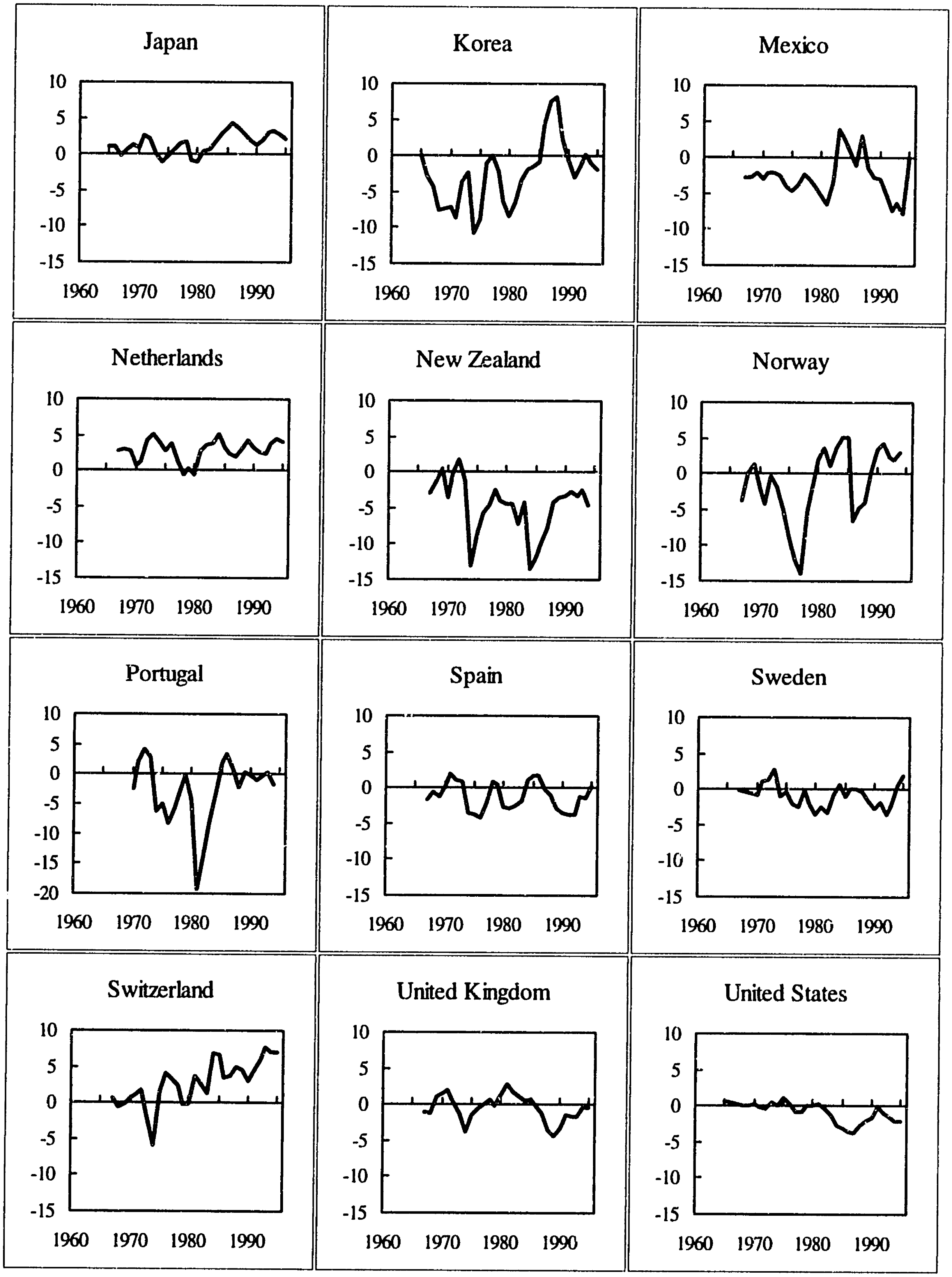


Figure B.1: Current Account (per cent to nominal GDP), OECD Countries



B.1.2 VARs, Granger Causality and Wald Statistics for Australia

Table B.2: VAR Estimates, 1951 to 1995

	VAR(1)		VAR(2)		VAR(3)	
	ΔZ_t	CA_t^S	ΔZ_t	CA_t^S	ΔZ_t	CA_t^S
ΔZ_{t-1}	0.01 (0.14)	0.07 (0.19)	-0.11 (0.18)	-0.19 (0.21)	-0.15 (0.18)	-0.06 (0.19)
ΔZ_{t-2}			-0.10 (0.13)	-0.28** (0.16)	-0.26 (0.18)	-0.08 (0.20)
ΔZ_{t-3}					0.24** (0.14)	0.13 (0.15)
CA_{t-1}^S	-0.58* (0.13)	-0.16 (0.17)	-0.40* (0.13)	0.13 (0.16)	-0.35* (0.15)	0.37* (0.16)
CA_{t-2}^S			-0.08 (0.15)	0.02 (0.18)	-0.04 (0.15)	-0.13 (0.17)
CA_{t-3}^S					-0.27** (0.15)	0.01 (0.16)
No. Obs.	44	44	43	43	42	42

Notes: * and ** indicate significance at 5 and 10 per cent levels respectively.

Table B.3: Granger Causality Tests -- F Statistics

	VAR(1)		VAR(2)		VAR(3)	
	ΔZ_t	CA_t^S	ΔZ_t	CA_t^S	ΔZ_t	CA_t^S
$CA_{t-i}^S \ \forall i \geq 1$	21.26*		5.38*		4.14*	
$\Delta Z_{t-i} \ \forall i \geq 1$		0.14		2.05		0.33

Notes: * indicates significance at a 5 per cent level.

Table B.4: Tests of the Nonlinear Consumption Smoothing Restriction

H_0: $\Phi_i = 0$ *for all i except* $\Phi_{1CA} = 1$

	VAR(1)	VAR(2)	VAR(3)
$\Phi_{1\Delta Z}$	-0.07 (0.15)†	-0.04 (0.22)	0.13 (0.18)
$\Phi_{2\Delta Z}$		-0.05 (0.15)	0.06 (0.15)
$\Phi_{3\Delta Z}$			-0.11 (0.11)
Φ_{1CA}	0.52 (0.16)†	0.55 (0.26)	0.72 (0.23)
Φ_{2CA}		0.09 (0.13)	0.17 (0.12)
Φ_{3CA}			0.24 (0.11)
Wald Statistic	22.39*	37.03*	21.07*

Notes: † indicates that standard errors are adjusted using White's correction for heteroskedasticity.
* indicates rejection of the joint null hypothesis at a 5 per cent significance level.

Table B.5: VAR Estimates -- using the Idiosyncratic Component of NCF 1951 to 1995

	VAR(1)		VAR(2)		VAR(3)	
	ΔZ_t^I	CA_t^S	ΔZ_t^I	CA_t^S	ΔZ_t^I	CA_t^S
ΔZ_{t-1}^I	0.18 (0.14)	0.11 (0.20)	-0.00 (0.18)	-0.12 (0.21)	-0.03 (0.18)	-0.06 (0.20)
ΔZ_{t-2}^I			-0.08 (0.14)	-0.36* (0.17)	-0.16 (0.19)	-0.23 (0.21)
ΔZ_{t-3}^I					0.29* (0.14)	0.15 (0.16)
CA_{t-1}^S	-0.60* (0.12)	-0.18 (0.17)	-0.45* (0.13)	0.10 (0.16)	-0.35* (0.15)	0.38* (0.16)
CA_{t-2}^S			-0.07 (0.15)	0.08 (0.18)	-0.08 (0.15)	-0.08 (0.17)
CA_{t-3}^S					-0.18 (0.15)	-0.06 (0.17)
No. Obs.	44	44	43	43	42	42

Notes: * and ** indicate significance at 5 and 10 per cent levels respectively.

Table B.6: Granger Causality Tests -- F Statistics

	VAR(1)		VAR(2)		VAR(3)	
	ΔZ_t^I	CA_t^S	ΔZ_t^I	CA_t^S	ΔZ_t^I	CA_t^S
$CA_{t-i}^S \ \forall i \geq 1$	25.76*		7.10*		3.79*	
$\Delta Z_{t-i}^I \ \forall i \geq 1$		0.32		2.77**		0.68

Notes: * and ** indicate significance at 5 and 10 per cent levels respectively.

Table B.7: Test of the Nonlinear Consumption Smoothing Restriction — using the Idiosyncratic Component of NCF

H_0: $\Phi_i = 0$ *for all i except* $\Phi_{1CA} = 1$

	VAR(1)	VAR(2)	VAR(3)
$\Phi_{1\Delta Z}$	-0.14 (0.19)†	-0.23 (0.31)	-0.21 (0.46)†
$\Phi_{2\Delta Z}$		-0.16 (0.22)	-0.21 (0.25)†
$\Phi_{3\Delta Z}$			-0.20 (0.14)†
Φ_{1CA}	0.56 (0.17)†	0.74 (0.35)	0.91 (0.41)†
Φ_{2CA}		0.14 (0.17)	0.18 (0.18)†
Φ_{3CA}			0.16 (0.12)†
Wald Statistic	25.97*	29.81*	9.32

Notes: † indicates that standard errors are adjusted using White's correction for heteroskedasticity.
* indicates rejection of the joint null hypothesis at a 5 per cent significance level.

Table B.8: VAR(1) Estimates - Restricted Sample Periods

	1951 to 1973		1974 to 1995	
	ΔZ_t^I	CA_t^S	ΔZ_t^I	CA_t^S
ΔZ_{t-1}^I	0.56* (0.20)	0.72** (0.37)	-0.08 (0.20)	0.05 (0.18)
CA_{t-1}^S	-0.75* (0.15)	-0.68* (0.27)	-0.54* (0.22)	0.23 (0.20)
No. Obs.	22	22	22	22

Notes: * and ** indicate significance at 5 and 10 per cent levels respectively.

Table B.9: Granger Causality Tests -- F Statistics

	1951 to 1973		1974 to 1995	
	ΔZ_t^I	CA_t^S	ΔZ_t^I	CA_t^S
CA_{t-1}^S	25.80*		5.83*	
ΔZ_{t-1}^I		3.807**		0.08

Notes: * and ** indicate significance at 5 and 10 per cent levels respectively.

Table B.10: Test of the Nonlinear Consumption Smoothing Restriction

H_0: $\Phi_{\Delta Z} = 0$ *and* $\Phi_{CA} = 1$

	1951 to 1973	1974 to 1995
$\Phi_{1\Delta Z}$	-0.38 (0.19)	0.10 (0.13)
Φ_{1CA}	0.57 (0.14)	0.60 (0.23)
Wald Statistic	88.06*	3.08

Notes: * indicates rejection of the joint null hypothesis at a 5 per cent significance level.

Table B.11: Asymmetric VAR(1) Estimates – using the Idiosyncratic Component of NCF

	1951-1995				1951-1983			
	ΔZ_t^{IP}	ΔZ_t^{IN}	CA_t^{SP}	CA_t^{SN}	ΔZ_t^{IP}	ΔZ_t^{IN}	CA_t^{SP}	CA_t^{SN}
ΔZ_{t-1}^{IP}	-0.12 (0.15)	0.25 (0.16)	0.27 (0.18)	0.49* (0.23)	0.05 (0.19)	0.62* (0.23)	0.39 (0.28)	0.75* (0.34)
ΔZ_{t-1}^{IN}	0.10 (0.15)	0.09 (0.16)	-0.34** (0.18)	-0.08 (0.22)	-0.08 (0.15)	0.03 (0.18)	-0.27 (0.22)	-0.06 (0.27)
CA_{t-1}^{SP}	-0.07 (0.12)	-0.58* (0.13)	0.22 (0.14)	-0.27 (0.17)	-0.14 (0.11)	-0.70* (0.14)	0.15 (0.17)	-0.42 (0.20)
CA_{t-1}^{SN}	-0.41* (0.13)	-0.13 (0.14)	-0.22 (0.15)	0.00 (0.20)	-0.27* (0.13)	-0.16 (0.16)	-0.30 (0.19)	-0.01 (0.23)
No. Obs.	44	44	44	44	32	32	32	32

Notes: * and ** indicate significance at 5 and 10 per cent levels respectively.

Table B.12: Granger Causality Tests -- F Statistics

	1951-1995				1951-1983			
	ΔZ_t^{IP}	ΔZ_t^{IN}	CA_t^{SP}	CA_t^{SN}	ΔZ_t^{IP}	ΔZ_t^{IN}	CA_t^{SP}	CA_t^{SN}
ΔZ_{t-1}^{IP} & ΔZ_{t-1}^{IN}			2.19	2.46**			1.24	2.75**
CA_{t-1}^{SP} & CA_{t-1}^{SN}	6.87*	14.10*			3.97*	15.69*		

Notes: * and ** indicate significance at 5 and 10 per cent levels respectively.

Appendix C

Further Results and Data for Chapter 4

C.1 Further Results

C.1.1 Average Variance of RERs - Figures and Confidence Intervals

Figure C.1: Average Variance of Monthly Effective RER Changes

- Mussa's Sample of 14 Industrialized Countries
- Multilateral RER
- up to Dec-90

Reg.	Mean	95% Confidence Interval		No Obs.
1	0.96	0.39	1.54	13
2				
3	1.84	1.07	2.62	14

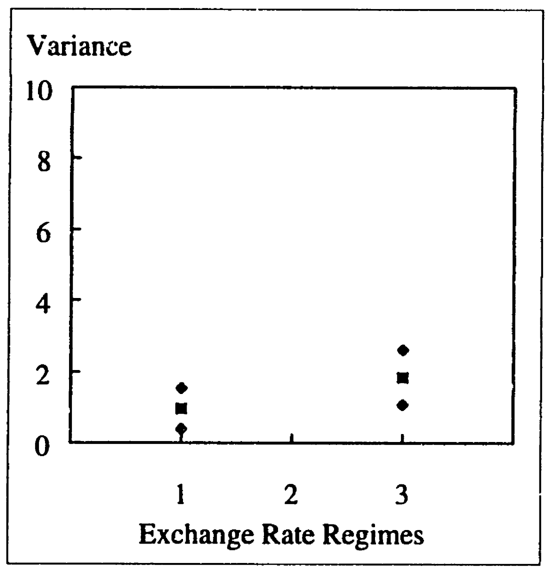


Figure C.2: Average Variance of Monthly Effective RER Changes

- Full Sample of 90 Countries
- Without correcting for regime switching

Reg.	Mean	95% Confidence Interval		No Obs.
1	113	14	213	67
2	130	-50	310	58
3	303	-138	744	46

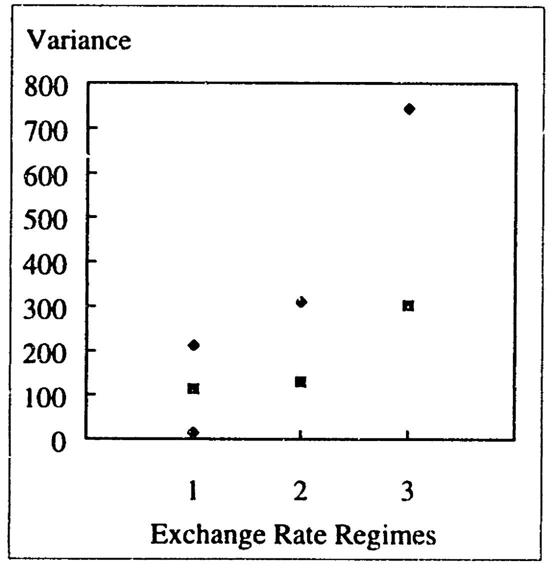


Figure C.3: Average Variance of Monthly Effective RER Changes

- Full Sample of 90 Countries
- With correction for regime switching

Reg.	Mean	95% Confidence Interval		No Obs.
1	62	29	94	63
2	107	-82	296	56
3	42	22	62	41

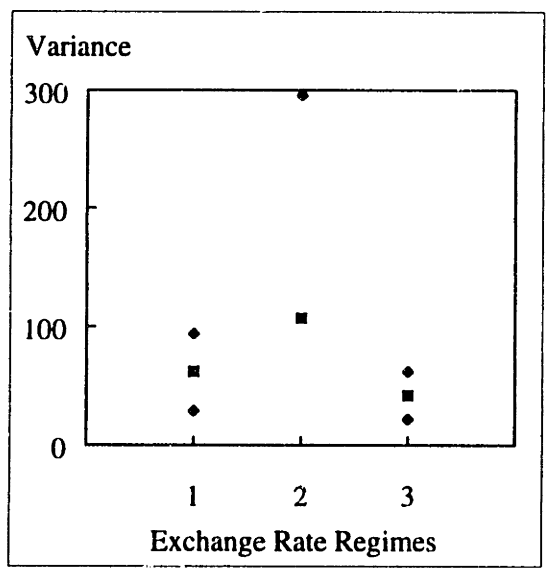


Figure C.4: Average Variance of Monthly Effective RER Changes

- 45 Low Inflation Countries
- Inflation less than 10 per cent per annum
- With correction for regime switching

Reg.	Mean	95% Confidence Interval		No Obs.
1	16	-12	43	26
2	2.36	1.30	3.41	24
3	3.31	2.17	4.44	13

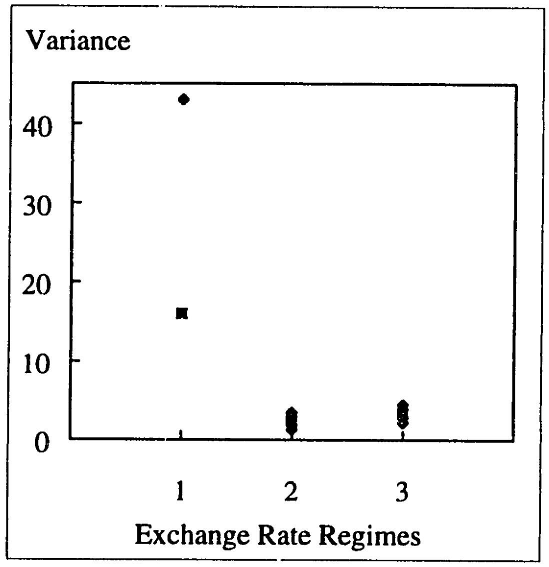
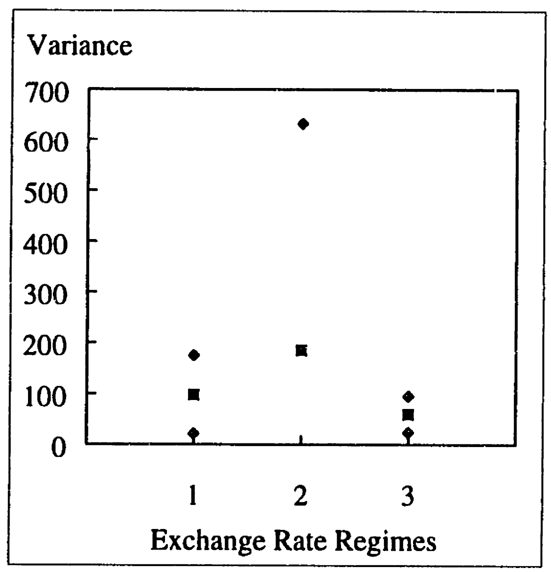


Figure C.5: Average Variance of Monthly Effective RER Changes

- 45 High Inflation Countries
- Inflation more than 10 per cent per annum
- With correction for regime switching

Reg.	Mean	95% Confidence Interval		No Obs.
1	98	21	175	35
2	185	-262	632	32
3	60	24	96	28



C.2 Data

C.2.1 Bilateral Exchange Rates and Regimes from Bretton Woods

The monthly series on bilateral real exchange rates for the set of industrialized countries used in Mussa's study were constructed using average exchange rates (versus the US dollar) and the consumer price indices from the *International Financial Statistics*. Data starts in January 1960.

Table C.1 indicates the classification scheme of the nominal exchange rate (versus the US dollar) that was adopted by Mussa and used in Section 4.2 of Chapter 4.

Table C.1: Nominal Exchange Regimes, Industrialized Countries, During and After Bretton Woods

	Country	Fixed to US dollar - Regime 1	Floating - Regime 3
1	Austria	60:1 to 70:12	73:3 to 90:12
2	Belgium	60:1 to 70:12	73:3 to 90:12
3	Canada	62:8 to 70:3	70:4 to 90:12
4	Denmark	60:1 to 70:12	73:3 to 90:12
5	France	60:1 to 70:12	73:3 to 90:12
6	Germany	60:1 to 70:12	73:3 to 90:12
7	Ireland*		79:1 to 90:12
8	Italy	60:1 to 70:12	73:3 to 90:12
9	Japan	60:1 to 70:12	73:3 to 90:12
10	Netherlands	60:1 to 70:12	73:3 to 90:12
11	Norway	60:1 to 70:12	73:3 to 90:12
12	Sweden	60:1 to 70:12	73:3 to 90:12
13	Switzerland	60:1 to 70:12	73:3 to 90:12
14	United Kingdom	60:1 to 70:12	73:3 to 90:12

* Ireland was fixed against the pound sterling until December 1978.

C.2.2 Nominal Exchange Rate Regimes

Table C.2 indicates how the many different nominal exchange rate regimes described by the IMF are aggregated into 3 broad groupings. Regime 1 is the fixed nominal exchange rate regime, regime 3 is a freely floating exchange rate regime, and regime 2 lies somewhere in between regimes 1 and 3 in terms of flexibility. Our data on nominal regimes starts in November 1978 and ends in December 1994.

Table C.2: Nominal Exchange Regimes - IMF Descriptions

	Description	Regime
1	pegged to US dollar	1
2	pegged to Pound Sterling	1
3	pegged to French Franc	1
4	pegged to Spanish Peseta	1
5	pegged to South African Rand	1
6	pegged to Australian Dollar	1
7	pegged to Indian Rupee	1
8	pegged to Deutsche Mark	1
9	pegged to Russian Ruble	1
10	pegged to Italian Lira	1
11	pegged to Ethiopian Birr	1
12	pegged to Singapore Dollar	1
13	pegged to SDR	1
14	pegged to other (currency) composite	1
15	exchange rate adjusted according to set of indicators	2
16	cooperative exchange rate arrangements	2
17	other, split into 3 categories as of July 31 1982	*
18	flexibility limited in terms of a single currency	2
19	more flexible: other managed floating	2
20	more flexible: independently floating	3

* Category 17 is simply denoted "other" in the *IFS* prior to July 31 1982. For dates prior to this we used information from the IMF *Annual Report on Exchange Arrangements and Exchange Restrictions*, to dissagregate category 17 into categories 18, 19 and 20 shown above. More detailed information is available on request.

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