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

by

Luis Oscar Herrera

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Abstract

This thesis consists of three empirical essays on international macroeconomics. The first two papers explore the empirical determinants of the current account in the short run and the long run, and the third one is an study on the dynamics of durable consumption in Chile and Israel.

Chapter 1 studies the behavior of capital flows in the long run from the perspective of the open economy neoclassical growth model. The empirical study involves a sample of 65 countries over the last two decades, including economies at different stages of development and varying degrees of international integration in goods and financial markets. The empirical study indicates that the pattern of international capital flows can be satisfactorily explained within the context of the neoclassical model, in the sense that overall the model explains about two thirds of the sample variability in the current account, and the pattern of signs is consistent with theory. However, the degree of observed capital mobility falls short of the implications of the open economy neoclassical model without factor price equalization. At face value, point estimates indicate that about one third or less of "structural" differences between investment and savings induces actual capital inflows (outflows), while the remaining two thirds require of adjustment in domestic savings and domestic investment to close their gap. The conclusion is that even when capital flows according to variables related to the neoclassical-life cycle model, the volume of flows falls short of the predictions of the model.

Chapter 2 asks if current account deficits (surpluses) are a sign of overvaluation (undervaluation), where overvaluation (undervaluation) is defined as a conditional prediction about the future path of the real exchange rate based on the state of the current account. The empirical relationship between current account imbalances and the dynamics of the real exchange rate is estimated using vector auto regressions techniques from a panel of 18 Latin American countries from 1950 to 1992. The identification of the VAR system is obtained using plausible long run constraints as those of Blanchard and Quah (1989), but leaving unrestricted the dynamic interactions between these variables in the short run. The first identification scheme imposes the long run exogeneity of the net foreign asset position, which is the cumulative result of trade imbalances, with respect to other unobservable disturbances in the system which affect the long run real exchange rate through the trade balance channel. The second identification scheme takes the opposite view, assuming that the long run exchange rate is exogenous to the long run level of absorption in the economy, consistent with a view of the real exchange rate as fully determined by supply side considerations. The estimation results indicate that trade imbalances help to detect transitory components in real exchange rate movements, and the dynamics of the trade balance correspond to what is expected from capital flows shocks: trade deficits on average are associated with an overvalued exchange rate in the sense that a future real depreciation is expected and the capital transfer shock accounts for a significant fraction of the transitory or cyclical variability of the real exchange rate,

between 40% and 60%, and for most of the variance of the trade balance. However, only a small fraction of the overall variability of the real exchange rates, below 15% is explained by this shock.

Chapter 3 is an empirical study on the determinants of durable consumption in Chile and Israel. The dynamics of durable consumptions are estimated separately for each country using a structural VAR approach identified through long run restrictions. The dynamics of the vector of aggregate consumption, durable and non durable purchases, are decomposed in three types of shocks: a wealth shock, that affects in a permanent way both components of consumption; a price shock, that reallocates consumption between durables and non-durables; and an intertemporal substitution effect that shifts purchases, mainly of durables, across time, but does not have long run effects on the consumption vector. The main empirical results of the paper can be summarized as follows. First, the long run behavior of durable purchases is estimated from a cointegrating relationship containing a wealth and a price trend. The elasticity on the wealth trend is estimated to be above 1.0 in the cases of Chile and Israel, and the price elasticity is estimated to be between -0.5 and -1.0. Second, the short run empirical dynamics of durable purchases shows that stock adjustment is slow, much slower than predicted by the standard permanent income model with no transaction costs. However, there is evidence that the adjustment period is characterized by an initial period of overshooting when most of the stock adjustment happens followed by gradual convergence to its long run value. Third, the model shows that most of the variance in durable purchases is accounted by permanent price and weath shocks, but substitution shocks account for a significant component too, particularly in the case of Israel. Furthermore, the substitution shock on durable purchases is significantly associated to financial variables like the black market premium and measures of capital flight showing the importance of speculative factors in the timing of durable purchases.

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1 Introduction

This thesis consists of three empirical essays on international macroeconomics. The first two papers explore the empirical determinants of the current account in the short run and the long run, and the third one is an study on the dynamics of durable consumption in Chile and Israel.

Chapter 2 studies the behavior of capital flows in the long run from the perspective of the open economy neoclassical growth model. Is the failure of international capital to flow to poor countries an equilibrium phenomena, i.e. a consequence of differences in technology, market distortions and other factors which affect the profitability of investment or the savings rate; or is it related to limited integration of world trade and capital markets, as proposed by Feldstein-Horioka?. We estimate an empirical model of long run capital flows on a set of variables related to the neoclassical-life cycle model to evaluate if this is the appropriate framework to understand the pattern of international capital movements observed in the world economy. The empirical study involves a sample of 65 countries, including economies at different stages of development and varying degrees of international integration in goods and financial markets, and covers the last two decades.

Analogously to the empirical literature on growth, we find that once structural factors related to the steady state level of output, like the initial endowment of human capital or market distortions, are controlled for the role of convergence factors on the determination of the current account increases. These control variables exercise a strong and significant effect on capital flows and the direction of their effects is according to theoretical presumptions. A higher level of human capital tends to increase capital inflows, and market distortions or political instability tend to decrease them. Variables related to savings like the social security system, the growth rate, and the intergenerational distribution of resources have an important role on the determination of the capital flows. Overall, the model explains about a two thirds of the sample variability in the current account, and parameter estimates are robust to alternative specifications of the model.

The empirical model provides the basis to estimate a measure of the degree of capital mobility in the same spirit of the work by Feldstein and Horioka (1980) and others. We estimate the fraction of the "structural" difference between domestic investment and savings which becomes a current account imbalance - one under perfect capital mobility and zero under no capital mobility. This fraction is closely related to the Feldstein-Horioka measure of capital mobility through simple manipulations of the basic national account identities. The main challenge for identification is to find instruments that on *a priori* grounds shift only the investment schedule or the savings schedule, the empirical model of the current account provides a set of relevant variables as potential instruments.

The evidence on capital mobility is consistent with the relatively low degree of international capital mobility indicated by traditional FH measures. At face value, point estimates indicate that about

one third or less of "structural" differences between investment and savings induces actual capital inflows (outflows), while the remaining two thirds require of adjustment in domestic savings and domestic investment to close their gap. The conclusion is that even when capital flows according to variables related to the neoclassical-life cycle model, the volume of flows is small compared to the implications of the one good neoclassical model.

Chapter 3 studies an old topic on international economics: the relationship between international capital transfers and the real exchange rate or terms of trade fluctuations. The main empirical question addressed on this paper is whether current account deficits (surpluses) are a sign of overvaluation (undervaluation), where overvaluation (undervaluation) is defined in the sense that conditional on the state of the current account we can expect a future movement of the real exchange rate.

The empirical relationship between current account imbalances and the dynamics of the real exchange rate is estimated from a panel of 18 Latin American countries from 1950 to 1992. However, the interpretation of the estimation results requires to take into account the endogenous nature of the current account and the real exchange rate determination. The pattern of correlation between these two variables depends on the specific source of the exogenous disturbance affecting them. Identification cannot be achieved imposing the contemporaneous exogeneity of either the current account or the exchange rate innovations as it is done commonly in VAR analysis, but requires of an alternative set of restrictions. We identify the VAR system using plausible long run constraints as those of Blanchard and Quah (1989), but leaving unrestricted the dynamic interactions between these variables in the short run.

A simple model of the joint determination of the current account and the real exchange rate suggests two sources of fundamental shocks to the real exchange rate: "capital account" or demand shocks, that affect the real exchange rate because they affect the equilibrium level of absorption relative to output; and "trade account " or supply shocks that affect the equilibrium real exchange rate for a given level for the trade balance. We explore two alternative schemes to identify these shocks based on long run constraints. The first scheme imposes the long run exogeneity of the net foreign asset position, which is the cumulative result of trade imbalances, with respect to other unobservable disturbances in the system which affect the long run real exchange rate through the trade balance channel. In a sense, this assumption moves the dichotomy between the "absorption" and the "elasticities" approach to the trade balance from the short run to the long run, and argue that in the long run the absorption level of the economy can be considered independent of the real exchange rate level. The second identification scheme takes the opposite view, assuming that the long run exchange rate is exogenous to the long run level of absorption in the economy, consistent with a view of the real exchange rate as fully determined by supply side considerations.

The estimation results indicate that trade imbalances help to detect transitory components in real exchange rate movements, and the dynamics of the trade balance correspond to what is expected from capital flows shocks: trade deficits on average are associated with an overvalued exchange rate in the sense that a future real depreciation is expected and the capital transfer shock accounts for a significant fraction of the transitory or cyclical variability of the real exchange rate, between 40% and 60%, and for most of the variance of the trade balance. However, only a small fraction of the overall variability of the real exchange rates, below 15% is explained by this shock.

Chapter 4 is an empirical study on the determinants of durable consumption in Chile and Israel. Understanding the empirical behavior of durable purchases is important because it represents the most volatile part of private consumption, and it is a major fraction of consumption goods imports in developing countries. Furthermore, at least theoretically, its behavior should be very different from non-durable consumption. Fluctuations on durable purchases should be highly predictable, and largely transitory, while non-durable purchases should follow approximately a random walk, and therefore its fluctuations be unpredictable.

One interesting and related question is to understand the behavior of durable purchases in major stabilization programs anchored in the nominal exchange rate. Two recent studies of exchange rate-based stabilization programs (ERBS's) implemented in Latin America and Israel point out the puzzling expansionary effects of these programs. Large increases in private consumption -- particularly, on durable consumption-- are observed at the beggining of these programs, while a recession comes only at a second stage of the program. (Kiguel and Liviatan (1992) and Vegh (1992)). Two of the leading hypothesis offered to account for the pattern of response of private consumption through ERBS's: permanent income revisions and expectations of abandonment of the nominal peg, have distinctive predictions on the behavior of durable consumption through the stabilization process. If abandonement expectations drive the behavior of durable goods in ERBS's, we expect booms in durable purchases to be short lived and largely reversed after a few periods, and without impact on the long run stock of durable goods. Furthermore, we expect a positive correlation of financial variables measuring devaluation expectations and durable purchases. In contrast, when permanent factors as wealth revisions or expansions on credit availability drive the boom, we expect a permanent change in the stock of durable goods.

The dynamics of durable consumptions are estimated separately for each country using a structural VAR approach. Using the methodology pioneered in papers by Blanchard and Quah (1989), Shapiro and Watson (1988) and King, Plosser, Stock and Watson (1989), long run restrictions identify the structural VAR system. In the first stage, the long run cointegration vector that links durable and non durable consumption is estimated, identifying the "deep" parameters that describe consumer preferences. In the second stage, the dynamics of the vector of aggregate consumption are estimated, imposing the long run relationship found in the first stage. The dynamics are decomposed in three types of shocks: a

wealth shock, that affects in a permanent way both components of consumption; a price shock, that reallocates consumption between durables and non-durables; and an intertemporal substitution effect that shifts purchases, mainly of durables, across time, but does not have long run effects on the consumption vector.

The main empirical results of the paper can be summarized as follows. First, the long run behavior of durable purchases is estimated from a cointegrating relationship containing a wealth and a price trend. The elasticity on the wealth trend is estimated to be above 1.0 in the cases of Chile and Israel, and theprice elasticity is estimated to be between -0.5 and -1.0. Second, the short run empirical dynamics of durable purchases shows that stock adjustment is slow, much slower than predicted by the standard permanent income model with no transaction costs (Mankiw, 1982; 1985). Durable purchases appear to be positively correlated in the short run, contradicting the negative correlation predicted by the standard model. However, there is evidence that the adjustment period is characterized by an initial period of overshooting when most of the stock adjustment happens followed by gradual convergence to its long run value. Third, the model shows that most of the variance in durable purchases is accounted by permanent price and wealth shocks, but substitution shocks account for a significant component too, particularly in the case of Israel. Furthermore, the substitution shock on durable purchases, which in practice corresponds to surges or depressions in durable purchases not accompanied by changes in non-durable consumption, is significantly associated to financial variables like the black market premium and measures of capital flight showing the importance of speculative factors in the timing of durable purchases.

The complexity of the dynamics revealed by the empirical estimates indicates how difficult is to provide the right account of the developments in durable purchases just from looking to the series. In the case of Israel, the structural VAR empirical model is used as a filter to disentangle the particular shocks hitting the economy during the stabilization program initiated in 1985, and provides an historical account of the leading shocks through the period. The estimates indicate that the initial expansion observed in durables through 1986, two quarters after the stabilization program started, is within normal levels once the special dynamics of durable goods are taken into account, and other structural variables like prices and permanent income are included in the regression. However, substitution effects start appearing towards the end of 1986 and continue over the next two years. Indeed, the observed surge in durable purchases precedes actual devaluations of the Israeli currency. The abandonment expectation hypothesis, stressed by Calvo (1986, 1991, 1992) and Drazen (1990) among others, do not appear to explain the initial period of expansion, but explains why it sustained in a later stage as the government delayed for political reasons a necessary and, according to observers, expected devaluation (Bruno, 1993).

Chapter 2

International Capital Flows in the Long Run: Why does Capital Flow from Rich to Poor Countries?

2.1 Introduction

This chapter studies the empirical determinants of international capital flows in the long run. Simple neoclassical models of trade and growth predict that capital should flow from rich to poor countries until equality in output per worker is achieved. If two countries producing the same good with the same constant returns to scale technology defined on homogeneous capital and labor inputs have different levels of production per worker, they must have different levels of capital per worker, since every thing else is ruled out. The Law of Diminishing Returns implies that the return of capital is higher and wages are lower in the poorer economy, then if trade in goods and capital is free, new investment should be allocated primarily in the poor economy until equality in factor returns is achieved. The strong convergence property predicted by these models contrasts with the large productivity differences observed across the world economy and the low volume of international capital flows (Lucas, 1990). There is some investment going from rich economies into poorer economies but the size of capital flows clearly falls short of theory's prediction. Lucas (1990) suggested that physical capital fails to flow to poor countries because of their relatively poor endowments of complementary human capital.[1] He shows some back of the envelope computations about the importance of human capital in the determination of capital yields, but no formal testing of the hypothesis is done against a broad sample of developed and developing countries.[2] Evidence from the empirical growth theory suggest that government distortions,

[1]He assumes that human capital accumulation directly increases the effective supply of labor and indirectly improves technology through external effects.

[2]Using the textbook neoclassical growth model based on a naive Cobb-Douglas production function and assuming a capital share equal to 0.4, Lucas (1990) estimates the marginal product of capital in India ought to be roughly

large differences in the relative price of capital, the lack of complementary public investment, political instability and threats to property rights, and other factors which cause differences on the private productivity of capital are important determinants of persistent differences in cross country output levels or in their growth rates (Barro, 1991; Mankiw, Romer and Weil 1992, DeLong and Summers 1991, 1993), Jones (1994) and others), and they should be important too in explaining why capital fails to flow from rich to poor countries.

Other factors related to the determination of the savings rate should be important too to explain the pattern of international capital movements. Taylor and Williamson (1994), for example, present evidence that a large share of the late nineteenth century capital flows from Britain to the New World, roughly three quarters according to their preferred estimate, could be accounted by demographic factors. And the life cycle theory of wealth accumulation suggest several other variables which could affect the volume of secular capital movements through their effects on the long run saving rate, i.e. the generosity of the social security system, the age of retirement, the extent of borrowing constraints at the consumer level, etc..

However, it must be recognized that there are substantial barriers to international trade in goods and assets which may prevent actual capital flows to resemble anything close to the predictions of the neoclassical model. Because of transport costs, tariffs and quotas and other barriers, international trade involves only a narrow set of goods and services, and capital transfers must go through that narrow window, which limits the substitutability between domestic savings and external savings as sources of funds for investment. Or because of sovereign country risk or information asymmetries between foreigners and residents or government regulations, the allocation of funds is biased towards home markets.

Most capital flows to developing countries, for example, do not originate in private international capital markets. According to the IMF classification of developing countries by type of creditor, only 27 countries out of 130 are counted in the *market borrowers* group which owe at least two thirds of their external obligations to commercial creditors. Most developing countries (71) fit the *official borrowers* definition owing more than two thirds of their total external obligations to official agencies, and the rest corresponds to *diversified borrowers*.[3] This composition of debt suggests that international politics, strategic factors, former colonial links or humanitarian reasons could be more important determinants of international capital flows than those factors pointed out by the neoclassical model or the life cycle model. Even within industrial countries, which presumably are much closely integrated than developing countries, the close correlation of saving and investment rates across industrialized economies, for example, suggest

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58!! times that of United States. However, after adjusting relative factor endowments for heterogeneity in labor force quality the yield differential almost disappears.

[3]See the statistical appendix in World Economic Outlook (1994).

that the main source of funds for domestic investment is domestic savings, both on average and at the margin (Feldstein and Horioka, 1980; Feldstein, 1984; Feldstein and Bacchetta, 1991).

This paper studies the behavior of capital flows in the long run from the perspective of the open economy neoclassical growth model.[4] Is the failure of international capital to flow to poor countries an equilibrium phenomena, ie. a consequence of differences in technology, market distortions and other factors which affect the profitability of investment or the savings rate; or is it related to limited integration of world trade and capital markets, as proposed by Feldstein-Horioka?.

Answering these questions has enormous importance to understand the workings of growth in the open economy, and to answer other related policy oriented questions. Perfect capital mobility, for example, implies rapid convergence, so cross country differences in output per capita that persist across time must be interpreted primarily as equilibrium differences, a consequence of differences in technology or in the availability of complementary fixed factors, and not as evidence of lack of capital. Under perfect capital mobility, the only relevant policies to increase capital formation and increase domestic wages are those oriented to eliminate distortions that decrease the profitability of investment. Other policies oriented to increase domestic savings as public savings, financial or social security reform or taxes and subsidies will be ineffective to this end. Similarly, foreign aid is not an effective tool to increase capital formation, or if it does is an inefficient utilization of resources, as residents will be better off if they could increase their consumption level. Conversely, if capital mobility is limited, external savings will not substitute one for one domestic savings as a source of funds for investment, and policies oriented to increase domestic savings and promote a closer integration in trade and assets markets will be effective ways to increase domestic capital formation.

Section 2.2 presents a basic model of the current account balance (or alternatively, the capital account balance) for a small open economy where international trade in final goods does not achieve factor price equalization. The model is based on the contribution of Matsuyama (1987) and describes the dynamics of investment, savings, and their difference: capital inflows (outflows), for an open economy working under the standard assumptions of the neoclassical model of growth. Investment is modeled along the lines of q-theory, and savings follows the life cycle-permanent income model. International capital passively flows in or out filling the gap between domestic investment and domestic savings at the exogenously given international interest rate.

The theoretical model makes a distinction between steady state capital flows and convergence capital flows. Steady state capital inflows (outflows) in a growing economy reflect permanent differences between the steady state stock of capital and the steady state stock of non human wealth in the hands of

[4]The empirical study focuses on medium and long run issues, five or more years averages of net capital transfers, leaving aside cyclical factors.

residents. The long run stock of capital depends among other variables on the technology available in the country, market distortions and the endowment of complementary production factors; while the long run stock of wealth depends on intertemporal preferences, the age structure of population and the intergenerational distribution of resources and other variables pointed out by the life cycle model. Convergence capital flows originate on deviations of the initial level of capital or the initial level of wealth from their long run positions. The neoclassical prediction that capital flows from rich to poor countries is a property of convergence flows, but proper testing of this prediction requires to control for heterogeneity in the steady state position across countries. Analogously to the empirical growth literature, convergence flows must be defined in a conditional sense, each country converges to its own steady state position depending on its own structural characteristics. As discussed in section 2.2 failure to take into account this heterogeneity will lead to underestimating the importance of convergence flows in the determination of the current account. The empirical model of capital flows is an attempt to evaluate the neoclassical model controlling for these structural differences across countries.

In section 2.3 we estimate an empirical model of capital flows on a set of variables related to the neoclassical-life cycle model to evaluate if this is the appropriate framework to understand the pattern of international capital movements observed in the world economy. The empirical study involves a sample of 65 countries, including economies at different stages of development and varying degrees of international integration in goods and financial markets, and covers the last two decades. The measure of capital flows, the current account balance as percentage of GDP, is averaged through the period 1971-1990 to filter out business cycle effects, so the study is based on the cross section dimension of the data only. An extension to panel estimates is left for future work. Analogously to the empirical literature on growth, we find that once structural factors related to the steady state level of output, like the initial endowment of human capital or market distortions, are controlled for the role of convergence factors on the current account increases. These control variables exercise a strong and significant effect on capital flows and the direction of their effects is according to theoretical presumptions. A higher level of human capital tends to increase capital inflows, and market distortions or political instability tend to decrease them. Variables related to savings like the social security system, the growth rate, and the intergenerational distribution of resources have an important role on the determination of the capital flows. Overall, the model explains about a two thirds of the sample variability in the current account, and parameter estimates are robust to alternative specifications of the model.

The model of section 2.3 provides the basis to estimate in section 2.4 a measure of the degree of capital mobility in the same spirit of the work by Feldstein and Horioka (1980), FH, and others. We estimate the fraction of the "structural" difference between domestic investment and savings which becomes a current account imbalance - one under perfect capital mobility and zero under no capital

mobility. This fraction is closely related to the FH measure of capital mobility through simple manipulations of the basic national account identities.

The estimation procedure takes explicit account of some of the criticisms related to the interpretation of the FH findings. One common criticism is that the correlation between investment and savings corresponds to correlation between their fundamentals rather than evidence of imperfect capital mobility, an identification problem. Indeed, there is a wide variety of models that produce comovements in savings and investment in response to exogenous disturbances (Obstfeld, 1985; Baxter and Crucini, 1989; Tesar, 1988).[5] This criticism is specially valid for time series evidence, but could affect cross-sectional estimates too. A simple model in section 2.4 makes explicit the identification assumptions necessary to interpret the FH coefficient and our coefficient as measures of capital mobility, and proceeds to estimate a joint model of determination of investment and savings which provides this estimate and is robust to these problems. The main challenge for identification is to find instruments that on *a priori* grounds shift only the investment schedule or the savings schedule, the empirical model of section 2.3 provides a set of relevant variables as potential instruments, and the model of section 2.2 motivates the choice of restrictions on these variables.

The evidence of section 2.4 is consistent with the relatively low degree of international capital mobility indicated by traditional FH measures. At face value, point estimates indicate that about one third or less of "structural" differences between investment and savings induces actual capital inflows (outflows), while the remaining two thirds require of adjustment in domestic savings and domestic investment to close their gap. The conclusion is that even when capital flows according to variables related to the neoclassical-life cycle model, the volume of flows is small, perhaps because of the low degree of integration of markets across national frontiers or alternatively because international capital flows take place through Hecksher-Ohlin trade. The main conclusions of the paper are presented in section 2.5.

2.2 A Neoclassical Model of the Current Account

In this section we develop a simple model of the current account determination in an economy which verifies the standard assumption of the textbook neoclassical model of growth: decreasing returns to scale, and exogenous population and productivity growth. The model emphasizes the investment-savings approach to the current account for a small open economy. We assume that international capital passively flows in or out filling the gap between domestic investment and domestic savings at the

[5]Tesar (1991) and Obstfeld (1993) survey the empirical literature and the criticisms of the FH measure of capital mobility.

external interest rate, and foreign goods are perfect substitutes of domestic goods which takes out of the analysis exchange rate movements.

The model is based on the contribution of Matsuyama (1987). Investment is modeled along the lines of q-theory, and savings follows the life cycle-permanent income model.

2.2.1 Investment and the steady state stock of capital

Consider a small open economy in a one-product world with perfect capital markets. The world interest rate r^* is given and for simplicity assumed to be constant over time.[6] The representative firm maximizes its net present value given the production and investment technology:

$$V_t = \max_{(I_s,\hat{L}_s)} \int_t^{\infty} \left\{ AF(K_s,\hat{L}_s) - w_s \hat{L}_s - \bar{q} I_s \left(1 + J(\frac{I_s}{K_s}) \right) \right\} e^{-r^*(s-t)} ds \tag{1}$$

where A is a technological parameter, $F(K,\hat{L})$ is a well behaved linear homogeneous production function in capital and labor efficiency units and $J(I/K)$ is an installment cost function with $J(\delta+n+\gamma)=0$, $J'(\delta+n+\gamma)=0$ and $J''>0$, δ is the depreciation rate, n is the rate of population growth and γ is the rate of technological progress. Technological progress is assumed to be labor augmenting and exogenous, as in the standard neoclassical growth model. Labor, measured in terms of efficiency units, is supplied inelastically and it is assumed to grow at the exogenously given rate $n+\gamma$.

The steady state stock of capital is defined by the condition of equality between the private return to physical capital and the long run user cost:

$$Af'(\bar{k}) = (r^* + \delta)\bar{q} \tag{2}$$

Two properties of this formulation are worth mentioning. First, the steady state capital stock and its dynamics are independent of the savings side of the economy. Because of the assumption of full integration between the home economy and the rest of the world, the steady stock of capital (normalized) is independent of the domestic savings rate and the rate of population growth which determine this variable in the closed economy version of the neoclassical model. On the other side, any distortion to the

[6] The real interest rate has varied widely in the last decades, negative in the inflationary seventies, and positive and very high in the early eighties. This variability, however, is not important in the empirical work as it is based on the cross-section dimenssion of the data set not on the time series dimenssion.

expected profitability of capital -- i.e. corporate taxes, expropriation risk, or distortions in the market for investment goods-- leads to a recomposition of wealth allocation from domestic capital towards foreign assets.[7]

Second, the model has only one good and two production factors, an assumption which immediately rules out factor price equalization through Heckscher-Ohlin-Samuelson, HOS, trade in final goods. If instead we allowed trade in final goods with different factor intensities, returns on capital (wages) could be equalized across countries without requiring international capital movements. Because the model above assumes that all differences on initial endowments create capital movements across countries, it is an upperbound of actual flows in the real world where HOS trade takes place.

Investment flows can be written as a function of the relative price of capital, q, which under the assumptions of constant returns to scale and competitive labor and product markets is identical to Tobin's q, and solves the differential arbitrage equation: $(r^* + \delta)q = Af'(k) + \dot{q}$. Normalizing the capital stock by labor efficiency units, and linearizing its dynamics around the steady state, we get the following system of linear differential equations:

$$\begin{bmatrix} \dot{k} \\ \dot{q} \end{bmatrix} \approx \begin{bmatrix} 0 & \bar{k}\lambda'(\bar{q}) \\ -Af''(\bar{k}) & (r^* + \delta - (n+\gamma+\delta)^2\bar{q}) \end{bmatrix} \begin{bmatrix} (k-\bar{k}) \\ (q-\bar{q}) \end{bmatrix} \tag{3}$$

where $\lambda'(.) \equiv 1/J''(.)$.

Adding the transversality condition that q converges to its steady state value $\bar{q}$, the equilibrium relative price of capital can be written as a function of the distance of the current capital-labor ratio from its steady state position: $q - \bar{q} = \varphi(\bar{k} - k)$, where $\varphi = \eta_1 \lambda^{-1}(n+\gamma+\delta)^{-1}$, and η_1 is the absolute value of the negative root of the second order polynomial on η: $\eta^2 - (r^* + \delta)\eta - (f''\bar{k}/f')(n+\gamma+\delta)\lambda'(r^* + \delta)$.[8] Substituting out the equation for q, and solving the system we get an approximation for the trajectory of the capital stock starting from k_0:

$$k(t) \approx \bar{k} + (k_0 - \bar{k})e^{-\eta_1 t}$$

[7] This property is non robust to some extenssions of the model. If a non tradable good is included in the model and investment and consumption requires traded and non traded goods, the model becomes an hybrid between the closed economy and the open economy neoclassical model. Each country converges to its own steady state level of output which depends not only on its technology, but also on domestic preferences and other institutional issues that affect the rate of national savings, and output converges gradually even if investment has no adjustment costs, because households smooth consumption in non traded goods (Brock and Turnovsky, 1994).

[8] The term $(n+\gamma+\delta)^2\bar{q}$ can be neglected as it is a small number.

(4)

which is independent of the saving side of the economy. From these expressions we can derive the dynamics of the capital stock value, qk, around the steady state which will be an important element in the determination of the current account as explained below:

$$\dot{q}\bar{k} + \bar{q}\dot{k} = \eta_1 \bar{q}(1 - \pi_{q,k})e^{-\eta t}(k_0 - \bar{k})$$

(5)

The key parameter for the sign of this expression is the elasticity of the price of installed capital with respect to deviations of the capital stock, $\pi_{q,k}$. This parameter determines whether the value of the stock of capital, qk, is rising or falling as the economy accumulates physical capital. If this elasticity is less than one and the economy starts from below the steady state level of physical capital, the value of wealth stored in the capital stock rises as the economy accumulates capital towards its steady state value. The counterpart of the rising capital stock, other things equal, is a rising level of external debt: a current account deficit. The impact on the current account is reversed if this elasticity is above one.

The magnitude of this price elasticity relative to the critical value of one cannot be determined a priori, but it can be shown that this elasticity is less or equal (in absolute terms) to $-f''(\bar{k})\bar{k}/f'(\bar{k})$. The price-stock elasticity can be above one if the elasticity of substitution is very low and the share of capital is very high, but most likely it is below one, and the economy runs a current account deficit if it is poorly endowed in capital. If the labor-capital substitution elasticity is close to one, for example, this inequality is enough to show that the price-stock elasticity is less than one.[9]

2.2.2 Saving and the steady state stock of wealth

Aggregate consumption is modeled using an overlapping generations model with the Blanchard-Yaari structure. This structure captures the effect of demographic and institutional variables on the medium and long run savings rate, not modeled in the infinite horizon representative consumer version.

[9]Assuming a Cobb-Douglas production function with a capital share equal to 0.4, a depreciation rate equal to 7% a year, an international interest rate for capital investment equal to 10% and a 3% anual growth rate for labor efficiency units, there is only one parameter left to determine this price elasticity. We can calibrate this parameter using the typical estimates of the convergence found in the empirical growth literature. Mankiw et al. (1992) and Barro (1991) report cross-section estimates for the speed of convergence around 2% a year, but there is some evidence of downward bias on their estimates due to the unaccounted correlation of country specific effects and the explanatory variables in growth regressions (Knight et al. (1993)). Panel estimates adressing this econometric problem estimate the speed of convergence to be faster, in the range of 4% to 6% a year (Knight et al. (1993)). Choosing a 3% a year rate of convergence, the model solves a price-stock elasticity equals to 0.5.

At each instant, a fraction θ of the population dies, and a new generation of size $L_t(\theta+n)dt$ is born, such that total population grows at rate n. Each consumer is born with zero non-human wealth and supplies labor inelastically, earning wage income ω , and has a constant probability of death θ , independent of its age. Consumers born at time z maximize the intertemporally separable log-utility function:

$$\int_z^{\infty} \ln(c^z) e^{-(\rho+\theta)(s-t)} ds \tag{6}$$

subject to the intertemporal budget constraint:

$$\dot{a}^z = \omega^z + (r^* + \theta)a^z - c^z \tag{7}$$

where ρ is the discount factor. The optimal consumption policy can be shown to be:

$$c^z = (\rho+\theta)(a^z + h^z) \tag{8}$$

where a^z $(=qk^z + b^z)$ represents the amount of non-human wealth in the hands of generation z, b^z represents foreign assets and h^z human wealth. Aggregation across cohorts implies that total consumption can be expressed as a fraction of total wealth in the economy:

$$C = (\rho+\theta)(A+H) \tag{9}$$

where upper-case letters refer to the corresponding variable aggregated across the population. The accumulation of (normalized) financial wealth or savings follows the differential equation:

$$\dot{a} = \left[\omega - (r^* + \theta)h\right] + (r^* - \rho)(a+h) - \theta a - (n+\gamma)a \,, \tag{10}$$

where lower case letters to the corresponding variable normalized per efficiency units.

If the stability condition $r^* < \rho + \theta + \gamma + n$ holds, (normalized) financial wealth converges in the long run to $\bar{a}$:

$$\bar{a} = \frac{\left[\bar{\omega} - (r^* + \theta)\bar{h}\right] + (r^* - \rho)\bar{h}}{\rho + \theta + n + \gamma - r^*},$$

(11)

where $\bar{\omega}$ and $\bar{h}$ correspond to the steady state level for the wage and human wealth respectively. The term in squared brackets is the long run impact of the life cycle component of savings on asset accumulation. This term shows the average across population of the difference between current labor income and permanent labor income. Higher output growth and population growth affect the savings rate and the current account through this channel because they shift the intergenerational distribution of resources towards the younger which according to simple versions of the life cycle model do all the saving. Higher output growth has an opposite effect on saving as it increases the average gap between permanent labor income and current labor income for everyone. However, most likely this effect is not operative because borrowing constraints prevent young workers of consuming against their future labor income. Similarly, fast rates of expansion in education tilts wealth distribution toward young workers, where all the expansion takes place, and productivity gains are reflected disproportionately in the earnings of young workers, inducing a positive aggregation effect on savings.

More elaborate versions of the life cycle model distinguish population growth from labor force growth: fast labor force growth increases saving, but fast population growth tends to decrease the saving rate as the proportion of dependent children raises, which could be interpreted as a portfolio substitution effect from financial wealth accumulation to human capital accumulation. The proportion of retirees may also increase the saving rate because of a bequest motive on savings and wealth accumulation.

Other well known effects which operate through the life cycle component of savings are the fiscal budget and social security. A policy of persistent government deficits, shifts the burden of taxation of a given path of government expenditures towards future generations, an intergenerational redistribution of wealth, which tend to reduce savings. Social security benefits tends to flatten the income path, which reduces private incentives of workers to accumulate assets to cover for their retirement period.

The second term on the RHS shows the long run impact of intertemporal substitution on asset holdings derived from the tilting effect of interest rates on the consumption path. This component depends on intertemporal preferences across the population, income variability and precautionary savings and other factors which affect ρ.

Next, we compute the dynamics of the system around the steady state. For simplicity, assume an age independent distribution of income which implies that human wealth follows the differential equation:

$$\dot{h} = (r^* + \theta - \gamma)h - \omega$$

(12)

In the absence of taxes, labor income equals the wage bill which depends on the capital endowment of the economy. Approximating the wage around the steady state and assuming a Cobb-Douglas production function with a share α for capital we obtain:

$$\omega(t) \approx \bar{\omega} + \alpha(r^* + \delta)\bar{q}(k_0 - \bar{k})e^{-\eta_1 t}$$

(13)

where $\bar{\omega} = A(f(\bar{k}) - f'(\bar{k})\bar{k})$ and we can solve the human wealth equation:

$$h(t) \approx \frac{\bar{\omega}}{r^* + \theta - \gamma} + \frac{\alpha(r^* + \delta)\bar{q}(k_0 - \bar{k})}{\eta_1 + r^* + \theta - \gamma} e^{-\eta_1 t}$$

(14)

Substituting out equations (13) and (14) in the differential equation for financial wealth we find the explicit solution for this variable around the steady state:

$$a(t) \approx \bar{a} + (a_0 - \bar{a})e^{-\eta_2 t} + (k_0 - \bar{k})\chi_1(e^{-\eta_1 t} - e^{-\eta_2 t})$$

(15)

where $\eta_2 = \theta + \rho$ and $\chi_1 = \alpha(r^* + \delta)(r^* + \eta_1 - \gamma - \rho)(r^* + \eta_1 + \theta - \gamma)^{-1}\bar{q} \geq 0$.

The first term on the RHS represents the effects on savings of deviations of wealth from its steady state level. Consumption smoothing considerations predict that this convergence process is slow. The second term shows the effects of the expected path of wages on savings when the capital stock differs from its steady state value. If, for example, the economy starts from a capital stock level below steady state consumers expect a positive trend on their labor income and spend on account of future income, if they are able to borrow, running a current account deficit. This effect is reversed later as old consumers pay their debts and financial wealth returns back towards its long run value.

2.2.3 The current account and the steady state stock of foreign assets

The long run level of foreign assets (debt) is obtained from the definition of non-human wealth:

$$\bar{b} = \bar{a} - \bar{q}\bar{k}$$

(16)

The current account surplus is identical to the change in the external asset position of the country, which in turn is the residual between wealth accumulation by domestic residents and capital accumulation:

$$\dot{b} = \dot{a} - \dot{q}k - q\dot{k}$$

(17)

Substituting out the corresponding expressions in (17) we arrive to the differential equation for normalized foreign assets around the steady state, the "normalized" current account:

$$\dot{b}(t) \approx -\eta_2 e^{-\eta_2 t}(a_0 - \bar{a}) + \frac{\chi_1(\eta_2 e^{-\eta_2 t} - \eta_1 e^{-\eta_1 t})}{\eta_2 - \eta_1}(k_0 - \bar{k}) + \eta_1 \bar{q}(1 - \pi_{q,k}) e^{-\eta_1 t}(k_0 - \bar{k})$$

(18)

This equation summarizes the predictions of the model about the convergence component of the current account. The first term on the RHS represents a *wealth effect* on the current account, if the level of domestic assets is above its steady state the economy runs a current account deficit until assets return to their steady state level. The second and third term on the RHS show the effects on the current account of deviations of the capital stock from its steady state value. The last term on the RHS shows the impact on the current account of a *portfolio substitution effect.* Capital accumulation induces a recomposition in the portfolio of domestic residents from foreign assets towards domestic physical capital. The key parameter for the sign of this expression is the price-stock elasticity, which most likely is below one, implying that the *portfolio substitution effect* induces a current account deficit if the economy is poorly endowed in capital.

Around the steady state, the current account is approximated to the normalized current account plus long run capital flows which keep the economy at its steady state position:

$$\dot{B}/\bar{Y} \approx -\eta_2 e^{-\eta_2 t}(b_0/\bar{y} - \bar{b}/\bar{y}) + (\eta_2 e^{-\eta_2 t} - \eta_1 e^{-\eta_1 t})\left[\frac{\chi_1}{\eta_2 - \eta_1} - \bar{q}(1 - \pi_{q,k})\right](k_0/\bar{y} - \bar{k}/\bar{y}) + (n + \gamma)\bar{b}/\bar{y}$$

(19)

Assuming the economy is growing, $n+\gamma>0$, long run capital inflows depend positively on all those variables which increase the profitability of investment and the steady state of capital, and negatively in all those variables which increase the domestic rate of savings.

The prediction that capital should flow from rich to poor economies refers to convergence flows. The definition of poverty refers to poorly capital endowed countries relative to their own steady state

level of capital and not with respect to some common absolute level of capital. Lucas (1990), for example, argues that consideration of differences in human capital endowments across countries can reconcile the large differences in income per capita observed in the world economy and the absence of large international capital flows. The implication is that proper testing of the importance of convergence flows requires previously of controlling adequately for differences in the steady state stock of capital, otherwise they will be downward biased as it is likely a positive correlation between the steady state level of capital, which *caeteris paribus* tends to increase capital inflows, and the initial level of capital, which *caeteris paribus* tends to decrease capital inflows.

Summarizing, an empirical equation for the current account derived from the theoretical model has the following form:

$$\Delta b_{t+T} = c_0 + c_1 k_t + c_2 b_t + \bar{C}\bar{X}_t \,, \tag{20}$$

where Δb_{t+T} is the current account balance for the T periods following t, $\bar{X}_t$ is a vector that includes those variables that control for the steady state of the system and the capital stock and net external asset position capture convergence flows. Variables in $\bar{X}_t$ are grouped in two subsets: investment related and savings related, and includes among others proxies of human capital, market distortions, public infrastructure, the relative price of capital, the age structure of population, output growth, the generosity of social security system, the fiscal balance, etc.. We could also introduce variability in the international interest rate which could differ across countries due to sovereign risk considerations.

2.3 Empirical Results on the Long Run Determinants of the Current Account

A previous question before examining the secular relationship between capital flows and output per capita is the proper definition of flows. The two alternatives of comprehensive measures of capital movements are the overall current account balance and the overall capital account balance. In theory, they are identical, but in practice they are different due to errors and omissions in the recollection of data. Because of the better quality of trade statistics compared to financial statistics in the great majority of countries, we have decided to use the current account deficit as the overall measure of capital inflows, normalizing it for GDP (both measured at current prices) and averaging it throughout the 1970-1989 period to filter out cyclical factors and have a measure of capital inflows in the long run. The choice implicitly attributes all of the statistical discrepancy to transactions in the capital account, and it is consistent, for example, with the phenomenon of capital flight prevalent in many Latin American countries through the eighties, which goes as unrecorded financial transactions (acquisitions of foreign assets by domestic residents). The current account itself has many other measurement problems, coverage

problems within each country or problems of comparability across countries due to differences in accounting practices. However, this type of problems are inevitable in any study of this nature that covers a wide range of economies.

Figure 2.1 shows a plot of the average current account deficit as a percentage of GDP from 1971 to 1990 and the initial level of GDP per capita computed at international prices using the Summers and Heston (1992) data set, for a panel of 114 countries, including industrial and developing countries. Individual country observations and a smooth line that corresponds to a moving median of current account deficits are shown in Figure 2.1. It is evident the existence of a weak negative relationship between capital inflows and the initial level of output per capita, but there is substantial volatility around this relationship that remains to be explained. Poor countries experience current account deficits which on average are equivalent to 4% to 6% of GDP, as the starting income level increases the magnitude of the average current account deficit gradually declines to converge to approximately 1%.[10] Dividing countries in quartiles according to their initial output per capita, shows that the relationship between this variable and capital inflows is non monotonic. The lower quartile in the sample received on average capital inflows equivalent to 3.6% of their GDP from 1971 to 1990, capital inflows were almost three percentage points larger in the second quartile reaching 6.5% of GDP, and lower in the third and four quartile, 3.0% and 1.3% respectively.

2.3.1 Main Results

This section estimates an empirical equation of the current account closer to the theoretical model described in section 2.2, controlling for variables related to investment, savings and also to the degree of financial and commercial integration. We start from a base model that we subsequently modify to include additional variables and to test some specific hypothesis about the behavior of the current account in the long run.

Table 2.2 shows regressions for the annual average (1971-1990) of the current account balance with respect to GDP. The first six columns presents the results for a cross section of 65 countries, and the last two columns excludes industrial countries from the sample. The sample consists of the largest number of countries for which I have been able to assemble data on the variables employed, only oil rich countries were previously excluded from the sample on *a priori* grounds. The data set was assembled from a variety of sources including among others Barro and Lee (1993), Summers and Heston (1992), the World Bank's *World Tables* and *Social and Development Statistics*, the IMF, the United Nations and

[10]It may look paradoxical that the average line do not crosses the horizontal axis, who is lending if everyone is borrowing?, but these are simple averages, not weighted averages.

other sources. Means and standard deviations appear in Appendix 1; and a list of the countries in the sample is in Appendix 2.

Because heteroskedasticity could be important across countries, the standard errors for the coefficients are based on White's (1980) heteroskedasticity-consistent covariance matrix. These standard errors do not differ greatly, however, from those obtained through ordinary least squares, nor do the coefficients or standard errors differ from weighted least squares estimates using population and initial GDP as weighting factors.

The initial specification of the equation includes the initial level of product per capita, the labor growth rate, a human capital proxy, the rate of GDP growth, the age dependency ratio and the fiscal balance on the savings side and proxies related to market distortions. The implications of the coefficient estimates for each of these variables are discussed below.

a. Initial level of GDP per capita

The initial level of GDP per capita (GDP70) proxies the incentives for convergence inflows coming from imbalances in the relative capital endowments across countries, other things equal, higher output per capita is associated to lower marginal profitability for capital which decreases incentives for capital inflows. The initial level of income is an imperfect proxy of the ideal variable: the rate of return of capital, however, there are no obvious alternatives. Using financial interest rates, for example, is a very poor proxy of the physical rate of return, because financial repression and inflation severely distorts financial returns, specially in developing countries. The initial capital stock is not directly available either, and a previous effort to compute this variable from investment data using perpetual inventory methods was unsuccessful, since for several countries in the sample the series on investment was not long enough to eliminate the bias associated to imputing the initial value of the capital stock.

The estimated coefficient on GDP70 is positive and highly significant. Because GDP70 is measured in thousands of 1980 US dollars at international prices (Summers and Heston v5.5), the result in regression 1 of Table 2.2 means that an increase in per capital real GDP by $1,000 lowers capital inflows in 0.91% of GDP, doubling the slope obtained when regressing the current account against the initial product alone. The sample range of variation in GDP70 from $431 to $13,290 "explains" a spread of about 12 percentage points (the sample range of the average current account balance is -13.8% to 2.4%, with a mean of -3.41%). Including the square of GDP70 in the regression to capture a non linearity in the relationship (not shown in Table I), delivered a negative coefficient on square output indicating that the force towards capital inflows (the negative relationship between the current account deficit and the initial level) attenuates as per capita GDP rises, however, the coefficient however was only marginally significant (t=1.39), and did not have any significant impact on the rest of the coefficient

estimates. The estimate of the coefficient in GDP70 from the sample excluding industrial countries (regression 7 in Table 2.2) is practically identical to the coefficient in regression 1.

b. Human capital

Regressions of Table 2.2 indicate that capital inflows are positively related to the proxies of human capital (HUMANK), which corresponds to the educational attainment indexes computed by Barro and Lee (1993) based on census data and interpolated through school enrollment data.[11] HUMANK is measured in years, so the result in regression 1 means that an extra year of school in the adult population increases capital inflows in 0.6 percentage points of GDP. The sample range of the school variable "explains" a range of variation in the current account of about 7 percentage points. Given the strong positive correlation between HUMANK and GDP70 (0.73), increases in HUMANK accompanied by an increase in GDP70 are not systematically related to subsequent capital inflows. But increases in this variable, with the initial level of output held fixed are highly correlated to subsequent capital inflows, and viceversa.

Including proxies for human capital in the model helps to control for output differences not related to differences in the relative endowment of capital, and for the profitability of marginal investment which affects the incentives for capital inflows. The significant role of human capital proxies in these regressions is consistent with the positive impact of human capital proxies in growth equations and the large increase in the speed of convergence once the stock of human capital is controlled for. Similarly, in these regressions the coefficient on initial output, which is a measure of the volume of convergence flows, increases after the inclusion of a proxy for human capital.

One problematic aspect of the educational indices is how to add up across the different levels of education to arrive to an overall index of human capital. HUMANK gives equal weights to all school level. In a market economy, the ideal weights could be derived from relative wage structure across educational segments, but we do not have the information necessary to build these weights. Including in the regression indices distinguishing between primary (PSCHOOL), secondary (SSCHOOL) and high school (HSCHOOL) instead of total schooling years in regression 4 of Table 2.2 indicates that the impact of an extra year of high school on capital inflows is almost five times stronger than the impact of primary or secondary school, although there is considerable imprecision on the point estimate. Since the rest of the estimated coefficients stays unchanged, and the overall fit of the regression does not change either, the distinction is dropped subsequently. Another proxy for human capital quality, life expectation at birth, was included in the model but its effect was very small and not significantly different from zero (not shown in Table 2.2).

[11] See Barro and Lee (1993) for further details.

c. Labor force and human capital growth

In the model of section 2.2 labor growth has an ambiguous effect on capital flows. Faster labor force pulls up the rate of investment to keep a constant capital-labor ratio, but similarly increases the rate of savings to keep a constant level of wealth per worker. Further, life cycle models indicate that faster labor growth increases the steady state level of assets per worker as young savers outnumber old retirees. Regressions of Table 2.2 indicate that average capital inflows (current account deficit) are positively related to the rate of growth in the labor force, an additional percentage point of growth in the labor force increases capital inflows in 0.2% of GDP, but the coefficient however is not significant and explains a very small amount of the current account as revealed by the standardized coefficients in regression 2, which reestimate regression 1.

The same considerations apply to expansions in human capital (HGROWTH). Results in regression 5 of Table 2.2 show that this variable has a positive and significant effect on the current account balance, decreasing capital inflows, which is consistent with a positive aggregation effect on savings.

d. Age structure

As suggested by life cycle models, the coefficient of the age dependency ratio - population younger than 15 years old and older than 65 years old as a percentage of working-age population- in the regressions of Table 2.2 is negative, and explains a relevant fraction of capital inflows as revealed by the standardized coefficients in regression 3. However, there is substantial imprecision on the point estimate as revealed by its low t-statistic (t=-0.82). Including separately the percentage of population older than 65 years to capture a bequest motive on savings delivered a positive coefficient on this variable (not shown in Table 2.2), according to expectations, but it was very small and non significant.

This findings confirm the results obtained by a number of authors on the role of demographics in the determination of savings (Leff (1969), Ando and Modigliani (1957), Fry and Mason (1982)) and more recent work by Taylor and Williamson (1994) in the context of capital flows in the late 19th century. However, in contrast with the findings of the last two authors who claim that between one third and all of the observed capital flows coming from England to the New World may have been attributable to the high dependency in the periphery, the evidence for the contemporaneous data shows a much smaller role for demographics on the determination of capital flows.

d. Output Growth

The regressions reported in Table 2.2 show that the rate of growth of per capita GDP (YGROWTH) has a positive and significant effect on the current account surplus, i.e. reduces net capital inflows. This results is consistent with the positive correlation between savings and growth documented in the

empirical literature on savings, most recently by Edwards (1995), Carroll and Weil (1993) and Bosworth (1993), and confirm one of the key implications of the life cycle model. The estimates indicate that an additional percentage point of average growth increases the annual current account balance in 0.6% of GDP per year.

In recent years, the new growth literature has reversed the interpretation of causality between savings and growth, claiming that indeed reflects the correlation between investment and growth in a world of approximately constant returns to scale. The additional assumption implicit in this interpretation is that most economies work in isolation from the rest of the world, because opening the economy breaks the identity between investment and savings. Recent evidence based on causality tests reported by Carroll and Weil also supports the traditional life cycle interpretation of the positive correlation between savings and investment, and the coefficient estimates of Table 2.2 are only slightly higher to the instrumental variables coefficients estimated by Edwards (1995) in a series of saving equations.

e. Social security and the fiscal balance

Variable SSEC measures the generosity of Social Security benefits and is computed as the ratio of social security benefits per person older than 65 years old with respect to the consumption per person below this age. This variable was built from 1980 government expenditures on social security and welfare as a percentage of GDP (SSY) obtained from the IMF *Government Statistics*, the age structure of population and the ratio of private consumption to GDP (CY) using:

$$SSEC = \frac{SSY}{CY - SSY} \frac{1 - pop_{>65}}{pop_{>65}} \tag{21}$$

The proxy for social security benefits (SSEC) is positively and significantly related to capital inflows as shown by estimates in Table 2.2. The interpretation is that high perceived benefits tend to depress the rate of savings because they decrease the incentives of active workers to accumulate assets to cover for their retirement period. The point estimate indicates that doubling the generosity of social security benefits, around the mean value, increases capital inflows about one percentage point of GDP per year. The mean value for this variable in the sample is 1.35, and the range of variation in the sample goes from almost 0 to 4.7, indicating that this variable could explain almost three percentage points of the average current account variability in sample.

Data on the consolidated public sector surplus was obtained from Easterly, Rodríguez and Schmidt-Hebbel (1994), and completed with data from the IMF government statistics to compute the average public sector surplus from 1970 to 1989 as a percentage of GDP. The regressions in Table 2.2 show that the public sector surplus (SGOV) has a positive and marginally significant impact on the

current account balance. The coefficient estimates indicate that an additional point in the fiscal surplus as a percentage of GDP increases the current account balance between 0.13 and 0.28 percentage points, depending on the sample and regression specification. It is interesting to note that the inclusion of additional variables in the current account model, specially the inclusion of GDP70, significantly reduces the impact and significance of the fiscal budget on the current account. The simple correlation between both variables in the sample is 0.55, but drops to 0.27 after the inclusion of the starting level of GDP.

There is a theoretical debate about the role of public savings as an additional determinant of savings, and therefore capital flows. Under the extreme assumptions of Ricardian equivalence the distinction between private and public savings should not be important. The assumptions that validate this hypothesis are extreme and the empirical evidence indicates that most likely government savings has an impact on total savings and therefore on capital inflows, although not one for one. Surprisingly, these estimates indicate that the impact of the fiscal budget on the current account is relatively small, in fact in most regressions of Table 2.2 the Ricardian equivalence hypothesis of zero impact of the fiscal deficit on the current account cannot be rejected at the 1% significance level. This finding seems to contradict evidence reported by Corbo and Schmidt-Hebbel (1991) on the strong impact of public savings in aggregate savings, but it can be reconciled under an alternative interpretation in a world with limited capital mobility, where additional flows of savings tend to stay at home increasing domestic investment, instead of flowing abroad (the Feldstein-Horioka finding). We come back to this subject on the next section.

f. Market Distortions

The next two variables in Table 2.2 the black market premium (BMP) obtained from Barro-Lee (1993) and a weighted measure of import tariffs (TARIFF), obtained from Lee (1993) proxy for market distortions. Estimates across Table 2.2 indicate a positive and significant effect of both variables on the current account balance, implying that they tend to reduce average capital inflows. The coefficient on the black market premium on regression 1 indicates that a one standard error (68 percentage points) in this variable is associated with a reduction in capital inflows of about half a percentage point of GDP. Overall the sample, the range for BMP spread about 3.8 percentage points of variability in the current account. Similarly, the TARIFF coefficient indicates that a one standard error (18 percentage points) increase in this variable reduces capital inflows in about half a percentage point and the range for this variable spreads about 3.9 percentage points.

This evidence is consistent with findings reported in the empirical growth literature on the negative impact of the same or similar measures of distortions on the average growth per capita. Presumably market distortions reduce the productivity of capital and increase the cost of capital, which for a given level of initial product tends to reduce incentives for investment and therefore for capital

inflows. The inclusion of government consumption, another variable commonly used in the growth literature as a proxy for government distortions (Barro, 1991), delivered a practically zero coefficient.

An alternative interpretation of the positive association between capital inflows and these two variables comes from potential sources of measurement error in the current account. High import tariffs may be associated to extended smuggling practices and systematic underreporting of imports, which automatically tends to increase the reported trade balance and the current account balances. The existence of a black market premium on the other hand may be systematically associated to underreporting of export revenues, which tends to operate in the opposite direction of our findings. The significance of the black market premium may be related to the use of the official exchange rate to compute the current account balance (reported in US$) with respect to GDP, instead of a shadow market value, some weighted average between the official rate and the black market rate depending on the relative coverage of the official market. For example, if net borrowers systematically impose restrictions to exchange markets, the correlation may reflect the fact that the use of the official rate tends to blow up the current account measure.

g. Cross-country variation in the price of capital

There is substantial evidence of wide differences in the price of capital across countries and the robust and systematic association between investment performance and cross country differences in the price of capital (Barro (1991), De Long and Summers(1991 and 1993), and Jones (1994)). De Long and Summers (1991, 1993) and Jones (1994) show that high relative prices for investment goods - relative to the domestic price of domestic consumption goods- reduces the investment ratio affecting negatively growth performance. Recently, Higgins(1994) has argued that most of the income differences between developing countries and developed economies can be traced back to important differences in the relative price of capital which is systematically higher in poorer economies, that is they are equilibrium differences which do not induce capital flows.

For our purpose it is necessary to distinguish between cross country variations in the price of investment goods as compared to the international price of investment goods (pi/pi*), and differences in the relative price of investment goods with respect to consumption (pi/pc). Increases in the domestic price of investment with respect to its international price directly reduces the profitability of investment, decreasing the intensity of convergence flows for a given initial position and the stock of capital at the steady state, which in turn reduces the steady state current account deficit, or alternatively increases the steady state current account surplus. However, increases in the relative price of investment goods with respect to consumption may increase capital inflows as the value of wealth accumulated in that stock of capital with respect to consumption increases, implying that residents need to accumulate less foreign

assets to reach a given wealth target, or alternatively they need more external funds to finance a given stock of domestic capital, if their domestic wealth is not enough.

Regression 6 includes the relative price of capital with respect to international prices obtained from the Summers-Heston PPP ratio for investment goods and the relative price of investment goods with respect to consumption goods in domestic markets. Including directly the relative prices does not affect at all the magnitude of the coefficient on the tariff measure or the black market premium, in fact we cannot reject the hypothesis that both coefficients in relative prices are equal to zero. Further, the pi/pi* variable has the wrong sign, indicating that a higher domestic price for investment goods attracts capital inflows. Perhaps the problem derives from the simultaneous determination of the current account balance and the real exchange rate, large capital inflows tend to appreciate domestic goods with respect to foreign goods (the real exchange rate) which produces a positive association between capital inflows and relative prices. The relative price of capital was entered as a deviation of the actual relative price of capital with respect to the price predicted by a linear regression on the real exchange rate, to capture deviations beyond this common factor, but the results stood unchanged.

h. Political instability

The results in Table 2.2 show the systematic negative association between political instability and capital inflows. The variable revolutions and coups obtained from Barro-Lee (1993) shows the average frequency of violent government transfers through the period and indicates that a one standard error increase in this variable decreases annual capital inflows in about one percentage point of GDP. Overall, the impact of this variable on the current account is quite important as revealed by the standardized coefficients in regressions 5 and 10. Additional variables related to internal political instability like the average number of political assassinations, and a war dummy if the country was involved in a conflict between 1960 and 1990 (external instability), showed no significant impact on the current account once the violent government transfer variable was included in the regression and were subsequently dropped.

i. Aid for development

Finally, the aid recipient dummy has a negative effect on the current account balance, but it is only marginally significant. This dummy indicates if the country receives a significant amount of foreign aid in terms of direct transfers or concessional loans, defined as aid flows beyond 2.5% of GDP, was built from United Nations and World Bank data. International transfers do not affect our measure of capital inflows as they are included in the current account measure, but this measure does not make a distinction between soft loans, at concessional interest rate and maturity terms, and market loans.

Standardized coefficients and robustness

The standardized coefficients for the overall sample appear in regression 2 of Table 2.2. They show that the single most important variable explaining capital inflows is the starting output level, other important variables are the human capital proxy, output growth, social security benefits and political stability.

We checked the robustness of these findings obtaining separate estimates for a sample consisting of developing countries only (regression 3 in Table 2.2), but no significant change in the estimated coefficients or in their significance is detected. A procedure to detect influential data points based on the normalized residuals (Greene, 1993), revealed two outliers, with residuals beyond two normal standard deviations, excluding these observations however did not alter in any significant form the estimation results described in Table 2.2 .

2.3.2 Other Variables

a. Trade integration

The theoretical model in section 2.2 assumed a one good model which is useful to obtain a simple derivation of the current account, but hides a very relevant aspect of its determination: the transfer problem. Because of transport costs and other trade barriers international trade involves only a narrow set of goods and services, and capital transfers must go through that narrow window, which limits the substitutability between domestic savings and external savings as sources of funds for investment. In the limit case when all goods are non tradable, the current account balance must converge to zero independently of the stock of physical or human capital or other variables which affect capital movements incentives. Since the degree of integration should not alter the sign of capital flows but only their magnitude, this variable should enter interactively affecting the responsiveness of capital flows to structural differences across countries.

Defining a summary measure of openness is difficult since there are multiple variables which have an impact on trade integration: tariffs, quotas, transport costs, idiosyncratic tastes, etc.. One variable commonly used in empirical growth studies is the volume of trade, exports plus imports as a percentage of GDP, but admittedly is an imperfect proxy as many factors unrelated to trade restrictions affect this variable too, i.e. the asymmetry of the resource base of a country with respect to the rest of the world (HOS trade) or its size (economies of scale trade).

Regression 9 of Table 2.3 present the results of a reestimation of the base model in section 2.3.1 after including a proxy for trade integration. The volume of trade variable enters interactively in this regression through a mean zero dummy variable which indicates the position of the country with respect to the median of the openness variable, and which affects all parameters in the same proportion. The

coefficient estimate indicates no significant difference between the slope parameters of both subsamples and the null of no difference in parameters cannot be rejected. Alternative formulations of the same regression using quartiles instead of the median arrived to similar results, it was detected a lower responsiveness in the lower quartile with respect to the openness variable, but further examination revealed that the coefficient shift captured the presence of the influential observations detected above, affecting some specific coefficients but not their global responsiveness.

b. Country Risk

Regression 10 of Table 2.3 shows the results of including a country risk measure in the regression. The probability of debt default or capital expropriation should increase the cost and reduce the volume of international funds available for a given country, reducing the actual amount borrowed by that country. Since 1979 the Institutional Investor publishes regularly a country risk index based on the results of a biannual survey carried on leading international banks about individual country risks prospects. The index covers only a subperiod of our sample, however country positions tend to be quite stable through time so an average of the 1979 to 1990 results may not be such a bad approximation of the country position over the whole period. Lee (1993) tested the power of credit ratings as predictors of debt rescheduling events finding favorable results.

The results of including the country risk index indicate a positive effect of credit risk on the capital inflows, against our interpretation, however the coefficient is not statistically significant from 0 at the 5% significance level. Perhaps the wrong sign on the country risk index is a consequence of reverse causality. It is likely that the current account is an important determinant of a country's position, even after controlling by many other variables. The risk evaluation of countries which do not borrow on net terms is better than similar countries running a current account deficit. An attempt to control for this source of bias instrumenting the risk index in a set of structural variables which according to sovereign borrowing models (Eaton and Gersovitz, 1981) should affect the country risk evaluation was not successful, because of the lack of identification power in the instrumental variables.[12]

[12]We included a set of variables measuring external and internal political instability which could produce exogenous events affecting the country ability or willingness to pay: the frequency of violent government transfers (coups and revolutions), the number of political assassinations and a dummy if the country was involved in a war between 1960 and 1990; a set of variables related to the benefits of international trade which affect the size of potential threats available to the international financial community: the volume of trade, terms of trade variability and the rate of growth in GDP; and the initial debt to output ratio as well as GDP per capita. The results of the first stage regression were satisfactory, the overall fit was about 0.85 and most variables came with the expected sign. The regression indicates that the most important determinants of country ratings are the level and rate of growth of GDP, and the political stability variables, but the results continue to indicate a positive effect of credit risk on the capital inflows, but not statistically significant from 0 at the 5% significance level.

c. Net external asset position and external debt

The initial level of the net external asset position is one of the state variables which determines the subsequent dynamics of the current account balance. Due to data limitations, external debt as a percentage of GDP (DEXT) is used as a proxy for the net external position, which introduces some problem as it does not account for the value of the stock of portfolio and direct investment by foreigners in the country and for the value of external assets in the hands of residents. Data on external debt for 1970, or the first available year up to 1974, was obtained from the World Bank Tables for a sample of developing countries only.

The coefficient of DEXT in regression 8 of Table 2.2 is negative, but not different from 0 at conventional significance levels (p-value=0.28). The estimate indicate that an additional 15 points of initial debt as a percentage of GDP, about one standard deviation in this variable, increases capital inflows in 0.3% of GDP per year. The model in section 2.2 predicted the opposite sign for the coefficient on the net external asset position coefficient, this model exhibits a stationary property which predicts that high initial liabilities tend to induce subsequent capital outflows until the economy converges back to its steady state position, however most likely this convergence process is very slow. However, it is important to point that this prediction is conditional on the steady state debt level, if the empirical model does not properly capture all the relevant variables for the determination of the steady state external liabilities, a negative sign may arise due to the positive correlation between the initial debt level and the steady state debt level.

d. Public investment and infrastructure

The production function can be further extended to incorporate public goods capital, as a complementary factor to private capital. Easterly and Rebelo (1993) report the robust correlation between growth and investment in transport and communications infrastructure, tasks generally allocated to the government in the great majority of countries. The role of public infrastructure on capital flows is similar to that of human capital: an increase on the endowment of public capital should help to control for income differences and increase the profitability of private investment inducing additional net capital inflows, *caeteris paribus* everything else. The rate of government investment (IGOV) is used as a proxy of public infrastructure.

The estimate of the coefficient on public investment is negative, as expected, and indicates that an increase in public investment equivalent to 3.7%, about one standard deviation, induce additional capital inflows for 0.15% of GDP per year. However, its coefficient is not significantly different form zero at the 10% level, and sample variation of the rate of public investment "explains" a small amount of the current account variability, approximately 0.85%.

e. Regional dummies

Table I showed the significant differences in the average current account deficits of industrial and developing countries and within developing countries between regions of the world. Regression xx of Table 2.3 shows that differences across regions averages tend to disappear after controlling for the variables described in subsection 2.3.1. Countries included in each dummy variable are described in appendix 2. The estimated coefficient on the LATAM variable - which equals one for countries in South and Central America, including Mexico- is negative but it has low statistical significance (t=-1.45), other regional dummies are not significant at all. Since the estimated coefficients for the rest of the parameters in the regression, their significance and the global fit of the equation are very similar to estimates without the regional dummies, the low significance of these dummies is not a consequence of collinearity between the explanatory variables.

2.4 Measuring Capital Mobility

The degree of international capital mobility is a key element to understand the workings of growth in the open economy. Feldstein and Horioka (1980) and many others subsequently, have examined investment-savings regressions to estimate the crowding-out coefficient: the fraction of a decrease in domestic savings which reduces domestic investment instead of inducing additional capital outflows. Sachs (1981, 1983) estimates an alternative but related measure: the fraction of marginal changes in investment financed through external savings. In this section we estimate a related measure of capital mobility: the fraction of the "structural" difference between domestic investment and savings which becomes a current account imbalance - one under perfect capital mobility and zero under no capital mobility, but we take into account several of the criticisms on the FH measure of capital mobility which are related to the measure estimated in this section too.

2.4.1 Identification and estimation

This subsection describes a simple framework which makes explicit the relationship between the alternative measures of capital mobility and the implicit assumptions behind their interpretation. The formulation is admittedly ad-hoc as savings and investment equations are not derived from explicit dynamic maximization equations, however because the empirical work is based on long run averages dynamics are not very interesting either. Feldstein (1984) presents a similar model to make explicit the identification assumptions behind the FH results.

The structural model consists of 3 behavioral equations, one for the investment rate, one for the savings rate and the last one for the international supply of funds, all as a percentage of GDP, and an

equilibrium condition that equates the demand and supply for international funds through the shadow cost of capital r_j:

$$s_j = \alpha_0 + \alpha_1 y_j + \alpha_2 v_j + \delta^s r_j + \varepsilon^s_j$$

$$i_j = \gamma_0 + \gamma_1 y_j + \gamma_2 w_j - \delta^i r_j + \varepsilon^i_j$$

$$f_j = \varphi_0 + \delta^f (r_j - r^*) + \varepsilon^f_j$$

$$i_j = s_j + f_j$$

(22a,b,c,d)

where y_j represent variables which affect both savings and investment, w_j represents a vector of variables which affect only savings, and v_j represents a vector which affects only investment, nor y_j, v_j or w_j affects directly external savings except through their effect on the shadow cost of funds, and ε_{js}, ε_{ji} and ε_{jf} represent random shocks which could be correlated among them, but are assumed to be orthogonal to variables y_j, v_j and w_j. This formulation has implicit some cross-equation restrictions which provide the necessary identification assumptions to test the perfect capital mobility hypothesis. Perfect capital mobility is equivalent in this framework to an elasticity of external savings with respect to the domestic rate of return, δ_f, equal to infinity, and no capital mobility to an elasticity equal to zero. An intuitive measure of capital mobility is θ_f, the fraction of the "structural" current account deficit which is closed through international capital inflows as opposed to adjustment in domestic investment or saving.

A finite interest rate elasticity of external investment is only a short cut for a number of factors which limit the substitutability between domestic savings and external savings. This elasticity could be less than infinity, for example, because liabilities of country j are not perfect substitutes of foreign liabilities in the portfolio of foreigners and residents.[13,14] For example, if the demand for assets is derived from a expected return-risk framework, risk aversion and real exchange rate variability limits the substitutability between domestic assets and external assets. Alternatively, information asymmetries between residents and foreigners about domestic asset's quality, the absence of an effective international court to solve contract disputes (sovereign country risk), or simply regulatory restrictions on the capital account of the balance of payments could play the same role. Even if home and foreign assets are perfect substitutes, transport costs, market idyosincracies and other trade barriers may imply imperfect substitution between home and foreign goods, which limits the substitutability between domestic and

[13]If this is the case the relevant variable in equation (22c) should be the net external *stock* position not external *flows*, but since we are working with long run averages the distinction is less important.

[14]Risk considerations associated to exchange rate variability, sovereign country risk or information asymmetries between foreigners and residents may cause this limited substitution.

external savings. Finally, assets and goods may be perfect substitutes, but country j may be too big in world capital markets.

We treat the shadow rate of return as a non observable variable. Financial rates of return which are commonly available represent only a segment of the capital market, which only under an assumption of perfect substitution can be equated to the rate of return on domestic capital (Frankel et al., 1986).[15] Further, in many developing countries included in the sample it is common to find persistently negative real rates of return, a symptom of financial repression which severely distort any informative value of financial rates as proxies for the return on domestic capital. The structural form cannot be estimated, but some identifying assumptions implicit in the formulation of the model described above allow to estimate subsets of the structural parameters or combinations of them, and the parameter of capital mobility can be derived from here.

The reduced form of the system makes explicit the structural parameters which can be estimated. The equations for investment and saving are:

$$\begin{bmatrix} s_j \\ i_j \end{bmatrix} = \underbrace{\begin{bmatrix} (1-\theta^s)\alpha_1 + \theta^s\gamma_1 & (1-\theta^s)\alpha_2 & \theta^s\gamma_2 \\ (1-\theta^i)\gamma_1 + \theta^i\alpha_1 & \theta^i\alpha_2 & (1-\theta^i)\gamma_2 \end{bmatrix}}_{\Pi} \begin{bmatrix} y_j \\ v_j \\ w_j \end{bmatrix} + \begin{bmatrix} \eta_j^s \\ \eta_j^i \end{bmatrix} \tag{23}$$

where constants have been omitted and θ coefficients are:

$$\theta^i = \frac{\delta^i}{\delta^i + \delta^f + \delta^s}, \quad \theta^f = \frac{\delta^f}{\delta^i + \delta^f + \delta^s} \text{ and } \theta^s = \frac{\delta^s}{\delta^i + \delta^f + \delta^s}$$

Perfect capital mobility is equivalent to the joint restrictions: Ho: $\pi_{13}=\pi_{22}=0$, which can be easily computed from the system estimates. This test on capital mobility checks if exogenous shifts on the investment schedule (shifts on vector w_j), uncorrelated to changes in savings under the null of perfect capital mobility, have a statistically significant influence on savings, or if exogenous shifts in the savings schedule affect investment.

An estimate of parameter θ_f, the fraction of the "structural" current account deficit which is closed through international capital inflows, provides an intuitive measure of capital mobility. Estimates of θ_i and θ_s, and implicitly of θ_f, can be obtained from the following instrumental variables regressions:

[15]The concept of capital mobility implicit in savings-investment regressions, the crowding out coefficient, should not be confused with financial integration, the absence of arbitrage opportunities on *tradable* assets. Financial integration is a necessary condition for perfect capital mobility, but is not sufficient.

$$s_j = \lambda_{11} y_j + \lambda_{12} v_j + \lambda_{13} i_j + u_j^s$$

(24)

$$i_j = \lambda_{21} y_j + \lambda_{22} w_j + \lambda_{23} s_j + u_j^i$$

(25)

Since i_j and u_{sj} are correlated, and so are s_j and u_{ij}, an instrumental variables procedure must be used to obtain consistent estimates of λ. The restrictions implicit in the structural formulation provide the necessary instruments to perform the estimation. Variables included in the empirical model of the current account of section 2.3 are used as instruments, after classifying them in three groups which correspond to vectors v_j, w_j and y_j based on theoretical considerations. A 2SLS procedure provides consistent estimates of θ, but efficiency can be improved using 3SLS to take into account the likely correlation between the residuals u_{js} and u_{ji}. The coefficient estimate of λ_{13} is an estimate of $\theta_s/(1-\theta_i)$, and the coefficient estimate of λ_{23} is an estimate of $\theta_i/(1-\theta_s)$. Solving these two non linear equations gives estimates of θ_s and θ_i, and therefore of θ_f, the delta method provides standard errors for these estimates.

2.4.2 Alternative measures of capital mobility

The Feldstein-Horioka (1980) measure of capital mobility is the β_1 coefficient estimate on a cross-country regression of the investment rate on the savings rate:

$$i_j = \beta_0 + \beta_1 s_j + \xi_j$$

(26)

Under some conditions β_1 provides an estimate of parameter θ_{13} in the regression above, which can be used to bound the capital mobility parameter $0 \leq \theta_f \leq 1-\lambda_{13}$. There is wide and robust evidence of the high correlation between savings and investment, and regression estimates indicate coefficients very close to one, which tightly bounds θ_f.[16]

The interpretation of this finding however is the subject of an active and ongoing debate. On one hand, there has been some conceptual confusion between the definition of international capital mobility implicit in saving-investment correlations, the crowding-out coefficient, and international financial integration, the absence of arbitrage opportunities in a much narrower range of internationally *tradable*

[16]Sachs(1981, 1983) estimated an alternative measure of capital mobility based on a regression of the current account on investment. His estimates indicated a large and negative coefficient consistent with substantial capital mobility, which originally was puzzling as simple manipulations of national accounts identities indicated the equivalency between his estimate and the FH parameter. However, further examination by Dooley and Penatti (1984) showed that estimates were highly sensible to the selection of the sample and period of estimation.

assets (Frankel et al. (1986)). Financial integration is a necessary condition for perfect capital mobility, but not a sufficient condition, so finding evidence against perfect capital mobility does not reject financial integration as many interpreted initially.

Another common criticism to this evidence is that a wide variety of models can produce positive comovements in savings and investment in response to exogenous disturbances even in the presence of full capital mobility. For example, temporary productivity shocks or the business cycle which affect the profitability of marginal capital and the level of transitory income can induce time series correlation between savings and investment even in the presence of full capital mobility (Tesar, 1991; Obstfeld, 1993). The original FH regressions was estimated using long run averages in order to avoid the simultaneity bias due to time series problems, but as argued by Obstfeld (1986) even long run cross-section correlation are subject to this bias as variables like population growth can still produce positive correlation between savings and investment which is irrelevant to evaluate the extent of capital mobility.

In terms of the simple model described above the discussion is on the independence assumption on saving and investment disturbances. A common set of variables y_j which affect simultaneously savings and investment, correlation between vectors v_j and w_j and or correlation within the vector of structural residuals ε_j can generate positive correlation between saving and investment under full capital mobility.[17] Direct estimation of the FH regression produces biased estimates, if no attention is placed on the likely correlation between the savings rate and the residual. The reverse regression and the correlation between saving and investment are subject to the same criticism.

More recently, Taylor (1994) estimates the correlation between investment and savings equations residuals. His procedure is equivalent to estimate the correlation left after filtering out all the correlation coming from correlation on fundamentals, and it is valid under the additional assumption of no correlation on the structural disturbances. The set of fundamental includes the relative price structure, demographic variables and the growth rate, and the estimates show that once these variables are controlled for, the correlation of saving and investment largely disappears specially on recent years.

2.4.3 Structural restrictions and instrumental variables

Since the choice of instruments plays a key role in the estimation procedure the implicit assumptions which motivates it are discussed at some detail. The empirical model of section 2.3 provides a set of variables which affect the current account in the long run, according to the framework described above these variables are assigned to vectors y_j, v_j and w_j.

[17] In the original contribution by Feldstein and Horioka (1980) the savings rate is instrumented on demographic and social security variables, so conditional on these exogeneity assumptions, their estimates are robust to this problem.

Vector y_j includes all those variables which affects both investment and savings. The initial level of GDP belongs to this vector. On the investment side, decreasing returns to scale imply that deviations of GDP with respect to its steady state level are negatively related to the marginal profitability of capital and through that channel to the rate of capital formation. However at steady state, they could be positively correlated to the rate of capital formation as countries with higher GDP probably have a higher capital stock, relative to output, to maintain. On the saving side, positive deviations of GDP with respect to its steady state should be positively correlated to savings if consumers follow the PIH[18], but since the growth rate is directly included in the saving equation we expect the last variable to absorb most of the explanatory power of GDP deviations on savings, more on growth below. At steady state, savings will be unaffected by GDP if we assume the homotheticity of preferences between present consumption and future consumption. On an introspection basis, it seems more reasonable a positive bias towards future consumption as income rises, so initial GDP must be included in the savings equation too.

Labor growth is another candidate for vector y_j. It affects investment directly through the replacement effect, and it is closely correlated to the age composition of population which affects the rate of savings. However, since the correlation is not perfect we include the rate of growth in the labor force and the age composition of population (the percentage of population younger than 15 years old and the percentage older than 65 years old) as separate regressors, the first variable in y_j, and the other two in v_j, variables which affect directly only the saving equation.

Other variables included in vector v_j are the social security variable, the fiscal surplus as a percentage of GDP and the average rate of growth on GDP per capita. The first one is not controversial, but the last two deserve more discussion. In relation to the fiscal surplus variable, Summers (1985) has argued that fiscal policy is deliberately manipulated to target the external balance, which invalidates the use of the fiscal surplus as an exogenous shifter of savings. However, it is reasonable to expect that this instrumental use of policy explains fluctuations of the fiscal balance through the business cycle but not long run averages as those considered in the empirical work in this section. In relation to growth, the controversial assumption is not whether to include it on the savings equation, but if it should be excluded from the investment equation. They are correlated since investment is one of the main determinants of growth, exogenous factors not included in vectors y_j *or* w_j could shift investment and through that channel growth and savings, inducing spurious correlation between saving and investment, so this variable was included in vector y_j to check the robustness of the results to this identification assumption.

Shifters of the investment schedule include labor growth, already discussed, the initial stock of human capital, the relative price of capital, a proxy for political instability (the frequency of violent

[18]The permanent income effect is assumed to dominate over the life cycle aggregation effect as this deviation is by definition transitory.

government transfers) and two proxies for market distortions: average tariff and the black market premium. Their inclusion in the investment equation is not controversial, they control for the steady state of capital, which determine the rate of replacement investment. It could be controversial however their exclusion of the savings equation. In the case of the relative price of capital or market distortions this seems a reasonable property, the assumption means that they lead to a reallocation of a given supply of savings from domestic capital to foreign assets, but not an alteration of the level of domestic savings (as a percentage of GDP). Political instability can affect savings through a precautionary savings effect and human capital through an income effect.

We check the robustness of these identification assumptions adding these two variables and GDP growth to the list of common determinants of saving and investment.

2.4.4. Results

Table 2.4 shows the simple correlation between variables included in the model. The cross-section correlation between saving and investment rates in the sample is 0.88, very close to one as expected from reported evidence. More important the correlations in this table show that the fundamentals of savings and investment are indeed highly correlated, which can induce spurious correlation between these two variables even under perfect capital mobility. The initial level of GDP (GDP70), for example, exhibits a negative correlation with the rate of growth in the labor force (LGROWTH) (-0.51), since the first variable should have a negative effect on investment and the second variable a positive effect on savings, they induce positive correlation between investment and savings. But other correlations, the positive correlation (0.70) between GDP70 and the proxy of social security (SSEC), for example, or the negative correlation between GDP70 and the children dependency ratio (POP15), induce the reverse pattern of correlation between investment and savings, so it is hard to tell if they induce a substantial bias on the FH estimates as measures of capital mobility.

Table V summarizes the results of the estimation of (24) and (25) through 2SLS and 3SLS procedures for the whole sample and subsamples defined according to (i) the level of development (LDCs and industrial countries), (ii) the IMF classification by main source of funds (market borrowers, official borrowers and diversified borrowers), (iii) openness (the upper half of the openness sample distribution) and (iv) population (the upper half of the population sample distribution), criterions which we expect to be correlated to the degree of capital mobility. For example, we expect that financial integration is much lower within the group of developing countries or within the group of official borrowers and this implies lower capital mobility coefficients for these groups, or better trade integration as proxied by the degree of openness means higher substitution between domestic and external savings and therefore higher capital mobility. Finally population is a rough measure of country size. The body of the table includes the 2SLS

and 3SLS estimates of λ_{13} and λ_{23} and their standard errors, the χ_2 joint test of perfect capital mobility and the implied θ coefficients and their corresponding errors (only for the 3SLS procedure).

The results for the whole sample (regression 1 of Table V) show no difference between the 2SLS estimates and the 3SLS estimates. At face value both estimates of θ_f indicate that about 27% of the "structural" deficit (surplus) in the current account is closed through international capital inflows (outflows), and the rest is closed through adjustments in the domestic saving rate (21%) and the domestic investment rate (52%) which according to the stylized model comes through variations in the shadow rate of return on capital. The large values in the χ_2 tests shows that the null of perfect capital mobility is easily rejected in this sample, and so is in each subsample included in Table V. However, there is considerable imprecision on the estimate of θ_f, a 95%-confidence interval has a range between -0.08 and 0.62, tight enough to reject perfect capital mobility, but still leaving a substantial range for the location of this parameter.

It is interesting to note that no significant differences were detected between the estimation results for subsamples and the results for the whole sample. In particular, the results indicate no pattern of association between these sampling criterions and the degree of measured capital mobility. The hypothesis of full capital mobility is easily rejected across all subsamples, and differences between the point estimates of θ_f are within reasonable limits considering their sampling error. The estimate for the group of countries financed through private sources in regression (15) of Table V is surprisingly very low (-0.04), however considering the large standard error on this estimate (0.52) its difference with respect to the rest of the estimates is irrelevant.

The last column of Table V shows the results for a different set of assumptions about the valid instrumental variables for investment and savings. The restrictions imposed by this specification are much weaker: age composition, labor growth, GDP growth, political instability and human capital are not restricted to affect either savings or investment exclusively, in terms of the model they belong to vector yj. The remaining restrictions are that variables SSEC and SG do not shift the investment schedule; and that market distortions variables, BMP and TARIFF, and the relative price of capital PI do not shift the investment schedule. The results of 2SLS and 3SLS for the weaker set of restrictions, shown only for the whole sample, are almost identical to the results for the complete set of restrictions in regression (13). In particular, the rejection of the hypothesis of perfect capital mobility is very strong and point estimates of θ_f are almost identical in both specifications, 0.32 vs. 0.27, but standard errors are much larger in the last column of Table V as a consequence of the loss of the information from the restrictions left out.

In conclusion, the results confirm most findings from saving-investment regressions about the low degree of international capital mobility. The evidence is consistent with a world where capital flows

slowly. However, it must be remembered that since the model excludes the possibility of factor price equalization and capital movements taking place through HOS trade, estimates represent a lower bound of the degree of capital mobility. Indeed, it is interesting to notice that the results in Table V indicate that the degree of capital mobility decreases as the degree of openess of the economy increases. This result would be expected in a world where international trade in capital mobility is a substitute of international trade in goods.

2.5 Conclusions

We started the paper asking if the failure of international capital to flow to poor countries is a consequence of differences in technology, market distortions and other factors which affect the profitability of investment, or is it related to limited integration of world trade and capital markets, as proposed by Feldstein-Horioka?. The theoretical model of section 2.2 makes the distinction between steady state capital flows and convergence capital flows. The neoclassical prediction that capital flows from rich to poor countries is a property of convergence flows, and proper testing of this prediction requires to control for heterogeneity in the steady state position across countries. If this heterogeneity is not considered it will probably lead to underestimating the importance of convergence flows in the determination of the current account. The empirical model of capital flows is an attempt to evaluate the neoclassical model controlling for these structural differences across countries. We find that once structural factors related to the steady state level of output (the initial endowment of human capital, market distortions, etc.) are controlled for, the role of convergence factors on the current account increases. This control variables exercise a strong and significant effect on capital flows and the direction of their effects is according to theoretical presumptions. The estimates in section 2.4 indicate that even when capital flows according to variables related to the neoclassical-life cycle mode, there is a relatively low degree of international capital mobility. The volume of flows is small, perhaps because of the low degree of integration of markets across national frontiers. Attempts to relate the degree of capital mobility to structural characteristics of the countries, like the degree of openness, country size or the degree of development, deserve further work.

Table 2.1

Average Capital Inflows 1970-89

	Current Account Deficit (%GDP)	Foreign Direct Investment (%GDP)
GDP70 Quartiles		
Q1	3.6%	1.1%
Q2	6.5%	1.0%
Q3	3.0%	1.3%
Q4	1.2%	0.2%
Region		
East Asia	2.1%	2.5%
Latin America	5.2%	1.2%
Africa Sub-Sahara	5.9%	1.4%
Industrial	1.4%	0.0%

TABLE 2.2

Dependent Variable: Current Account Surplus (%GDP)
average ratio from 1971 to 1990

Regression	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	All	All a/	All b/	All	All	All	LDC	LDC
GDP70	0.907	1.030	0.869	0.929	0.809	0.918	0.916	0.968
	5.627	5.627	6.341	5.367	5.452	5.676	3.651	3.252
HUMANK	-0.632	-0.553	-0.629	-	-0.601	-0.697	-0.458	-0.366
	-4.066	-4.066	-4.384	-	-3.673	-4.272	-2.431	-2.051
LGROWTH	-0.223	-0.071	-0.130	-0.152	-0.828	-0.243	-0.045	-0.134
	-0.514	-0.514	-0.371	-0.350	-1.681	-0.564	-0.071	-0.204
AGEDEP	-2.756	-0.205	-2.374	-2.616	-4.220	-2.874	-2.796	-2.826
	-0.823	-0.823	-0.836	-0.785	-1.294	-0.875	-0.648	-0.644
YGROWTH	0.616	0.384	0.495	0.596	0.545	0.592	0.639	0.670
	3.209	3.209	3.574	3.030	2.894	2.704	3.140	2.932
SSEC	-0.767	-0.321	-0.942	-0.762	-0.797	-0.792	-1.391	-1.436
	-2.050	-2.050	-0.334	-2.022	-2.226	-2.093	-3.080	-3.130
SGOV	0.165	0.199	0.110	0.165	0.164	0.169	0.236	0.206
	1.978	1.978	1.728	2.021	1.842	2.097	2.426	2.085
BMP	0.822	0.183	0.992	0.729	0.872	0.879	0.998	0.968
	2.348	2.348	3.815	2.040	2.440	2.454	4.191	3.477
TARIFF	2.943	0.174	1.904	2.915	2.892	2.876	2.626	2.379
	2.661	2.661	2.115	2.648	2.669	2.336	2.305	2.015
REVCOUP	4.087	0.336	3.586	4.287	3.843	4.070	3.919	3.739
	4.915	4.915	4.678	4.956	4.642	4.540	4.232	4.087
ODA	-1.181	-0.185	-2.110	-1.163	-1.390	-1.091	-1.255	-0.895
	-1.343	-1.343	-3.561	-1.307	-1.471	-1.270	-1.403	-0.978
PSCHOOL	-	-	-	-0.533	-	-	-	-
	-	-	-	-2.927	-	-	-	-
SSCHOOL	-	-	-	-0.392	-	-	-	-
	-	-	-	-1.094	-	-	-	-
HSCHOOL	-	-	-	-2.871	-	-	-	-
	-	-	-	-1.682	-	-	-	-
GHUMANK	-	-	-	-	-0.486	-	-	-
	-	-	-	-	-1.590	-	-	-
GHUMANK*GLPOP	-	-	-	-	0.283	-	-	-
	-	-	-	-	1.930	-	-	-
Q	-	-	-	-	-	-0.516	-	-
	-	-	-	-	-	-0.530	-	-
PPPI	-	-	-	-	-	-0.292	-	-
	-	-	-	-	-	-0.257	-	-
DEXT70	-	-	-	-	-	-	-	-1.937
	-	-	-	-	-	-	-	-1.034
R2	0.618	0.618	0.698	0.623	0.659	0.624	0.606	0.630
N	65	65	63	65	61	65	48	47

a/ Standarized Regression: all variables normalized to (0,1)
b/ Excluding influential observations: xx and xx. (see description on text)
OLS regressions, t-statistics below coefficients, all standard errors are derived using White-heteroskedasticity robust errors.

TABLE 2.3

Dependent Variable: Current Account Surplus (%GDP)
average ratio from 1971 to 1990

Regression	(9)	(10)	(11)	(12)
Sample	All a/	All a/	All b/	All b/
GDP70	0.906	0.737	0.836	0.898
	5.527	4.468	6.089	5.660
HUMANK	-0.630	-0.644	-0.587	-0.608
	-3.925	-4.336	-3.865	-3.431
LGROWTH	-0.220	-0.445	-0.091	-0.049
	-0.487	-1.067	-0.248	-0.101
AGEDEP	-2.745	-0.747	-2.061	-3.359
	-0.830	-0.231	-0.695	-0.968
YGROWTH	0.616	0.375	0.429	0.514
	3.213	2.308	2.886	2.379
SSEC	-0.766	-0.683	-0.756	-0.749
	-1.983	-1.929	-2.269	-1.849
SGOV	0.164	0.111	0.091	0.180
	1.795	1.319	1.405	2.043
BMP	0.816	0.262	0.898	0.658
	2.092	0.427	3.202	1.627
TARIFF	2.948	2.408	1.921	2.385
	2.742	2.691	2.139	2.151
REVCOUP	4.086	4.480	3.460	4.434
	4.796	5.156	4.479	4.169
ODA	-1.171	-1.110	-2.156	-1.422
	-1.448	-1.168	-3.579	-1.789
OPEN>Q50%	0.007	0.080	-	
	0.029	0.651	-	
COUNTRY RISK	-	1.667	-	
	-	1.660	-	
IGOV	-	-	-0.050	
	-	-	-0.690	
LATAM	-	-		-1.119
	-	-		-1.449
EAST ASIA	-	-		-0.746
	-	-		-0.688
AFRICA (sub-sahara)	-	-		-0.321
	-	-		-0.376
INDUSTRIAL	-	-		-0.877
	-	-		-0.602
R2	0.618	0.675	0.666	0.627
N	65	61	64	65

a/ NonLinear Regression (see description on text)
b/ OLS regression.
All standard errors for t statistics are derived using White-heteroskedasticity robust errors.

TABLE 2.4
Correlation Matrix

	SAVING	INVWB	GDP70	GLPOP	HUMANK	BMP	OWTI
SAVING	1.00						
INVWB	0.88	1.00					
GDP70	0.46	0.24	1.00				
LGROWTH	-0.14	0.03	-0.51	1.00			
HUMANK	0.54	0.41	0.83	-0.45	1.00		
BMP	-0.44	-0.43	-0.33	0.27	-0.32	1.00	
OWTI	-0.19	-0.21	-0.43	0.27	-0.33	0.17	1.00
REVCOUP	-0.26	-0.36	-0.33	0.15	-0.23	0.38	0.16
YGROWTH	0.66	0.64	0.14	-0.05	0.35	-0.46	-0.06
SSEC	0.43	0.35	0.70	-0.32	0.62	-0.24	-0.38
SGOV	0.39	0.22	0.40	-0.22	0.32	-0.30	-0.17
POP15	-0.53	-0.35	-0.84	0.76	-0.83	0.42	0.39
POP65	0.41	0.23	0.85	-0.77	0.78	-0.37	-0.43

	REVCOUP	GRGDP	SSEC	SUPF	POP15	POP65
SAVING						
INVWB						
GDP70						
LGROWTH						
HUMANK						
BMP						
OWTI						
REVCOUP	1.00					
YGROWTH	-0.20	1.00				
SSEC	-0.32	0.35	1.00			
SGOV	-0.24	0.25	0.29	1.00		
POP15	0.35	-0.33	-0.71	-0.39	1.00	
POP65	-0.33	0.23	0.66	0.34	-0.94	1 00

TABLE 2.5

Measures of Capital Mobility
2SLS and 3SLS Instrumental Variables

Regression	(13)	(14)	(15)	(16)	(17)	(18)
Sample	All	LDC	Market	Open>Q50%	Popul.<Q50%	All
2SLS						
λ13	0.44	0.39	1.19	0.80	0.37	0.51
	(0.19)	(0.21)	(0.15)	(0.12)	(0.19)	(0.29)
λ23	0.65	0.57	0.97	0.73	0.72	0.65
	(0.11)	(0.13)	(0.18)	(0.08)	(0.08)	(0.11)
implied parameters						
θ1	0.51	0.45	1.17	0.35	0.62	0.48
θ2	0.21	0.21	-0.20	0.52	0.14	0.27
1−θ1−θ2	0.27	0.33	0.03	0.13	0.24	0.26
3SLS						
λ13	0.44	0.40	1.12	0.78	0.36	0.21
	(0.17)	(0.18)	(0.10)	(0.12)	(0.19)	(0.61)
λ23	0.65	0.58	1.05	0.77	0.73	0.65
	(0.07)	(0.10)	(0.10)	(0.07)	(0.07)	(0.08)
$\chi 2(2)$: λ13=λ23=0	84.04	38.76	192.94	196.68	101.89	72.48
implied parameters						
θ1	0.51	0.44	0.70	0.43	0.63	0.59
	(0.13)	(0.13)	(0.20)	(0.09)	(0.16)	(0.63)
θ2	0.21	0.22	0.33	0.44	0.14	0.08
	(0.09)	(0.09)	(0.60)	(0.14)	(0.08)	(0.67)
1−θ1−θ2	0.27	0.34	-0.04	0.13	0.24	0.32
	(0.21)	(0.21)	(0.52)	(0.21)	(0.24)	(0.47)
N	65	48	30	33	33	65

Notes: All regressions, except (6) assume that vector yj includes GDP70, vector vj includes POP15, POP65, SSEC, SG, and GROWTH, and vector wj includes LGROWTH, HUMANK, IG, TARIFFS, BMP and PI. In Regression (6) variables GROWTH, LGROWTH, POP15, POP65 and HUMANK are added to vector yj and correspondingly dropped from vj and wj. Standard errors for parameters l13 and l23 are White-heteroskedasticity robust. Standard errors for 3SLS estimates of q parameters are derived from standard errors of l parameters using the delta method.

APPENDIX

Table A.1
Summary Statistics

Series	Observ.	Mean	Std Error	Minimum	Maximum
CASA	65	-3.41	3.08	-13.76	2.41
GDP70	65	3.73	3.50	0.43	13.30
YGROWTH	65	1.50	1.92	-2.81	6.22
HUMANK	65	5.02	2.69	0.68	11.56
GHUMANK	61	2.46	2.81	-0.15	20.15
PSCHOOL	65	3.58	1.77	0.56	8.01
SSCHOOL	65	1.23	1.00	0.09	4.49
HSCHOOL	65	0.21	0.20	0.01	0.96
LGROWTH	65	2.14	0.99	0.48	4.18
POP	65	29242	74154	615	554911
POP15	65	36.68	9.59	19.26	51.82
POP65	65	6.14	4.19	2.31	15.73
AGEDEP	65	0.66	0.23	0.29	1.16
SSEC	65	1.35	1.29	0.00	4.71
SGOV	65	-4.22	3.71	-13.40	4.00
MONEY	64	70.49	39.63	10.58	188.03
INFLATION	64	50.17	141.60	3.85	776.84
ASSAS	65	0.03	0.08	0.00	0.47
COUP	65	0.04	0.08	0.00	0.36
REVOL	65	0.14	0.19	0.00	0.88
REVCOUP	65	0.18	0.25	0.00	1.19
GOVWB	65	0.14	0.05	0.06	0.27
BMP	65	0.38	0.69	0.00	4.60
TARIFF	65	0.17	0.18	0.01	1.32
QRESTR	64	0.21	0.24	0.00	0.89
DY70	48	20.21	13.74	0.38	65.80
PPPY	65	0.64	0.26	0.20	1.19
PPPI	65	0.86	0.45	0.35	2.99
Q	65	1.48	0.90	0.67	6.37
IGOV	64	7.23	3.73	2.44	20.89
VARTOT	63	0.04	0.03	0.01	0.13
OPEN	65	55.40	28.38	15.13	188.81
AREA	64	901	1992	1	9976
DISTANCE	64	5.87	2.46	1.73	11.52
COUNTRY RISK	61	47.49	26.53	8.00	96.42
INVWB	65	21.86	5.57	9.52	41.68
SAVING	65	18.45	6.51	5.99	34.77
FDI	64	0.68	1.23	-1.58	6.60

Table A.2

Countries in the sample

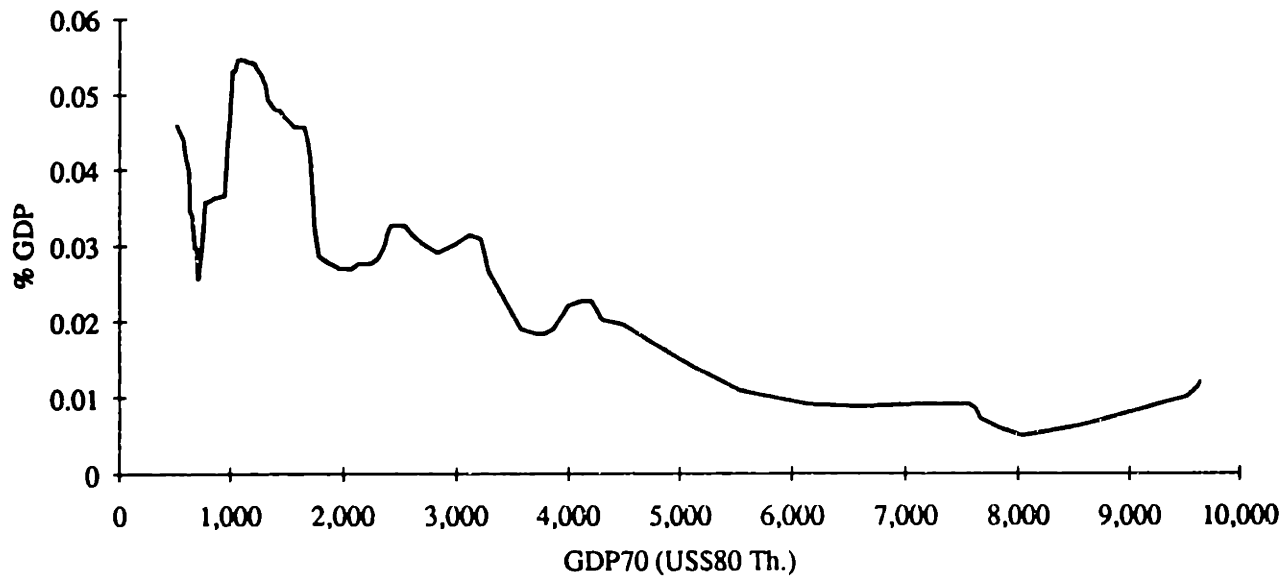
COUNTRY	WBCODE	INDUSTRIAL	OPEN>Q50	POP>Q50	MARKET	OFFICIAL
1 Benin	BEN	0	1	0	0	0
2 Cameroon	CMR	0	0	0	0	0
3 Central African Rep	CAF	0	1	0	0	1
4 Egypt	EGY	0	1	1	0	1
5 Ghana	GHA	0	0	1	0	1
6 Kenya	KEN	0	1	1	0	1
7 Malawi	MWI	0	1	0	0	1
8 Mauritius	MUS	0	1	0	0	1
9 Rwanda	RWA	0	0	0	0	1
10 Senegal	SEN	0	1	0	0	1
11 Sierra Leone	SLE	0	0	0	0	1
12 Tanzania	TZA	0	0	1	0	1
13 Tunisia	TUN	0	1	0	0	0
14 Zaire	ZAR	0	0	1	0	1
15 Zambia	ZMB	0	1	0	0	1
16 Zimbabwe	ZWE	0	0	0	0	0
17 Canada	CAN	1	0	1	1	0
18 Costa Rica	CRI	0	1	0	0	0
19 El Salvador	SLV	0	1	0	0	1
20 Guatemala	GTM	0	0	0	0	0
21 Haiti	HTI	0	0	0	0	1
22 Jamaica	JAM	0	1	0	0	1
23 Mexico	MEX	0	0	1	1	0
24 Nicaragua	NIC	0	0	0	0	0
25 Trinidad & Tobago	TTO	0	1	0	1	0
26 United States	USA	1	0	1	1	0
27 Argentina	ARG	0	0	1	1	0
28 Bolivia	BOL	0	1	0	0	1
29 Brazil	BRA	0	0	1	1	0
30 Chile	CHL	0	0	1	1	0
31 Colombia	COL	0	0	1	0	0
32 Ecuador	ECU	0	0	0	1	0
33 Paraguay	PRY	0	0	0	0	0
34 Uruguay	URY	0	0	0	1	0
35 Venezuela	VEN	0	1	1	1	0
36 Bangladesh	BGD	0	0	1	0	1
37 India	IND	0	0	1	0	0
38 Indonesia	IDN	0	0	1	0	0

Table A.2 cont.

Countries in the sample

COUNTRY	WBCODE	INDUSTRIAL	OPEN>Q50	POP>Q50	MARKET	OFFICIAL
39 Korea	KOR	0	1	1	1	0
40 Malaysia	MYS	0	1	1	1	0
41 Nepal	NPL	0	0	1	0	1
42 Pakistan	PAK	0	0	1	0	1
43 Philippines	PHL	0	0	1	1	0
44 Singapore	SGP	0	1	0	1	0
45 Sri Lanka	LKA	0	1	1	0	1
46 Syria	SYR	0	0	0	0	0
47 Thailand	THA	0	0	1	0	0
48 Austria	AUT	1	1	1	1	0
49 Cyprus	CYP	0	1	0	0	0
50 Denmark	DNK	1	1	0	1	0
51 Finland	FIN	1	1	0	1	0
52 France	FRA	1	0	1	1	0
53 Germany, West	DEU	1	1	1	1	0
54 Greece	GRC	1	0	1	1	0
55 Ireland	IRL	1	1	0	1	0
56 Italy	ITA	1	0	1	1	0
57 Netherlands	NLD	1	1	1	1	0
58 Norway	NOR	1	1	0	1	0
59 Spain	ESP	1	0	1	1	0
60 Sweden	SWE	1	1	1	1	0
61 Switzerland	CHE	1	1	0	1	0
62 United Kingdom	GBR	1	1	1	1	0
63 Yugoslavia	YUG	0	1	1	0	0
64 New Zealand	NZL	1	1	0	1	0
65 Papua New Guinea	PNG	0	1	0	1	0

Figure 2.1: Average Current Account Deficit vs. Initial GDP per capita



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Chapter 3

Current Account Imbalances and Real Exchange Rate Dynamics

3.1 Introduction

Popular stories link the strength of a country's currency with the state of its current account. The recent depreciation of the dollar, for example, has been attributed by the chairman of the FED, Alan Greenspan, and the president of the Bundesbank, Hans Tietmeyer, on the persistent U.S. fiscal deficit and its impact on the sustained current account deficit shown by the US economy during the last decade.[1] Similarly, the devaluation of the Mexican peso on December 1994 was blamed on the large and persistent current account deficits run by the Mexican economy through the first half of the nineties.

The impact of current account imbalances (or, equivalently, international capital transfers) on exchange rates (or terms of trade) is an old question in international economics. The issue goes back at least to the famous debate between Keynes and Ohlin regarding the transfer problem and the additional burden imposed on the paying country in the form of a terms of trade deterioration. As it is well known, the issue hinges on the difference between residents and nonresidents marginal spending propensities across domestic goods and foreign goods. Under the reasonable assumption that each country has a higher marginal propensity to spend on its own goods, i.e. some goods are not traded internationally, then a capital transfer requires of a deterioration in the terms of trade (or the real exchange rate) of the paying country to be effected.

However, the effect of capital transfers on terms of trade or the real exchange rate should be mostly transitory as capital transfers cannot go forever if the nation's intertemporal budget constraint is respected. As Krugman (1985) poses it commenting on the appreciated dollar during the mid 80's: "In the absence of a shift of world demand toward US. goods, a permanent high dollar would mean a permanent US. trade deficit and, because of interest payments on accumulated debt, an ever growing US. current account deficit. Nobody believes this is possible forever; thus any serious analysis of the exchange rate must presume that the dollar will eventually come down". (Krugman, 1985). This issue is examined in section 3.2, which surveys theoretical and empirical

[1]The Economist, October 21, 1995

results on the literature of fiscal and external sustainability and implications of the intertemporal budget constraint for income and expenditure processes.

Based on this idea, this chapter studies the existence of transitory components on real exchange rates associated to international net capital movements (or current account imbalances). Detecting the existence of a transitory component in real exchange rate movements is analogous to establishing the predictability of these movements, so we examine the theoretical and empirical conditions under which current account imbalances predict future movements of the exchange rate, and the empirical significance of this source of volatility on exchange rates.

In the empirical literature developed to test the purchasing power parity condition, real exchange rates have been characterized as near random walks, with unpredictable movements (Roll, 1979; Adler and Lehmann 1983; Meese and Rogoff, 1983). This literature is mostly based on univariate models and establishes that lagged movements of exchange rates are poor forecasters of future movements, but does not rule out that a larger information set could better forecast exchange rate movements and detect a significant transitory component on real exchange rate fluctuations.[2] This paper reexamines the issue of transitory components on real exchange rate movements but in a multivariate setting which includes information about trade flows and other related variables.[3]

This chapter examines the empirical relationship between current account imbalances and the dynamics of the real exchange rate in a panel of Latin American countries from 1950 to 1992. We estimate their relationship in a structural vector autoregressive system (VAR) using pooled annual data of a panel of 18 Latin American countries from 1950 to 1992. The simplest formulation includes the trade balance and the exchange rate, but other formulations include related variables as terms of trade and productivity differentials, and inflation differentials.

The interpretation of the estimation results requires to take into account the endogenous nature of current account and real exchange rate determination. The pattern of correlation between these two variables depends on the source of the exogenous disturbance affecting them. Identification cannot be achieved imposing the contemporaneous exogeneity of either the current account or the exchange rate innovations as it is done commonly in VAR analysis, but requires of an alternative set of restrictions. We identify the VAR system using plausible long run constraints

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[2]See Rogoff (1995) for a complete survey on the empirical literature on PPP testing. Recently, several authors have uncovered evidence in favor of long run PPP based on long samples, although the speed of mean reversion is very slow. (Rogoff, 1995).

[3]Several recent studies for the currencies of the G-7 economies have found evidence of transitory components on real exchange rate fluctuations adding information on lagged inflation differentials. The focus of these papers is on the existence of short run non-neutrality of nominal fluctuations on real exchange rates while the focus of this paper is on real sources of fluctuation.

as those of Blanchard and Quah (1989), leaving unrestricted the dynamic interactions between these variables in the short run.

A simple model of the joint determination of the current account and the real exchange rate suggests two sources of fundamental shocks to the real exchange rate: "capital account" or demand shocks, that affect the real exchange rate because they affect the equilibrium level for the trade balance; and "trade account " or supply shocks that affect the equilibrium real exchange rate for a given level for the trade balance. We explore two alternative schemes to identify these shocks based on long run constraints. The first scheme imposes the long run exogeneity of the net foreign asset position, which is the cumulative result of trade imbalances, with respect to other unobservable disturbances in the system which affect the long run real exchange rate through the trade balance channel. In a sense, this assumption moves the dichotomy between the "absorption" and the "elasticities" approach to the trade balance from the short run to the long run, and argue that in the long run the absorption level of the economy can be considered independent of the real exchange rate level.

The second identification scheme takes the opposite view, assuming that the long run exchange rate is exogenous to the long run level of absorption in the economy, consistent with a view of the real exchange rate as fully determined by supply side considerations.

The estimation results indicate that trade imbalances help to detect transitory components in real exchange rate movements, and the dynamics of the trade balance correspond to what is expected from capital flows shocks: trade deficits on average are associated with an overvalued exchange rate in the sense that a future real depreciation is expected. The capital transfer shock accounts for a significant fraction of the transitory or cyclical variability of the real exchange rate, between 40% and 60%, and for most of the variance of the trade balance, but for a small fraction of the overall variability of real exchange rates, below 15%. Exploratory analysis indicates that the origin of shocks on trade imbalances is important, as the expected dynamics are different whether the source of the shock is a shift on investment or a shift on savings. Trade account imbalances which originate on shifts on the investment schedule tend to be associated to a permanent real appreciation, while trade imbalances originated in shifts in private or public consumption are associated to a permanent real depreciation.

The rest of the paper is organized as follows. The next section discusses the implications of the intertemporal budget constraint of a nation on the issue of the transitoriness of current account imbalances or capital transfers and the existing empirical tests on the sustainability property. Section 3.3 discusses the econometric methodology, and section 3.4 presents and discusses the main empirical results of the paper. Section 3.5 concludes.

3.2 Implications of the Intertemporal Budget Constraint for the Behavior of the Current Account

The effect of capital transfers on the real exchange rate should be mostly transitory as capital transfers cannot go forever if the nation's intertemporal budget constraint is respected. The implications of the intertemporal budget constraint (IBC) for the behavior of the current account have been examined in the sustainability literature. In recent years, several researchers studying the sustainability of the US fiscal and current account deficit have developed various tests of the infinite horizon IBC.[4] Empirical tests of the IBC examine the stationarity of primary deficits (trade account) or the interest inclusive deficit (current account), finding only mixed evidence for the verification of the sustainability property on government and external deficits.[5] We are not aware of similar studies for the countries in our sample, so we come back to this issue in section 3.4, where empirical evidence is presented.

Following Trehan and Walsh (1991), a budget process is sustainable if the expected present discounted value of the future stock of debt converges to zero. This requirement is needed for wealth maximization of debt holders under the assumption that dynamic efficiency holds, and rules out Ponzi schemes where debt is perpetually rolled over. Starting from the dynamic budget constraint:

$$d_t = d_{t-1}R^* - nx_t \tag{1}$$

[4] Hamilton and Flavin (1986), Hansen, Roberds and Sargent (1987), Wilcox (1989), Bohn (1991), Kremers (1989), Trehan and Walsh (1991) and Ahmed and Rogers (1995) present tests of the government IBC; and Husted (1992), Wickens and Uctum (1993) and Ahmed and Rogers (1995) test the external IBC.

[5] Trehan and Walsh (1988) are unable to reject the hypothesis of intertemporal fiscal budget balance for the US using data from 1890 to 1986; while Wilcox (1989), Hansen, Roberds and Sargent (1987) and Hakkio and Rush (1991) conclude the rejection of the US intertemporal fiscal balance for the postwar period. Husted (1992) rejects the sustainability of current account imbalances in the US based on a sample starting on 1960, while Wickens and Uctum (1994) allowing the endogeneity of the trade balance on the level of accumulated debt conclude in favor of intertemporal external balance. Finally, Ahmed and Rogers (1995) find evidence that strongly supports the hypothesis of external and fiscal intertemporal balance for the US and the UK using a very long sample starting for some series even from the 17th century. .

In a different context, Goldberg, Gosnell and Okunev (1995) study the speed of adjustment of the current account concluding that in a sample of the G-7 countries, all countries, except Japan and Canada, have constant long term means, which is the stationarity property described above implying the verification of the IBC condition. Masson, Kremers and Horne (1993) find evidence for the US, Germany and Japan supporting a long run relationship between the net foreign asset position and demographic variables, and document the existence of feedback mechanisms from debt accumulation towards expenditures, which stabilize the external position of countries. Wickens and Uctum (1993) show that this feedback property is a sufficient condition to verify the IBC.

where d_t is the real stock of outstanding debt at the end of period t, R^* is one plus the international real interest rate, assumed to be constant and positive, and nx_t represents net exports or the trade account balance. Taking expectations of (1) conditional on some information set I_{t-1}, and recursively eliminating future values of the stock of debt yields the IBC:

$$d_{t-1} = \sum_{i=0}^{\infty} R^{*-(i+1)}{}_{t-1}nx_{t+i} + \lim_{j\to\infty} R^{*-j}{}_{t-1}d_{t+j} \qquad (2)$$

where $_{t-1}X_{t+i}$ is the expectation of X_{t+i} conditional on I_{t-1},. The sustainability requirement means that the last term in (2) must equal zero:

$$\lim_{j\to\infty} R^{*-j}{}_{t-1}d_{t+j} = 0 \qquad (3)$$

Trehan and Walsh (1991) show the restrictions implied by equation (3) on the joint process of d_t and nx_t: If the evolution of d_t is given by (1) with a constant and positive expected interest rate, and $(1-\lambda L)nx_t$ is a mean zero stationary stochastic process with $0\leq\lambda< R^*$, then (3) holds if and only if there exists a linear combination of d_t and nx_t which is stationary. (Proposition 1 (p. 209)). The derivation assumes a stationary economy, but population and output per capita growth can be introduced in this framework normalizing all variables by GNP, and discounting the rate of GNP growth of the real interest to capture the expansion in the economy's resources.

This proposition implies that: i. if the debt stock (or the debt-to-GNP ratio in a growing economy) is stationary, the IBC is verified iff the trade balance level is stationary. Then if exchange rate movements are required to adjust transitory shifts in the trade balance, those effects must be stationary or fully transitory. ii. If the debt stock has a unit root then the trade balance will be I(1) too, as the trade deficit (surplus) has to cointegrate with the surplus (deficit) on the balance of financial services. If we take the stock of external debt as predetermined, an increase in the trade deficit which increases the stock of external debt will be matched in the future by a permanently larger trade surplus to service additional interest payments on accumulated debt. The accommodation of these predictable shifts on the trade balance will require of corresponding predictable shifts on the exchange rate, or a temporary component on the real exchange rate. iii. The same analysis as in ii. follows if the debt stock follows a stochastic exponential trend with $(1-\lambda L)d_t$ stationary and $1<\lambda< R^*$, however this case seems less plausible as it implies an increasing debt-to-GDP or debt-to-exports ratio increasing incentives for default and the risk of that external debt.

The conditions are modified in the case of a variable expectation of the real interest rate, but as long as interest rates are bounded from below by a positive number, which rules out the dynamic inefficiency case, then stationarity of the current account is sufficient to show the satisfaction of the IBC. (Trehan and Walsh (1991), Proposition 2 (p. 215)).[6]

In conclusion, fluctuations of the trade balance in one direction create the expectation of a future movement in the opposite direction (mean reversion). At the end of the process the trade balance may end up at the original level, before the shock, or somewhat different if the stock of external debt has changed, because changes in the stock of external debt create a flow of interest payments or receipts to be matched through a larger trade surplus (deficit). The corollary is that if capital transfers are significant contributors to real exchange rate movements and they correct themselves relatively rapidly, they should predict significant transitory movements on this relative price.

3.3 Econometric Issues

3.3.1. Identification assumptions

On the next section, we examine the empirical dynamics of exchange rates and the trade balance using a VAR system. This section discusses some of the prior or structural assumptions used to interpret the VAR's results described in the next section.

A simple model of the real exchange rate determination suggests two sources of fundamental shocks to the real exchange rate: "capital account" or demand shocks, and "trade account " or supply shocks.[7] Consider a small dependent economy (*home*) which trades with the rest of the world (*RoW*) in a traded good and securities. Additionally, this economy produces and demands a nontraded good. The excess of demand over supply in the market for nontraded goods, $d(t)$, is a fraction α of the excess of total absorption over GDP: the trade balance deficit, $-nx(t)$; minus the (negative) effect on $d(t)$ of the relative price of nontraded goods in terms of traded goods, $p(t)$,, i.e. the familiar Marshall-Lerner condition; plus a "catch all" variable $z(t)$ which captures shifts in the incentives to demand or supply nontraded goods for a given real exchange rate:

$$d(t) = -\alpha nx(t) - \beta p(t) + z(t) \tag{4}$$

[6]However, is not a necessary condition, which means that the current account could show some non-stationarities in an scenario of changes in the world interest rate or changes in output or population growth.
[7]See for example Mussa (1984), Kouri (1978), Dornbusch and Fisher (1980), Rodríguez (1980), and Faruquee (1994)

Assuming full employment, implies that equilibrium in nontraded markets requires that there is no global excess demand for home goods, $d(t) = 0$.[8] From this condition, the standard trade balance equation that relates net exports to the real exchange rate is derived. The real exchange rate is defined as the relative price of the non-tradable good with respect to the tradable good:

$$p(t) = \frac{z(t) - \alpha nx(t)}{\beta} \tag{5}$$

The role of relative price adjustments to effect international transfers hinges on the sign and magnitude of parameter α/β. The standard result of the negative impact on the real exchange rate of the paying country obtains if $\alpha/>0$. This restriction encompasses the "orthodox" assumption in the analysis of international transfers that the propensity of *home* residents to spent on *home* goods is greater than the propensity of foreigners, equivalent to $\alpha > 0$ in this context as foreigners do not demand domestic goods; and simultaneously rules out PPP since β must be finite.

Variable $z(t)$ captures a variety of long run and short run influences on the equilibrium real exchange rate. A partial list includes trend effects on real exchange rates derived from differences in productivity growth across tradable and nontradable sectors (the Balassa-Samuelson effect); secular differences on demand growth across sectors (the Baumol-Bowen effect); and shifts in the relative endowment of resources when the relative factor intensities differ across the traded and non-traded sectors (Obstfeld and Rogoff, 1995; Kravis and Lipsey, 1983; Baghwati, 1984)[9]. Also includes permanent and transitory terms of trade shocks; shifts in domestic and foreign trade policies and other barriers to trade (Ostry, 1988; Edwards, 1989; Khan and Ostry, 1991); natural resource discoveries; and changes in the sectoral composition of aggregate demand.[10]

We need some restriction to identify "capital transfers" or "trade account" disturbances in the data from the vector of innovations. Traditional VAR analysis assumes a triangular contemporaneous decomposition of shocks, which for the simplest specification of the VAR would be equivalent to assume that the exchange rate or the trade balance is exogenous in the short run. The first assumption could be interpreted as the "elasticities" approach to the trade balance, which

[8] Alternatively, nominal rigidities could be introduced in the model, letting $d(t)$ endogenous, and assuming gradual adjustment for nominal prices to excess or deficits in $d(t)$.

[9] Obstfeld and Rogoff (1995) consider the case of labor intensive non tradable sector, where negative shifts in the labor supply, due for example to wealth effects, tend to expand the tradable sector and contract the non tradable sector for given prices, the Rybcinsky effect. Kravis and Lipsey (1983) and Baghwati (1984) analyze the complementary case of gradual accumulation of capital stock due to investment.

[10] Froot and Rogoff (1991) examine the consequences on the real exchange rate of shifts in the composition of aggregate demand towards government expenditure.

interpret movements on the trade balance as the result of exogenous exchange rate adjustments. The second assumption could be interpreted as the "absorption" approach to the trade balance, which assumes the exogenous determination of the trade balance, while the exchange rate adjust endogenously. Both assumptions are problematic, because variables are simultaneously determined by shocks to the fundamentals. An alternative identification scheme is needed, we examine two possibilities.

The first alternative is to use an instrumental variables procedure, and project trade balance fluctuations in a set of variables related to the "capital transfers" shock, but uncorrelated to "trade account" shocks. However, the problem is to get appropriate and correlated instruments. Some candidates for instrumental variables are the government deficit, demographic variables determining the savings rate, the world real interest rate and the volume of available capital inflows (outflows) from the main world economies. All of them shift aggregate demand, without affecting microeconomic incentives to supply or demand nontraded goods for a given price.[11]

The second alternative, and the one used in this paper, is to impose some *a priori* long run constraint to achieve identification *a la* Blanchard-Quah (1988), letting the data to speak freely on the shape of short run dynamics. This approach has been successfully applied to decompose movements on GNP and stock prices, where variables like the unemployment rate or the savings rate in the case of output, or the price-dividend ratio in the case of stock prices, show significant forecasting power for future changes in these variables (Blanchard and Quah, 1989; Cochrane, 1994; Fama and French, 1988).

Instead of assuming that either the current account (absorption) or the exchange rate is exogenous in the short run, the system is identified imposing the long run exogeneity of one of these variables. We argue that in the long run the stochastic trend on net foreign assets, the cumulative result of trade imbalances, can be considered "nearly" exogenous of the stochastic trend of the real exchange rate, although in the short run their movements could be correlated. In a sense, we move the dichotomy between the "absorption" and the "elasticities" approach from the short run to the long run, and argue that in the long run the absorption level of the economy can be considered independent of the real exchange rate level. The argument is that in the long run, shifts in the net foreign asset position are the result of changes in trend savings and investment rates which should be determined by factors related to the life cycle considerations, fiscal budget policies, the world interest rate, the country risk perception and other barriers to international

[11]Edwards (1989) uses this approach in an uniequational model of the real exchange rate that includes among other independent variables the ratio of net capital inflows to GDP. He uses lagged variables, however the method is potentially inconsistent as he includes the lagged dependent variable in the regression.

capital market integration; rather than related to the level of terms of trade shocks, the trade policy regime or sectoral productivity differentials.

In this identification scheme, however, permanent movements on the net foreign asset position could affect the long run real exchange rate through the demand channel, which implies a positive long run relationship between the net foreign asset position and the real exchange rate, since at steady state a larger stock of international assets creates a larger flow of interest receipts compensated by a larger trade deficit.

The identification assumption is obviously questionable but as long as the most important determinants of long run investment and savings rates are orthogonal to the most important determinants of the trade balance for a given real exchange rate, then the assumption is "nearly correct".[12] The robustness of the results is assessed adopting the alternative identification scheme: the long run exogeneity of stochastic trend of the real exchange rate, which is consistent with a view of the exchange rate as fully determined by supply side considerations.[13] Further, another assessment of the validity of the identification scheme is derived from contrasting the resulting dynamics against prior presumptions of how, for example, the pure "transfer" shock should look like, an informal specification test.[14] Finally, for some issues as the detection of forecastability or transitoriness in real exchange rate movements, the identification scheme it is irrelevant.

3.3.2. Econometric Model

We describe the simplest specification of the model which includes the net exports-to-GDP ratio (nx_t) and the (log) real exchange rate, p_t. We assume two types of disturbances affecting the system. The first shock in vector v_{1t} is the "capital account" shock, which under the first identification scheme has a long run impact on the net foreign asset position of the country and the real exchange rate. The second shock v_{2t} is the "trade account" shock, which under the same identification scheme has a permanent effect on the real exchange rate, but does not alter the net foreign asset position of the country. Under the second identification scheme v_{2t} has a long run impact on both variables, and v_{1t} affects only the net foreign asset position of the country.

Call the vector of variables $\Delta x_t' = \left[nx_t \quad \Delta p_t \right]$, and assume the data on x_t as being generated by the following structural VAR model:

$$\Delta x_t = B(L)\Delta x_{t-1} + \delta + \Gamma v_t \quad \text{, where } E(v_t) = 0 \text{ and } Var(v_t) = I. \tag{6}$$

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[12] Blanchard and Quah (1989) derive the precise conditions that validate this assertion.

[13] For example, in a 2x2 model of the dependent economy, with full international capital mobility and labor mobility, the real exchange rate is determined exclusively by supply factors (Rogoff, 1992).

[14] This is the "duck test" proposed by Clarida and Gali (1994): "If it walks like a duck and quacks like a duck, it must be...".

Matrix Π defines the contemporaneous structural relationship among the innovations to foreign assets and the real exchange rate. The two independent structural shocks are stacked in vector $v_t' = \left[v_t^1 \quad v_t^2 \right]$. The polynomial lag B(L) can be estimated directly using least squares methods, while identification restrictions are needed to estimate Π.

First, we obtain the moving average representation of the VAR process estimated above:

$$\Delta x_t = \underbrace{(I - B(L))^{-1}\Pi}_{C(L)} v_t \tag{7}$$

The assumption that the first shock does not have a long run impact on the net foreign asset position implies that $C_{12}(1+r^*) = 0$, where C_{12} is the upper-right polynomial term evaluated at one plus the international interest rate. This is enough to identify the structural Π and recover an estimate of the structural system dynamics defined by C(L), as well as a time series of the structural shocks v_t. Define the matrix of permanent impulse responses with respect to structural shocks as $\overline{C}$:

$$\overline{C} = \overline{B}\Pi = \begin{bmatrix} B_{11}(1+r^*) & B_{12}(1+r^*) \\ B_{21}(1) & B_{22}(1) \end{bmatrix} \Pi \tag{8}$$

where $B(\lambda) = B_0 + B_1\lambda + B_2\lambda^2 + \ldots$. An estimate of $\overline{C}$ is obtained from the unique lower triangular Choleski decomposition of the variance of permanent level innovations on x_t with respect to e_t, where $e_t = \Pi v_t$ and the variance term is $\overline{B} Var(e_t) \overline{B}'$; an estimate of Π is obtained $\overline{B}^{-1}\overline{C}$.

3.4 Empirical Results

The VAR is estimated using a panel data set of yearly data of 18 Latin American countries from 1950 to 1992 obtained from the Summers-Heston 5.6 data set. The use of a panel data set instead of individual country time series allows to estimate more robust short run and long run dynamics, at the cost of ignoring potentially important heterogeneity in the parameters across countries. We deal with this heterogeneity using fixed individual effects. We allow a heteroscedastic structure for the residual variance, and correlation of time observations across countries is dealt with using fixed time effects. Edwards (1989) uses a similar approach estimating an uniequational model for the real exchange rate using pooled annual data for a sample of 12 developing countries from 1962 to 1984.

3.4.1 Capital Flows and Real Exchange Rate Dynamics

a. Unit roots:

First, we characterize the stochastic long run behavior of the real exchange rate (RER) and the net exports-to-GDP ratio (NX). An implicit assumption in the VAR specification is that the real exchange rate follows an integrated process of order one while the net exports ratio is a stationary variable. These assumptions can be tested directly using Dickey-Fuller unit roots tests, but the panel nature of the data set means that traditional critical values are inapplicable to test the null of non stationarity. Quah (1994) shows that the critical values are close to normal when individual time series observations are drawn from a common distribution. However, the inclusion of a set of country-specific intercepts drives the critical values to reject non-stationarity above 10 in absolute value (Levin and Lin, 1993; Frankel and Rose, 1995).

Table 3.1 present the results of DF and augmented DF tests using one lag. The NX ratio is measured at current international prices, thus avoiding the correlation induced by real exchange rate movements on the size of the trade account relative to GDP, and RER is the log of the domestic CPI to US CPI ratio.[15] The model includes a set of individuals and time dummies. Two extremely large outliers (out of 750 observations) were previously excluded.[16]

Tests reject the hypothesis of non-stationarity in the NX variable, but accept it for the RER. Also included in Table 3.1 are the results of unit root tests for domestic GDP relative to the US GDP (Y) and for the terms of trade (TOT), which will be included below in the VAR model. Tests fail to reject the hypothesis of non stationarity for both variables. Finally, the existence of a cointegration relationship between the three non-stationary variables according to tests results on Table 3.1 -- RER, Y and TOT-- is rejected.

The stationarity of the trade balance is not a sufficient nor a necessary condition to verify the IBC condition, remember that what is needed is the stationarity of a linear combination between the trade balance and foreign assets. Only if $r^*=0$ or foreign assets, A_t, are stationary , both properties are equivalent. If r^* is small and the variance of A_t is small compared to the total variance of NX_t, this may not be a bad approximation. Alternatively, if $r^*>0$ and we impose the IBC condition, then the result implies that net foreign assets follow a stationary process. In both cases, evidence of a stationary trade balance implies that the capital account determinants have no long run effects on the real exchange rate through the demand side. We can test this implication on the next section looking at the significance of the long run impact of the shock identified as the "capital account" disturbance. The alternative is to impose the IBC condition and use this finding to

[15] Using S-H 5.6 terminology: NX=100xLOG(CC+CI+CG), and RER=100xLOG(PC).
[16] Bolivia, 1954, and Nicaragua, 1987.

identify the "capital account" disturbance as the shock that has no long run impact on the real exchange rate.

b. Dynamic effects:

The VAR is estimated using four lags of each variable, and including a set of time and individual effects. Results of Granger-causality tests are shown in Table 3.2.1. The first column shows the results for the trade balance: lagged observation of itself have predictive power for its future behavior, while we cannot reject the null hypothesis of exclusion on the set of lagged RER movements. The second column shows test results for the first difference of the RER: both lagged variables, NX and RER, have predictive power for future RER movements, implying that an abnormal level for the trade balance is associated to a transitory movement in the real exchange rate. This result is important because as shown by Evans and Reichlin (1994), finding evidence of Granger causality of a variable W on a variable ΔV implies that the variance of the transitory component of V conditional on its own lagged values and the lagged values of W is strictly larger than the same ratio derived from an univariate representation. Therefore the inclusion of NX in the RER equation adds forecasting power to the model. However, the small $\overline{R}^2$ in the RER equation, 7.5%, indicates that overall the forecasting power is very small .

The dynamic effects of disturbances are reported in Figure 3.1, which contains the impulse response functions of the two endogenous variables with respect to the two system's structural disturbances. The identification assumption is that "trade balance" shocks have no long run impact on the net foreign asset position of the country. The rate of accumulation of foreign debt-to-output, r-g, is set at 3%, but estimations for larger or smaller rates had no impact on the results reported below. The vertical axis in upper figures of Figure 3.1 denotes the log(RER)x100, and in lower figures represents the trade account deficit as a percentage of GDP (measured at constant prices). The horizontal axis denotes time in years. Each figure includes the point estimate and an interval of confidence at the 90% significance level computed from 500 bootstrapping replications of the estimation procedure. The large number of observations allows to estimate the impulse response functions with considerable precision.[17]

First, look to the dynamics induced by the "capital flows shock" in the first column of Figure 3.1 described by labels k→ NX and c→ RER. An increase in capital inflows by definition induces a trade account deficit, which gradually and monotonically disappears through time. The half life of the impact on the trade deficit shock lasts between 2 and 3 years. On impact, the k-shock increases the trade deficit in 1.8% of GDP, and appreciates the RER on 1.7%, but later as the

[17]In each case, we construct pseudo-histories of variables RER and NX for each country by drawing with replacement from the empirical distribution of its VAR innovations, without mixing observations across countries.

volume of international funds flowing to the country declines, the RER depreciates. The initial positive impact on the RER disappears between the second and third year, and the RER continues depreciating, converging in the long run at a level 2% below its original level, before the k-shock. This result is consistent with the model described in section 3.3.1, where initially the capital account shock appreciates the domestic currency to effect the capital transfer, but in the long run requires of a depreciation to service the additional external debt accumulated in the process.

However, the permanent impact of the capital account shock on the real exchange rate is not consistent with the finding of a stationary NX ratio described in Table 3.1. One possibility is that indeed NX is non stationary, and inference based on Table 3.1 is wrong. This possibility is likely as the variance of the permanent component is very small compared to the variance of the transitory component. For example, consider the implications of the point estimates of the NX stochastic process derived from the VAR system in Table 3.1. The persistence of capital account shocks is well approximated by an AR(1) process with ρ=0.6, using r-g equal to 3%, the long run impact on the net foreign debt-to-output ratio of a 1.8% shock on the trade deficit, as in Figure 3.1, is 4.7%. If the international interest rate is approximately 5%, then the long run impact of the k-shock on the NX ratio is -0.23%, which is relatively small compared to the standard error of the same variable, 1.85%. This could explain the contradiction between the stationarity property of NX asserted in Table 3.1, and the long run impact of the capital account shock on the RER. However, if this was the case then there would be an inconsistency between the small impact of the initial capital transfer on the RER, which implies an elasticity of 1, and the long run elasticity of NX with respect to RER which is approximately 0.1.[18]

Looking at the dynamics associated to the trade account or "competitiveness" c-shock. It appreciates on impact the RER by 13.8%, c→ RER, which is much larger than the impact of the "capital inflows" shock. The initial impact is partially reversed and the permanent appreciation of the RER is 9%, which is consistent with the existence of a unit root on this variable. Contrasting, the impact of the trade account shock on capital inflows, c→NX is negligible as shown by the upper-right panel in Figure 3.1.

c. Variance decomposition:

Since shocks in Figure 3.1 correspond to one standard deviation of the corresponding disturbance, they have been normalized and imply that c-shocks are a much more important source

[18]Another possibility is that the model exhibits hysteresis through the supply side. For example, Baldwin and Krugman (1989), and Dixit (1989) have studied the implications of costly entry and exit in trade models. In this type of models, if the initial appreciation of the currency is large enough to induce the exit of firms from the tradable sector into the domestic sector; then in the long run, once the impulse for appreciation is gone, the real exchange rate returns at a level below its original level, to accommodate the persistent contraction in the supply of tradable goods.

of variability on the RER than k-shocks. We asses the relative importance of both shocks on RER dynamics looking at the variance decomposition statistics.

The top of Table 3.2 reports the split of conditional variance of the log-level of the RER at various horizons between unforecastable structural "competitiveness" shocks and unforecastable structural "capital flows" shocks. The confidence intervals on these statistics, not reported, are narrow as a result of narrow confidence bands in Figure 3.1. The standard error of the RER level increases asymptotically as the horizon goes to infinity since this variable is I(1). The results indicate that the "capital flows" shocks account for a very small fraction of the RER level variance at all horizons, 1.4%, in the short run and 5.2% in the long run. The fraction is higher in the long run, because the c-shock has a partial mean reverting component.

The bottom panel in Table 3.2 decomposes the conditional variance of the log-difference of the RER at various horizons into fractions of the variance due to both structural shocks. As the forecast horizon increases, the standard error and variance fractions converge to the corresponding statistics on the unconditional distribution of RER differences. The results indicate that at steady state, just 3.4% of real exchange rates shocks are accounted by the capital flows shock, while the rest is accounted by competitiveness shocks. The conclusion is that very little of total variability on RER is due to the effect of capital transfers, however, the next section shows that capital transfers represent a significant percentage of the transitory or cyclical component of RER movements.

The corresponding variance decomposition for the NX variable, not shown, implies that its variance is almost completely due to the capital account shock as defined by this procedure.

d. Permanent and transitory components:

Looking at the dynamics in Figure 3.1 and Granger causality tests in Table 3.2.1, there is evidence of transitory or cyclical components in RER movements as both shocks induce an initial depreciation, later followed by a partial or complete reversion. The transitory or cyclical component is defined in the Beveridge-Nelson (1981) sense, as the difference between the current level of the variable and the infinite horizon expectation of it, excluding deterministic trends. In other words, the transitory component is the stochastic part of the expected appreciation (depreciation) on the RER. We use as a summary measure of transitoriness the ratio of the variance on the transitory component relative to the RER variance, both measured as conditional 1-step variances. We compare this measure to the corresponding measure derived from an univariate AR representation

of the model estimated with the same number of lags in order to asses the marginal contribution of the trade balance in the detection of transitory fluctuations in real exchange rates.[19]

The results in Table 3.2.3 show that the conditional variance of the transitory component 19% of the conditional variance of RER, which is only slightly above the variance of the transitory component obtained from an univariate decomposition, 13%.[20] This indicates that the inclusion of lagged NX on the RER equation has only a marginal impact, although statistically significant, on the predictability of the RER. It is important to remark that this result does not depend on the identification assumption, only the allocation of the permanent and transitory component across structural shocks is determined by it.

The decomposition of permanent and transitory innovations between both shocks, shows that the capital account shock accounts for 38% of the 1-step conditional variance of the transitory or cyclical component of the RER, while its contribution to the permanent component of the RER is just 5.5%. Therefore, capital transfer shocks as identified by this procedure account for an important fraction of the transitory component on RER, but the transitory component represents a very small fraction of the overall variance of RER.

e. Contrasts between investment and savings shocks to capital flows:

In the simple set-up of section 3.3.1, we could distinguish three sources of shocks on capital inflows. The first two are internal or pull factors: shifts in the savings schedule, shifts in the investment schedule; and the last one corresponds to external or push factors: shifts in the international interest rate or country risk perception which shift the supply of external funds available for the country. Now we ask if there is a difference in the response of the RER with respect to investment and savings shocks. As it was argued in section 3.4 is more likely the orthogonality of shifts on savings or external credit conditions with respect to shifts in the trade balance determinants of the RER, than the orthogonality of investment shocks with respect to the same fundamentals, because investment shocks are more likely correlated to productivity shocks which affect the RER too.

We use a crude method to obtain a measure of investment and savings shocks instrumenting the trade balance ratio directly on the investment and the consumption ratio, and then running the same estimation procedure. Figure 3.2 shows two impulse responses of the RER

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[19]This measure is related to the persistence measure proposed by Campbell and Mankiw (1987) based on the impulse response function of an univariate process. Consider the moving average representation (or impulse response function) for one step movements in the log real exchange rate:

$$\Delta q_t = C(L)v_t$$

[20]Adding more lags to the VAR system increased the variance accounted for the transitory component to 30%, but did not affect other results.

associated to each instrumented capital account shocks. In both cases we observe an appreciation of the RER in the short run, later followed by a depreciation of the currency. However, the expected reversion is much larger in the case of the savings shock. An additional percentage point in the trade deficit induced by the savings shock is associated to an expected depreciation of 4.4%, while if its associated to the investment shock the corresponding expected depreciation is 1.4%. In the first case, the RER converges in the long run up to a level below its original level, while in the second case it remains above it. The results are suggestive, but further exploration would require of a better set of instrumental variables since under imperfect capital mobility, or for other reasons, investment and savings are highly correlated.

f. Alternative long run identification scheme:

As an alternative identification assumption we considered a decomposition scheme that defines the capital transfer shock as one that has no long run impact on the real exchange rate, but allows real exchange rate shocks to have a long run impact on the net foreign asset position. This assumption is equivalent to accept the joint hypothesis of a stationary NX ratio and the verification of the IBC, as they imply that capital transfers have no long run impact on the RER through the demand channel.

The dynamics appear in Figure 3.3, and related statistics are reported in tables 3.1 and 3.2. The results are very similar: the temporary trade deficit identified as the capital transfer shock appreciates the real exchange rate in the short run, and predicts a future depreciation (k→RER). There is a big increase on the impact effect of the capital transfer shock on the RER, which now appreciates in 4.8% after a 1.75% impulse on NX. The effect on the RER is almost completely undone by the fourth year. Correspondingly, the size of the transitory component associated to the capital account shock is larger and accounts now for 60% of the conditional variance on the expected RER appreciation (depreciation). However, still the capital transfer shock accounts for just 11% of the 1-step conditional variance of the RER, 14.5% of the steady state (long run) variance of the RER differences, and by definition 0% of the RER level variance.[21]

Summarizing, the results indicate that the "capital transfer" shock, which in practice is identified by the model as unexpected movements in the trade balance, induce transitory but small movements on the RER. The capital transfer shock as identified by this procedure account for an important fraction of the transitory component on RER, but the transitory component represents a very small fraction of the overall variance of RER. The results indicate that trade account deficits,

[21] Increasing the number of lags to 8, makes larger the initial impact of the capital transfer on the RER, 6%, and the transfer shock accounts for 21% of the 1-step conditional variance of the RER level, and 25% of the long run variance of RER differences, and by definition none of the RER level.. The capital account shock accounts now for 72% of the conditional variance on the expected RER appreciation (depreciation).

below some normal level, are a symptom of an "over appreciated" currency, in the sense that they predict a future real depreciation, but not necessarily evidence of any disequilibrium in the economy.

3.4.2 Terms of Trade and Productivity Shocks

Next we add the terms of trade (TOT) and relative productivity (Y) to the VAR model described above. Granger causality tests are reported in Table 3.4.1. The results continue to indicate that lagged observations of the trade account have significant predictive power for future RER movements, and so do lagged observations of TOT movements and RER differences, while lagged observations of Y could be excluded at the 5% significance level. In the case of NX, lagged observations of itself and of TOT movements have significant predictive power for the evolution of this ratio, while Y and the RER rate can be excluded at conventional significance levels. In relation to TOT shifts, only NX and marginally the RER have some predictive power for its future evolution. Finally, all variables, except lagged TOT, have a statistically significant predictive power for output.

It is interesting to notice the significant role of the trade balance in predicting transitory movements on relative output and in the terms of trade. This property is consistent with the implications of an intertemporal consumption smoothing model of the current account, where transitory income movements are smoothed out through transitory capital flows (current account imbalances). We come back on this issue below.

The dynamic effects of disturbances and confidence intervals based on bootstrapping simulations are shown in Figure 3.4. The identification assumptions are equivalent to those in Figure 3.1. We use a triangular long run decomposition of the vector TOT, y, NX and RER, ordered from the most (long run) exogenous to the least (long run) exogenous. The stochastic trend of net foreign assets (relative to GDP) is exogenous to the stochastic trend of the real exchange rate as in section 3.4.1., but productivity and terms of trade shocks could affect it.

First, look the dynamics of the RER with respect to each of the structural disturbances in the lower row of Figure 3.4. The impulse response function of the RER with respect to the capital transfer shock (third column, last row, k→RER) is very similar to the impulse response function in Figure 3.1: an innovation of 1.7% of GDP on the trade deficit appreciates the RER in 2.0% on impact, but through time as the trade deficit disappears, the real exchange rate depreciates, converging in the long run to a level 2.6% below its original value.

Shocks on productivity have an immediate impact on relative output of approximately 4%, and almost no effects on TOT or NX (second column in Figure 3.4: Y→TOT and Y→NX). The RER shows no contemporaneous effect of the increase in productivity but through time appreciates gradually up to a 2.1% in the long run (Y→RER). The direction of the long run effects is consistent with the Balassa-Samuelson effect described in section 3.3.1, and quantitatively is remarkably similar to panel estimates of 0.5 for the (long run) RER elasticity with respect to Y obtained by De Gregorio (1995) for a panel of 78 countries.

An improvement on TOT has an immediate and permanent effect on TOT and Y, which includes a terms of trade correction (first column, TOT→TOT and TOT→y). At the same time, the response of NX is negligible (TOT→NX). However, the RER shows a strange pattern of response to the terms of trade shock, it appreciates in the short run, but depreciates in the long run, however the response is not significantly different of 0 (TOT→RER). Finally, the response of the RER with respect to the competitiveness shock (RER→RER) is very similar to the response shown in Figure 3.1, showing a significant transitory component.

The variance decomposition of the RER level between unforecastable structural disturbances is reported in Table 3.4.2. In the short run, one year, the "capital flows" shock accounts for a very small fraction of total variance, 2.1% approximately, in the long run its contribution increases to 7.9% of the total variance. The competitiveness shock accounts for most of the variance, 98% at the 1-step horizon and 85.8% in the long run. Surprisingly, the contributions of the terms of trade and productivity shocks to the RER variance are very small.

The role of transitory components on real exchange rate movements is shown in Table 3.4.3, and remains almost unchanged. The conditional 1-step variance of the transitory or cyclical component is larger than the corresponding variance from an univariate representation, and most of it is allocated to the capital flows shock, 40%, and the competitiveness shock, 48.8%. In conclusion, adding relative output and terms of trade does not alter the description of real exchange rate dynamics obtained from the simpler VAR model in Figure 3.1, but simply decomposes the sources of variation on its permanent component.

Looking at the rest of the dynamics in Figure 3.4, it is interesting to notice that the capital inflows shock is associated to a transitory terms of trade fall. The capital inflows shock is responsible for 22% of the 1-step conditional variance of TOT, and 25% of the unconditional variance. This result can be explained in the consumption smoothing framework for the current account determination, where transitory terms of trade shocks are smoothed out through temporary

current account deficits (Svenson and Razin, 1983; Sachs, 1981).[22] The problematic aspect is that this deterioration of terms of trade is associated to a real exchange rate appreciation which is counterintuitive although theoretically possible. (Edwards, 1989)

One possibility is that these dynamics are the consequence of imposing a structure of shocks which is too simple. For example, if there are two types of terms of trade shocks: permanent and transitory, and economic agents can distinguish between them, then the dynamic response of the trade balance and the real exchange rate will be different to each type of shock. However incorporating this additional shock renders the empirical model unidentified and the estimated impulse response functions correspond to a mix of the true impulse responses function in the system. This could be the explanation of the strange pattern of response of the RER to the terms of trade shock, and the predictive role of the trade balance for future terms of trade movements.

We attempted to deal with this problem including as exogenous variables lags and leads of changes in the terms of trade and output, identifying a simpler VAR model with the two variables NX and RER, using the same identification scheme as in Figure 3.1. The results, not reported, essentially replicated those in Figure 3.1 and Table 3.3.2.

Finally, estimates based on the alternative long run identification scheme in which the trade account shock by definition has no long run impact on the real exchange rate, are reported in Table 3.5. The results are very similar to those in Figure 3.4: trade account deficits are systematically associated to transitory overvaluations of the real exchange, i.e. an expected depreciation of the real exchange rate, and the trade account shock account for approximately 18.5% of the 1-step conditional variance on innovations, and 20.3% of the unconditional variance (Table 3.5.1). The capital flows shock accounts for 63.6% of the conditional variance of the transitory or cyclical component on real exchange rate movements. Since 87% of the variance on the trade account is associated to the capital inflows shock, once again we confirm the finding that abnormal trade deficits are associated to "over-appreciated" exchange rates. However, overall the permanent component of RER movements is much larger than the transitory component.

3.4.3 Nominal shocks

Next we add nominal shocks to the VAR system. Several papers have investigated the role of inflation differentials (or alternatively, nominal exchange rate movements) in predicting transitory real exchange rate deviations (Clarida and Gali, 1994; Lastrapes, 1992; Evans and

[22]This finding suggests a permanent-transitory decomposition of terms of trade movements based on a VAR between net exports and terms of trade. Cochrane (1994) uses a similar framework to decompose income movements in transitory and permanent looking at the joint behavior of savings and income.

Lothian, 1993). The inclusion of lagged inflation differentials in the model does not alter any of the conclusions obtained above, and particularly we do not find any evidence of additional transitory movements on the real exchange rate induced by the nominal shock. (Figure 3.5) In fact, the only significant impact of the nominal shock on real variables is a transitory increase in real output (last column, third row).

3.4.4 Individual Countries Results

The structural VAR for NX and RER was estimated separately for each individual country in the sample. The main results related to the capital transfer shock are summarized in Table 3.6 and Figure 3.6 shows the dynamics for each country of the RER with respect to both structural shocks. The identification assumption is that the capital transfer shock has no long run impact on the RER. Overall, the results indicate that some caution is needed in the interpretation of the results obtained above, since there are important differences across individual country estimates. First, the results of Dickey-Fuller unit root tests on the net exports-to-output ratio shows that for 5 countries in the sample the unit root hypothesis cannot be rejected for the trade account ratio at the 5% significance level and for 11 countries the hypothesis is not rejected at the 1% level. However, it is known that unit root tests based on relatively short time series as those in Table 3.6 have small power, and using a panel framework as in Table 3.1 can provide dramatic improvements in statistical power compared to performing a separate unit root for each individual time series (Levin and Lin, 1991). Second, there is wide dispersion on the point estimates of the short run impact of a 1% capital transfer shock on the RER, despite narrow confidence bands for individual countries. The capital transfer depreciates the RER for 7 out of 18 countries, against theory and the results described above. Third, the multivariate model detects significant transitory components on RER movements, but the role of capital transfers on those movements varies widely across countries from 2% to 99%.

3.5 Conclusions

This paper has used a structural VAR methodology to examine the empirical relationship between current account imbalances and real exchange rates dynamics in a panel of Latin American countries from 1950 to 1992. We have assumed two types of fundamental disturbances generating real exchange rate and current account dynamics, the first one having a permanent impact on the net foreign asset position of the country and the second having only transitory effects. We call the first one a "capital account" shock, and the second one a "trade account" shock. Under that interpretation we have detected that capital inflows (outflows) shocks have a transitory and positive (negative) impact on real exchange rates, and a negative (positive) impact on the trade balance

which disappears approximately in 4 years. The dynamics correspond to what is expected from capital flows shocks, since if capital flows do indeed require of exchange rate movements to be accommodated, then those effects should be mostly transitory as capital flows fluctuations should themselves be transitory if the IBC of the country is verified.

The main finding is that the capital account shock makes a significant contribution to the transitory component of the real exchange rate, but overall it makes a small contribution to total RER movements, since the permanent component clearly dominates the variance of RER movements. This evidence is consistent with evidence supporting a random walk description of real exchange rates (Roll, 1979; Adler and Lehmann 1983; Meese and Rogoff, 1988), and it is consistent with evidence on transitory components for the currencies of the main industrial economies reported by Clarida and Gali, 1994; Evans and Lothian, 1993; Lastrapes, 1992 who include inflation differentials in the information set. However, once the trade balance is included in the VAR, inflation differentials show no predictive power for real exchange rate movements.

Finally, the evidence suggest that trade imbalances are an important piece of information to asses the sustainability of exchange rates, as the data shows that trade deficits are on average associated with an overvalued exchange rate in the sense that a real depreciation is expected. However, incorporating more information about the source of the imbalance could alter this conclusion as for example trade account imbalances which originate on shifts on the investment schedule tend to be associated to a permanent real appreciation, while trade imbalances originated in shifts in private or public consumption are associated to a permanent real depreciation.

Table 3.1: Unit Root Tests

	DF	ADF(1)
unit roots		
real exchange rate (RER)	-5.46	-5.72
net exports (NX)	-13.06	-12.20
relative output (y)	-4.12	-5.04
terms of trade (TOT)	-5.52	-5.11
cointegration		
$RER = \alpha_1 TOT + \alpha_2 Y$	-9.78	-9.79
n	18	18
nT	748	748

Note: All regressions include a set of individual and time effects dummies:

$$\Delta x_{it} = \rho x_{it-1} + \sum_i \delta_i D_i + \sum_t \delta_t D_t + u_{it}$$

Table 3.2.1: VAR(4) estimate

Real Exchange Rate and Net Exports

	NX	ΔRER
	Granger causality test /2	
$\{NX\}_{t-i}$	88.138	3.429
	(0.00)	(0.01)
$\{\Delta RER\}_{t-i}$	1.361	11.265
	(0.25)	(0.00)
$\bar{R}^2$	0.342	0.075
s.e.	1.849	14.236
n	18	18
nT	676	676

Notes: 1. VAR estimates based on a panel of 18 latinamerican countries from 1950-1991. Regression includes a constant, a complete set of specific time and individual effects, and four lags of each variable. 2. F-tests and p-values.

Table 3.2.2: Variance Decomposition

horizon	*stand.deviation*	*capital flows*	*competitiveness*
	Real exchange rate level		
1	14.14	1.36%	98.64%
2	19.26	0.86%	99.13%
3	21.89	0.78%	99.21%
4	23.65	1.32%	98.67%
5	24.96	2.05%	97.94%
10	32.62	3.11%	96.88%
∞	-	5.20%	94.80%
	Real exchange rate difference		
1	10.97	1.36%	98.64%
2	11.04	1.77%	98.22%
3	11.36	2.68%	97.32%
4	11.51	3.28%	96.71%
5	11.56	3.33%	96.66%
10	11.60	3.36%	96.63%
∞	11.61	3.36%	96.63%

Notes: 1. Based on VAR(4) estimates in Table 3.2.1.
2. Identification procedure: net foreign assets are long run exogenous of the real exchange rate. The rate of accumulation, r-g, is set equal to 3%.

Table 3.2.4: Permanent and Transitory Components

Real exchange rate

standard deviation	*capital flows*	*competitiveness*	*total multivariate*	*univariate*
Transitory comp.	3.8	4.9	6.2	5.3
Permanent comp.	2.2	9.1	9.4	9.6
Total	1.6	14.0	14.1	14.9
V(Tr)/V	5.32	0.12	0.19	0.13

Notes: 1. Based on VAR(4) estimates in Table 3.2.1. 2. Identification procedure: net foreign assets are long run exogenous of the real exchange rate. The rate of accumulation, r-g, is set equal to 3%.

Table 3.3.1: Variance Decomposition

horizon	*stand. error*	*capital flows*	*competitiveness*
	Real exchange rate level		
1	14.14	11.63%	88.36%
2	19.26	9.94%	90.06%
3	21.88	8.27%	91.72%
4	23.65	7.09%	92.91%
5	24.97	6.40%	93.59%
10	32.62	3.77%	96.22%
∞	-	0.00%	100.0%
	Real exchange rate difference		
1	14.14	11.63%	88.36%
2	14.20	12.16%	87.84%
3	14.52	13.56%	86.44%
4	14.66	14.39%	85.61%
5	14.71	14.49%	85.51%
10	14.77	14.54%	85.46%
∞	14.77	14.54%	85.46%

Notes: 1. Based on VAR(4) estimates in Table 3.2.1.
2. Identification procedure: capital account shock has no long run impact on the RER. Rate of accumulation, r-g, set equal to 3%.

Table 3.3.2: Permanent and Transitory Components

	Real exchange rate			
standard error	*capital flows*	*competitiveness*	*Total multivariate*	*univariate*
Transitory comp.	3.9	4.8	6.2	5.3
Permanent comp.	9.4	0.0	9.4	9.6
Total	13.3	4.8	14.1	14.9
V(Tr)/V	0.09	1.00	0.19	0.13

Notes: 1. Based on VAR(4) estimates in Table 3.2.1. 2. Identification procedure: capital account shock has no long run impact on the RER. Rate of accumulation, r-g, set equal to 3%.

Table 3.4.1: VAR(4) estimates

Real Exchange Rate, Net Exports, Productivity and Terms of Trade

	ΔTOT	ΔY	NX	ΔRER
Granger causality test				
/2				
$(\Delta TOT)_{t-i}$	1.15	1.11	6.02	3.77
	(0.33)	(0.35)	(0.00)	(0.00)
$(\Delta Y)_{t-i}$	0.50	3.32	0.77	1.98
	(0.73)	(0.01)	(0.54)	(0.09)
$(NX)_{t-i}$	7.10	2.36	89.26	4.73
	(0.00)	0.05	(0.00)	(0.00)
$(\Delta RER)_{t-i}$	2.93	3.66	1.28	13.67
	(0.02)	(0.00)	(0.27)	(0.00)
$\bar{R}^2$	0.046	0.044	0.361	0.103
s.e.	1.41	4.55	1.82	14.01
n	18	18	18	18
nT	676	676	676	676

Notes: 1. VAR estimates based on a panel of 18 latinamerican countries from 1950-1991. Regression includes a constant, a complete set of specific time and individual effects, and 4 lags of each variable. 2. F-tests and p-values.

Table 3.4.2: Variance Decomposition

horizon	*stand. error*	*terms of trade*	*productivity*	*capital flows*	*competitiveness*
		Real exchange rate level			
1	13.84	0.04%	0.01%	2.06%	97.89%
2	18.87	1.04%	0.15%	1.32%	97.48%
3	21.41	1.22%	0.53%	1.10%	97.14%
4	23.16	1.23%	1.16%	1.41%	96.18%
5	24.43	1.19%	2.59%	1.56%	95.24%
10	31.73	1.01%	2.98%	3.04%	92.96%
∞	-	1.20%	5.12%	7.93%	85.75%
		Real exchange rate difference			
1	13.84	0.04%	0.01%	2.06%	97.89%
2	14.04	1.40%	0.35%	2.62%	95.63%
3	14.41	1.47%	0.55%	3.49%	94.49%
4	14.53	1.50%	0.68%	3.94%	93.86%
5	14.69	2.83%	0.76%	3.90%	92.49%
10	14.75	2.87%	0.86%	3.99%	92.29%
∞	14.75	2.87%	0.86%	3.99%	92.27%

Notes: 1. Based on VAR(4) estimates in Table 4.1.2. Identification procedure described in text. Rate of accumulation, r-g, set equal to 3%.

Table 3.4.3: Permanent and Transitory Components

Real exchange rate

stand. error	*terms of trade*	*productivity*	*capital flows*	*competitiv.*	*multivariate*	*univariate*
Transitory	1.3	2.2	4.6	5.1	7.4	5.3
Permanent	1.1	2.1	2.7	8.6	9.3	9.6
Total	0.3	0.1	2.0	13.7	13.8	14.9
V(Tr)/V	24.15	445.34	5.48	0.14	0.28	0.13

Notes: 1. Based on VAR(4) estimates in Table 4.1. 2. Identification procedure: capital account shock has no long run impact on the RER.

Table 3.5.1: Variance Decomposition

horizon	*stand. error*	*terms of trade*	*productivity*	*capital flows*	*competitiveness*
		Real exchange rate level			
1	13.84	0.04%	0.01%	18.46%	81.49%
2	18.87	1.04%	0.15%	15.81%	82.99%
3	21.41	1.22%	0.53%	13.53%	84.70%
4	23.16	1.23%	1.16%	11.74%	85.86%
5	24.43	1.19%	2.59%	10.70%	86.12%
10	31.73	1.01%	2.98%	6.52%	89.48%
∞	-	1.20%	5.12%	0.00%	85.75%
		Real exchange rate difference			
1	13.84	0.04%	0.01%	18.46%	81.49%
2	14.04	1.40%	0.35%	18.87%	79.37%
3	14.41	1.47%	0.55%	20.24%	77.74%
4	14.53	1.50%	0.68%	20.85%	76.95%
5	14.69	2.83%	0.76%	20.42%	75.97%
10	14.75	2.87%	0.86%	20.31%	75.97%
∞	14.75	2.87%	0.86%	20.31%	75.97%

Notes: 1. Based on VAR(4) estimates in Table 4.1.2. Identification procedure described in text. Rate of accumulation, r-g, set equal to 3%.

Table 3.5.2: Permanent and Transitory Components

Real exchange rate

stand. error	*terms of trade*	*productivity*	*capital flows*	*competitiv.*	*multivariate*	*univariate*
Transitory	1.3	2.2	5.9	3.5	7.4	5.3
Permanent	1.1	2.1	0.0	9.0	9.3	9.6
Total	0.3	0.1	5.9	12.5	13.8	14.9
V(Tr)/V	24.15	445.34	1.0	0.08	0.28	0.13

Notes: 1. Based on VAR(4) estimates in Table 4.1. 2. Identification procedure: capital account shock has no long run impact on the RER. .

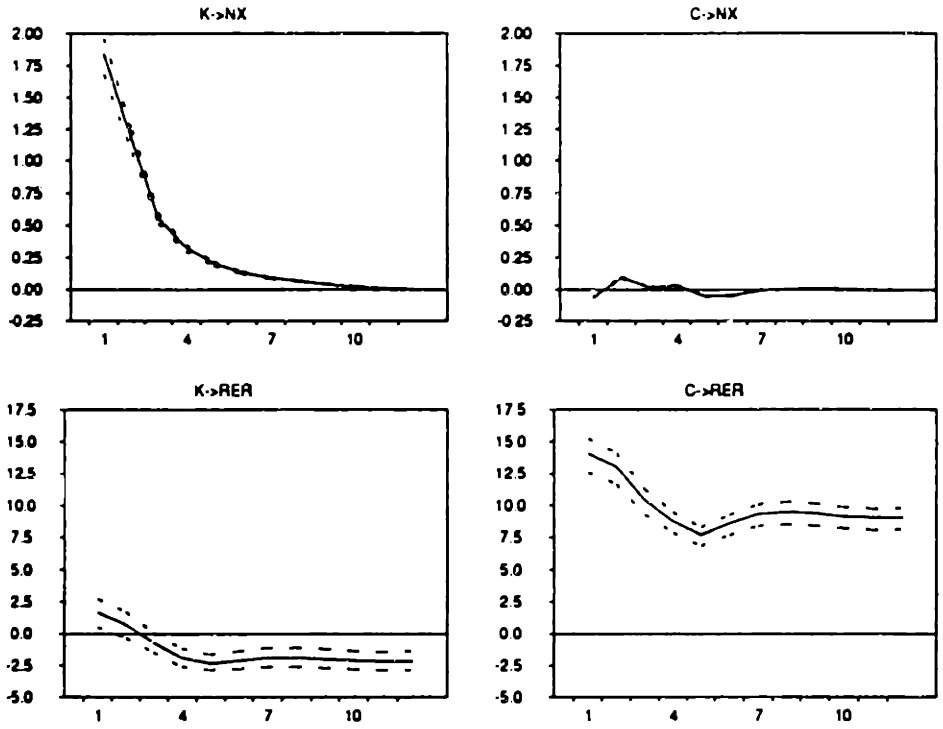
Table 3.6: Individual Countries Results

Summary of Results Related to Capital Flows Shock

	DF Test on NX	short run RER impact 1% shock	% of V(RER) 1-step	% of V(RER) 2-steps	% of RER transitory variance	V(Tr)/V(RER) 1-step
Costa Rica	-3.19	4.41	32.7%	21.2%	89.8%	59%
Dom. Rep.	-3.80	1.78	10.6%	10.9%	35.4%	54%
El Salvador	-1.81	-4.25	34.8%	42.1%	9.6%	606%
Guatemala	-3.37	-0.55	0.5%	0.6%	2.0%	50%
Honduras	-4.15	1.25	8.1%	4.5%	17.1%	70%
Jamaica	-2.73	-1.09	7.9%	4.6%	99.7%	28%
Mexico	-1.74	-4.14	2.9%	2.0%	67.8%	21%
Nicaragua	-3.28	1.69	10.3%	5.7%	36.5%	53%
Argentina	-2.95	31.43	40.6%	37.5%	99.3%	64%
Bolivia	-4.62	-1.78	5.9%	12.6%	12.4%	67%
Brazil	-3.04	11.15	27.2%	20.0%	60.3%	67%
Chile	-3.73	0.72	1.8%	8.1%	12.7%	29%
Colombia	-2.96	6.83	38.2%	45.7%	60.8%	80%
Ecuador	-4.44	-0.52	0.98%	2.9%	4.0%	46%
Paraguay	-3.48	8.68	59.3%	53%	76%	88%
Peru	-3.23	6.24	40.1%	44.0%	99.8%	63%
Uruguay	-2.57	10.9	47.1%	47.3%	81.7%	76%
Venezuela	-2.92	-0.99	10.9%	10.1%	42.0%	51%

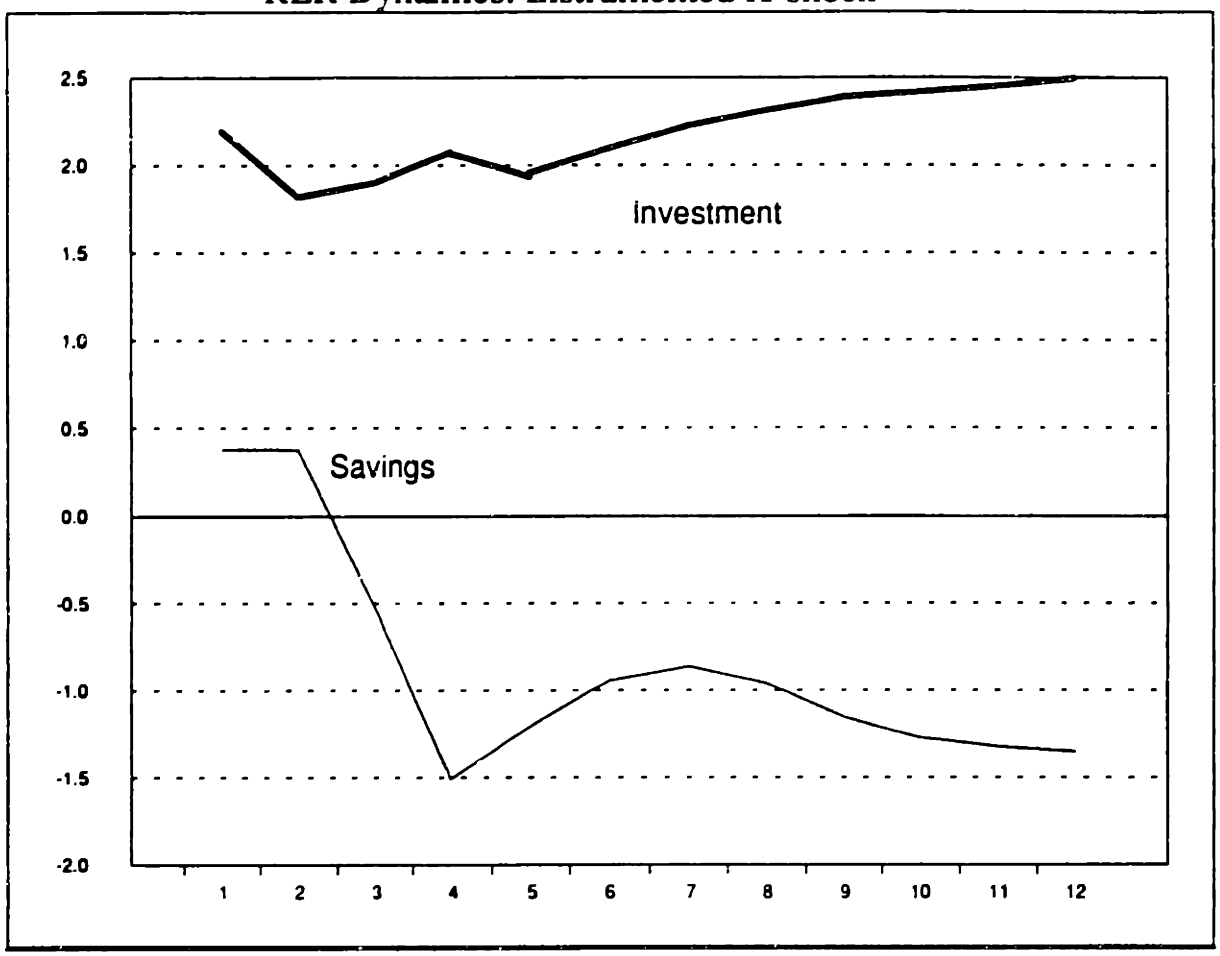
Notes: 1. Based on VAR(4) estimates. 2. Identification procedure: capital account shock has no long run impact on the RER.

Figure 3.1
VAR(4): NX and RER



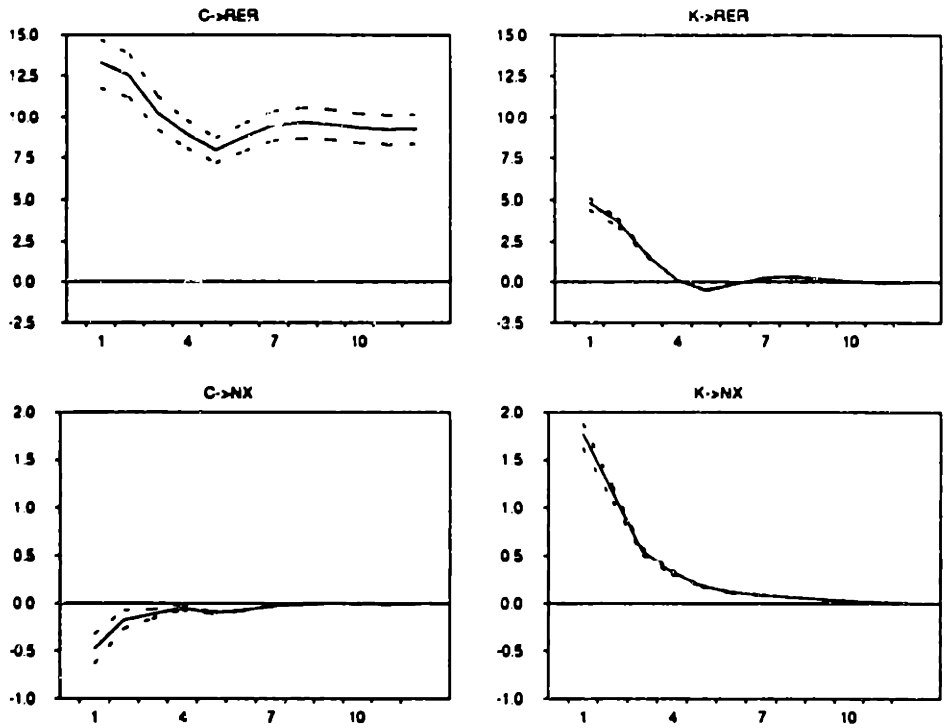
Notes: 1. Confidence interval at the 90% significance level obtained from 500 bootstrapping simulations. 2. The K-shock corresponds to the capital flows defined as the stochastic trend of net foreign assets (debt), and the C-shock corresponds to the competitiveness shock, defined as a shock that has no impact on the long run level of net foreign assets.

Figure 3.2
RER Dynamics: Instrumented K-shock



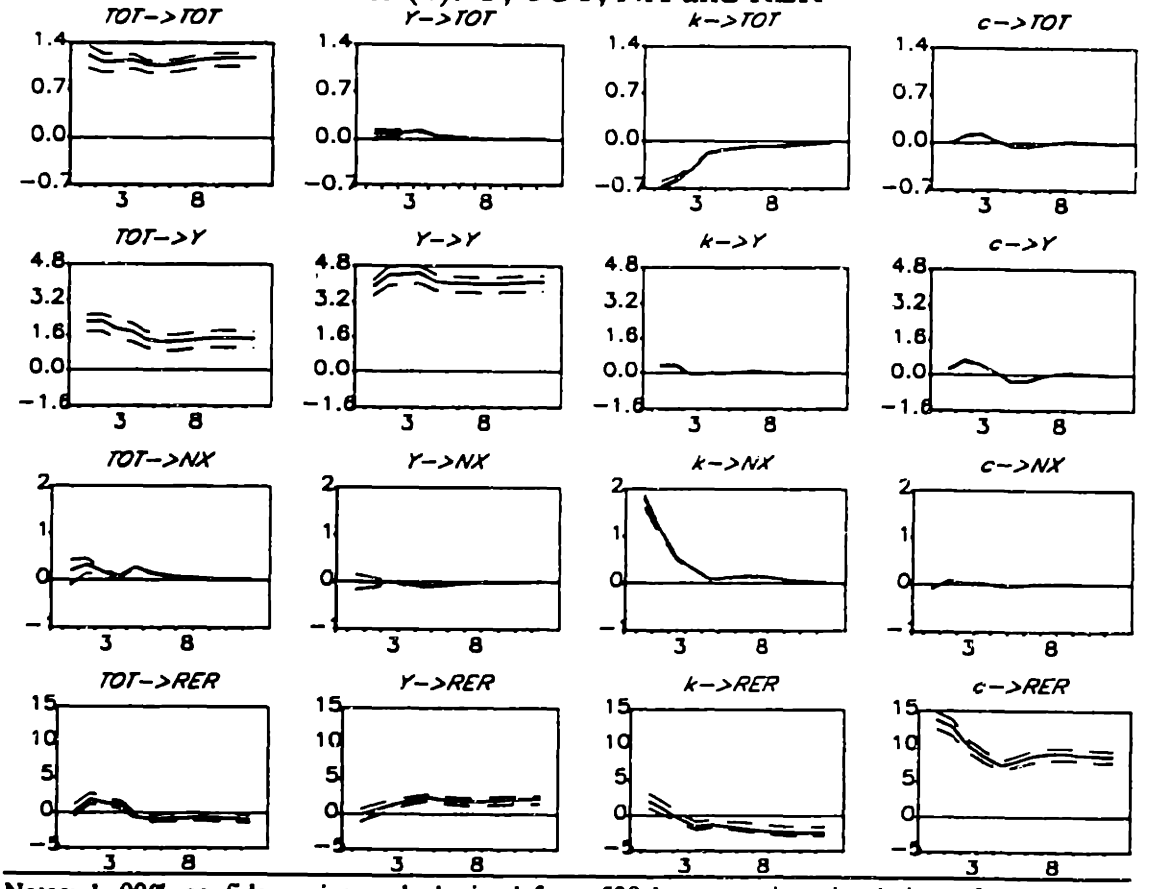
Notes: 1. The K-shock corresponds to the capital flows defined as the stochastic trend of net foreign assets (debt). The KIV-Investment corresponds to the results of instrumenting the trade balance fluctuations on investment, and KIV-Saving corresponds to the results of instrumenting the trade balance fluctuations on savings.

Figure 3.3
VAR(4): NX and RER



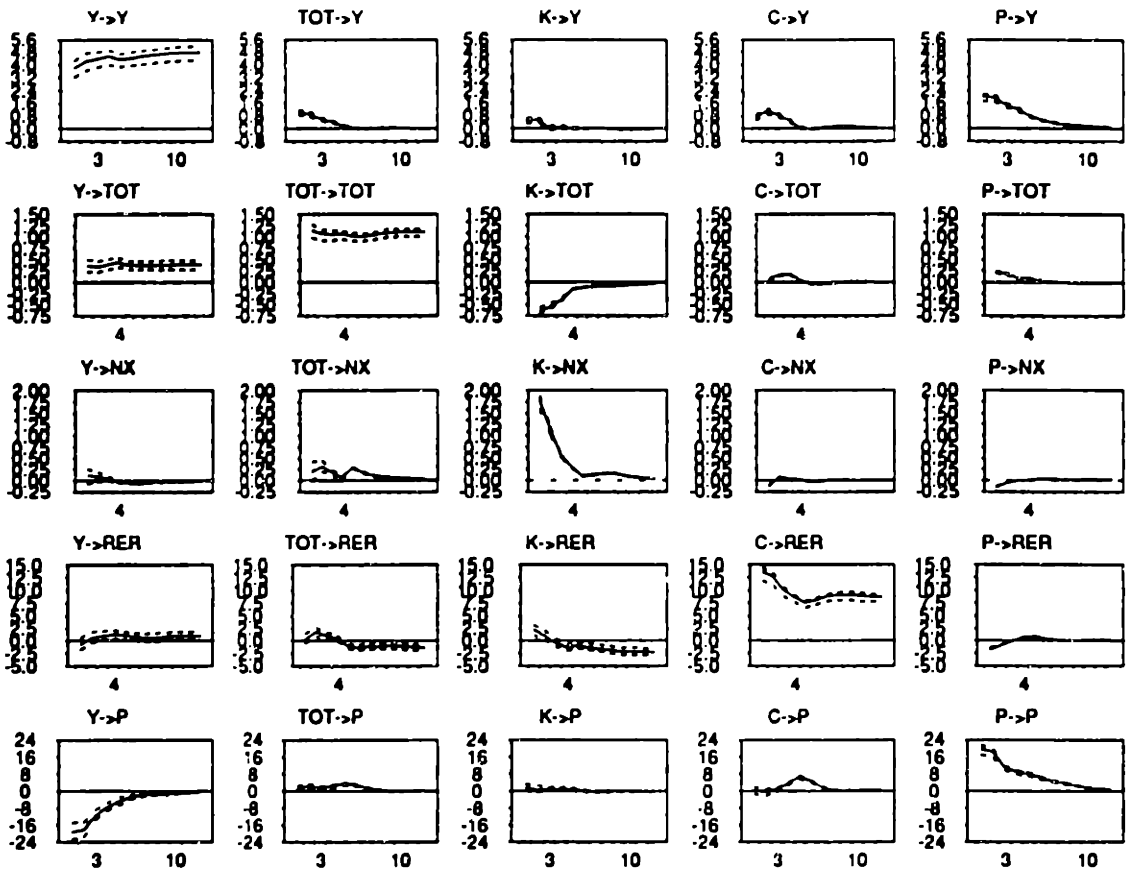
Notes: 1. 90% confidence interval obtained from 500 bootstrapping simulations. 2. The K-shock corresponds to the capital flows defined as a shock that has no impact on the long run level of RER, and the C-shock corresponds to the competitiveness shock that has a long run impact on RER and net foreign assets.

Figure 3.4
VAR(4): Y, TOT, NX and RER



Notes: 1. 90% confidence interval obtained from 500 bootstrapping simulations. 2. The K-shock corresponds to the capital flows defined as a shock that has no impact on the long run level of RER, and the C-shock corresponds to the competitiveness shock that has a long run impact on RER and net foreign assets.

Figure 3.5
VAR(4): Y, TOT, NX, RER and P



Notes: 1. 90% confidence interval obtained from 500 bootstrapping simulations.
2. The K-shock corresponds to the capital flows defined as a shock that has no impact on the long run level of RER, and the C-shock corresponds to the competitiveness shock that has a long run impact on RER and net foreign assets.

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Chapter 4

Consumption of Durable Goods in Israel and Chile

4.1 Introduction

This paper is an empirical study on the determinants of durable consumption in Chile and Israel. Understanding the empirical behavior of durable purchases it is important because it represents the most volatile part of private consumption, and it is a major fraction of consumption goods imports in developing countries. Furthermore, at least theoretically, its behavior should be very different from non-durable consumption. Fluctuations on durable purchases should be highly predictable, and largely transitory, while non-durable purchases should follow approximately a random walk, and therefore its fluctuations be unpredictable.

One interesting and related question is to understand the behavior of durable purchases in major stabilization programs anchored in the nominal exchange rate. Two recent studies of exchange rate-based stabilization programs (ERBS's) implemented in Latin America and Israel point out the puzzling expansionary effects of these programs. Large increases in private consumption -- particularly, on durable consumption-- are observed at the beggining of these programs, while a recession comes only at a second stage of the program. (Kiguel and Liviatan (1992) and Vegh (1992)). Two of the leading hypothesis offered to account for the pattern of response of private consumption through ERBS's: permanent income revisions and abandonment expectations, have distinctive predictions on the behavior of durable consumption through the stabilization process. If abandonement expectations drive the behavior of durable goods in ERBS's, we expect booms in durable purchases to be short lived and largely reversed after a few periods, and without impact on the long run stock of durable goods. Furthermore, we expect a positive correlation of financial variables measuring devaluation expectations and durable purchases. In contrast, when permanent factors as wealth revisions or expansions on credit availability drive the boom, we expect a permanent change in the stock of durable goods.

The dynamics of durable consumptions are estimated separately for each country using a structural VAR approach. The VAR provides a flexible tool to describe the dynamics of consumption of durables and non-durable goods, but at the same time imposes enough structure to interpret the source of their fluctuations and understand the nature of their dynamics. Using the methodology pioneered in papers by Blanchard and Quah (1989), Shapiro and Watson (1988) and King, Plosser, Stock and Watson (1989), long run restrictions identify the structural VAR system. In the first stage, the long run cointegration vector

that links durable and non durable consumption is estimated, identifying the "deep" parameters that describe consumer preferences. In the second stage, the dynamics of the vector of aggregate consumption are estimated, imposing the long run relationship found in the first stage. The dynamics are decomposed in three types of shocks: a wealth shock, that affect in a permanent way both components of consumption; a price shock, that reallocates consumption between durables and non-durables; and an intertemporal substitution effect that shift purchases, mainly of durables, across time, but does not have long run effects on the consumption vector.

The main empirical results of the paper can be summarized as follows. First, the long run behavior of durable purchases is estimated from a cointegrating relationship containing a wealth and a price trend. The elasticity on the wealth trend is estimated to be above 1.0 in the cases of Chile and Israel, and theprice elasticity is estimated to be between -0.5 and -1.0. Second, the short run empirical dynamics of durable purchases shows that stock adjustment is slow, much slower than predicted by the standard permanent income model with no transaction costs (Mankiw, 1982; 1985). Durable purchases appear to be positively correlated in the short run, contradicting the negative correlation predicted by the standard model. However, there is evidence that the adjustment period good is characterized by an initial period of overshooting when most of the stock adjustment happens followed by gradual convergence to its long run value. Third, the model shows that most of the variance in durable purchases is accounted by permanent price and weath shocks, but substitution shocks account for a significant component too, particularly in the case of Israel. Furthermore, the substitution shock on durable purchases, which in practice corresponds to surges or depressions in durable purchases not accompanied by changes in non-durable consumption, is significantly associated to financial variables like the black market premium and measures of capital flight showing the importance of speculative factors in the timing of durable purchases.

The complexity of the dynamics revealed by the empirical estimates indicates how difficult is to provide the right account of the developments in durable purchases just from looking to the series. In the case of Israel, the structural VAR empirical model is used as a filter to disentangle the particular shocks hiting the economy during the stabilization program initiated in 1985, and provides an historical account of the leading shocks through the period. The estimates indicate that the initial expansion observed in durables through 1986, two quarters after the stabilization program started, is within normal levels once the special dynamics of durable goods are taken into account, and other structural variables like prices and permanent income are included in the regression. However, substitution effects start appearing towards the end of 1986 and continues for the next two years, and surges in durable purchases precedes actual devaluations of the Shekel. The abandonment expectation hypothesis, stressed by Calvo (1986, 1991, 1992) and Drazen (1990) among others, do not appear to explain the initial period of expansion, but explains why it sustained in a later stage as the government delayed for political reasons a necessary and according to observers expected devaluation.

The next section presents a theoretical model of durable consumption. Section 4.3 describe an empirical model for durable consumption and section 4.4 estimates this model for Israel and Chile.

4.2 The Model

In this section we derive a model of the aggregate demand for consumption of durable goods based on the representative consumer assumption. The model is a version of the permanent income frictionless model of consumption, and the same structure has been used by Mankiw (1982, 1985), Lusardi (1990) and several others for studying the behavior of durable goods in the U.S.. The permanent income frictionless model imposes tight restrictions on the stochastic behavior of durable consumption which are rejected by the data, (Caballero, 1994), but despite this, provides a useful framework to understand the main determinants of the demand for durable goods and organize the empirical work of this paper.

The representative consumer maximizes the following utility function:

$$\underset{\{C_{t+s},X_{t+s}\}}{Max} E_t \sum_{s=0}^{\infty} \beta^s U(C_{t+s}, K_{t+s}) \tag{1}$$

subject to an intertemporal budget constraint, which has the dynamic representation:

$$A_{t+1} = R_{t+1}(A_t - C_t - P_t X_t) \tag{2}$$

The stock of durables changes over time according to the following equation:

$$K_{t+1} = X_{t+1} + (1-\delta)K_t \tag{3}$$

where :

E_t = expectation conditional on information available at time t;

C_t = consumption of non-durable good at time t;

K_t = stock of the durable good at time t;

X_t = durable good purchases at time t;

A_t = stock of wealth at time t (measured in units of non-durable good);

R_{t+1} = interest rate at time t (measured in units of non-durable good);

P_t = relative price of durable goods at time t (measured in units of non-durable good);

The solution to this problem is standard so I skip the details to focus directly on the first order conditions necessary for the maximization of (1),

$$\Theta_t + E_t\left[\beta(1-\delta)\Lambda_{t+1}P_{t+1}\right] = \Lambda_t P_t \tag{4}$$

$$\Lambda_t = E_t\left[\beta R_{t+1}\Lambda_{t+1}\right] \tag{5}$$

where:

Λ_t = marginal utility of non-durable good consumption at time t;

Θ_t = marginal utility of durable good consumption at time t;

Equation (4) shows that along the optimal plan the consumer is ex-ante indifferent between buying an extra unit of the durable good and selling it on the next period, or buying P_t units of the non-durable consumption good. Equation (5) is the standard Euler equation for non-durable consumption.

In order to link theory with observations we need some parametrization Θ_t and Λ_t in terms of observable variables. Following the standard in the empirical literature I assume separability across goods and an iso-elastic utility function for each good. (Mankiw (1982, 1985); Clarida (1993)):

$$\Theta_t = \theta K_t^{-\gamma} \tag{6}$$

$$\Lambda_t = C_t^{-\sigma} \tag{7}$$

Ex-post equation (4) can always be written as:

$$\Theta_t + \beta(1-\delta)\Lambda_{t+1}P_{t+1} = \Lambda_t P_t G_{t+1} \tag{8}$$

where G_{t+1}= ex-post excess returns on buying a durable good at time t;

The excess returns variable $\{G_{t+1}\}$ accounts for a variety of factors that prevent (4) from holding exactly at each point in time. It includes innovations to the information set, unobservable taste shocks, adjustment costs, liquidity constraints, measurement error and other possible departures of the model from reality.

This equation can be log-linearized using a first order Taylor approximation for the right hand side of equation (8):

$$log(G_{t+1}) + log(\Lambda_t P_t) = log(\Theta_t + \beta(1-\delta)\Lambda_{t+1} P_{t+1})$$

(9)

$$g_{t+1} + \lambda_t + p_t \equiv a_0 + \rho(\lambda_{t+1} + p_{t+1}) + (1-\rho)\theta_{t+1}$$

(10)

where lowercase letters represent the log of the corresponding uppercase letter and ρ is a number below but very close to one.

Defining a new variable z_t:

$$z_t = \lambda_t + p_t - \theta_t$$

(11)

equation (10) can be written as:

$$z_t \equiv a_0 + \rho\Delta\theta_{t+1} - g_{t+1} + \rho z_{t+1}$$

(12)

solving forward, and using the fact that z_t is a stationary variable, and the orthogonality of the excess returns variable g_{t+s} with respect to all information available at time t, $E_t g_{t+s} = 0$, $\forall s \geq 1$, then (12) can be expressed as a present discounted value relationship:

$$z_t \equiv \gamma k_t - \sigma c_t + p_t \equiv \sum_{s=1}^{\infty} \rho^s(\rho\gamma\Delta k_{t+s}) + \frac{a_0}{1-\rho}$$

(13)

The intuition behind this expression is straightforward, z_t represents the deviation of the stock of durables K_t from its long run demand, therefore positive deviations from the long run demand level predicts a period of falling durable. If K_t is an I(1) variable, one implication of equation (13) is the existence of a cointegrating relationship between K_t, C_t and P_t.

$$\gamma k_t - \sigma c_t + p_t \sim I(0)$$

(14)

The cointegrating vector corresponds to the variable z_t, and the coefficients from this vector identify the parameters from the utility function. Holding constant the marginal utility of wealth, the long-run price elasticity of durable goods with respect to its relative price is $-1/\gamma$, holding constant the price, the long run elasticity of durable consumption with respect to non-durable consumption is σ/γ.

Mankiw (1982) simplifies the model, and assumes certainty equivalence, R_t=R and P_t=P, and

arrives to the following expression characterizing the behavior of durable purchases:

$$K_t = K_{t-1} + e_t^*$$

$$\Delta K_t = e_t^* - (1-\delta)e_{t-1}^* \tag{15}$$

where e_t^* is a White noise innovation that represents wealth shocks. Fluctuations in durable purchases are expected to be more volatile than non durable purchases, more predictable and negatively autocorrelated. As it is well known, the tight restrictions on the variable g_t implied by the standard frictionless permanent income model are dramatically rejected by the evidence (Mankiw, 1982; Caballero, 1994). At the aggregate level, there is too much inertia in durable purchases, implying the predictability of g_{t+1}. As will be evident in the empirical section of the paper, the same observation is true for the sample of developing countries considered here. However, this does not necessarily invalidate the cointegration restriction derived in (14). Imposing the weaker restriction that the excess returns variable g_t follows a stationary mean zero process, the model still predicts the existence of a cointegrating vector between K_t, C_t and P_t.

The next step is to combine the two first order conditions in (4) and (5), to understand where do transitory deviations z_t come from. First, I write the ex-post log-linearized version of equation (5):

$$\Lambda_t H_{t+1} \equiv \beta R_{t+1} \Lambda_{t+1} \tag{16}$$

$$\lambda_t + h_t = a_1 + r_{t+1} + \lambda_{t+1} \tag{17}$$

where H_t = excess log-returns on holding wealth (financial assets). Combining equations (13) and (17) and after simple manipulations we arrive to:

$$z_t \equiv a_2 + \frac{\rho(r_{t+1} - \Delta p_{t+1})}{1-\rho} - g_{t+1} + \rho h_{t+1} \tag{18}$$

Taking expectations conditional on information available at time t, and imposing the orthogonality condition on the residual term h_t we have an equation that describes the relationship between z_t and the real interest rate in terms of durable goods:

$$z_t \equiv a_2 + \frac{\rho E_t(r_{t+1} - \Delta p_{t+1})}{1-\rho} \Rightarrow \gamma k_t \equiv \sigma c_t - p_t + a_2 + \frac{\rho E_t(r_{t+1} - \Delta p_{t+1})}{1-\rho} \tag{19}$$

This equation highlights the three determinants of durable goods consumption: permanent income, measured here by c_t, the relative price p_t and the real interest rate measured in terms of durable goods. The expectation of a low interest rate increases the durable stock beyond its long run demand.

As in the case of durable goods, there is a relatively large literature showing that the tight orthogonality conditions imposed by the standard permanent income model on h_t are rejected by the data, both in developed and developing economies. The rejection is less severe that in the case of durable goods, because c_t follows approximately a random walk as implied by the model; however, a number of variables, in particular expected income growth, have significant forecasting power for consumption changes. The same observation is true for the sample of countries considered in this paper. Given this evidence, I do not place too much emphasis on this aspect of the data. For the purposes of this paper, the main result of this section refers to the long-run properties of the data: the existence of a cointegration relationship in the system (K_t, C_t, P_t). Under the mild restriction of stationarity of g_t and h_t, the model predicts that these three variables should share two stochastic trends: the wealth trend and the price trend.

4.3 An Empirical Model for Durable Consumption

In this section an empirical model for durable consumption is set-up based on the discussion of section 4.2. One possibility would be to pursue an explicit formulation of the theoretical model described above and to test the implied restrictions. This strategy is not followed because there is enough evidence documenting the rejection of the standard consumption model, particularly for durable goods. Instead, a more general model is studied, which is likely to be more useful to understand the behavior of durable purchases. The empirical strategy follows the same approach that papers by Blanchard and Quah (1989), King et al. (1990), Shapiro and Watson (1987) in the context of output fluctuations. In particular, I use the long run properties of the model, that are more likely to be robust to specification issues than the short run properties, as a way to decompose its dynamics.

a. Long run properties

Assume that the first difference of $Y_t = [P_t, C_t, K_t]$ is generated by the vector autoregression of order p:

$$\Delta Y_t = \mu + A(L)\Delta Y_{t-1} + u_t \tag{20}$$

The 3-dimensional sequence of disturbances $\{u_t\}$ is white noise with zero mean vector and covariance matrix Σ. Empirically each of the variables in Y_t will be shown to be I(1), and following King et al. (1988) the model can be written as a general factor model, where the common factors are random walks. The common trends representation can be written as:

$$Y_t = \kappa + A\tau_t + D(L)\varepsilon_t$$

$$\tau_t = \nu + \tau_{t-1} + \eta_t$$

(21)

where κ is a 3x1 vector of constants, τ_t is a kx1 vector of random walks with drift ν and innovation vector η_t (where $k \leq 3$), L is the lag operator, D(L) is a 3x3 matrix of lag polynomials, and ε_t is a 3x1 vector of serially uncorrelated innovations. The lag polynomial D(L) is assumed to decay sufficiently rapidly such that $D(L)\varepsilon_t$ is stationary. The matrix A has dimension 3xk, and it is assumed to have full column rank. Innovations in η_t may be correlated to innovations ε_t.

The formulation in (21) decomposes the vector Y_t into permanent and transitory components. The first component on the right hand side, A_t, is non-stationary and tracks the stochastic trend of the system, while the second component $D(L)\varepsilon_t$ captures the short run dynamics of the vector. The fact that one of the components is nonstationary while the other is stationary means that certain characteristic of (21) can be investigated without additional assumptions about the relation between the innovation of the two components. Particularly, optimal estimates of $A\tau_t$ can be obtained without any additional assumption about the correlation between the permanent component and the transitory component. Since $D(L)\varepsilon_t$ is stationary, it cannot have any influence on the long run level of the first component. Similarly, issues like the number of common stochastic trends in τ_t or estimates of the coefficients in the cointegrating vector can also be studied without imposing extra identifying assumptions on (21).

The theoretical model on durable consumption predicts the existence of one cointegration relationship that links P_t, C_t and K_t in the long run, so the vector τ_t includes only two elements: τ_{wt}, the wealth trend, and τ_{pt}, the price trend. Estimation of the cointegrating vector identifies the parameters γ and σ in the utility function, the elasticities of marginal utility with respect to the durable good and non-durable good respectively.

With estimates of γ and σ at hand, the basic model described in section 4.2.1 is exactly identified and tests of the orthogonality conditions on h_t and g_t could be computed. These restrictions are easily rejected for the data, so I proceed to describe a more general framework to study the dynamics of adjustment of durable and non-durable purchases to price, wealth and substitution shocks.

b. Dynamics

It is useful to write the VAR model in (20) in terms of its fundamental Wold representation:

$$\Delta Y_t = \delta + C(L)u_t, \text{ where } u_t = Fe_t$$

(22)

The restriction of one cointegrating vector implies that the matrix C(1) is singular, that is $\alpha'C(1)$

$= 0$, where α is the cointegrating vector. The vector e_t contains the structural shocks to Y_t, matrix F and the lag polynomial C(L) describe how these shocks are propagated to Y_t. Based on the model described in section 4.2, three different structural shocks are postulated, only two of which have permanent effects on the vector Y_t.

The first permanent shock represents a wealth or permanent income shock, e_{wt}, that increases the long run level of durable and non-durable consumption; the second one, e_{pt}, represent a relative price shock that reallocates expenditure from the durable goods to the non-durable good. The third shock to the system is a transitory shock, e_{st} that we interpret as an intertemporal substitution effect that captures intertemporal shifts in expenditure due to changes in the relevant interest rate, but other stationary shocks like measurement errors could also be captured by this shock.

The cointegration relationship is imposed by replacing one of the variables in first differences by the residual of the long run relationship, interpreted here as the departure from the long run demand for durable goods. We replace the third variable, changes in the durable stock K_t by the variable z_t estimated from the cointegration relationship.

The interpretation of impulse response functions from estimates of the reduced form requires of additional identification assumptions on the underlying innovations. The three structural shocks are assumed to be uncorrelated at all lags and leads, however these does not restrict a priori their correlation with the vector of observed variables, because this depends on the matrix F. The identification of F requires of at least three additional restrictions.

The first two restrictions come from the assumption that the long run level of nondurable consumption is exogenous to changes in prices or substitution effects. In other words, its stochastic trend depends exclusively on the shock e_{wt}. This is obviously an approximation which is very useful for our purposes, although changes in relative prices or in the relevant interest rate do have a long run impact on non durable consumption. However, these are likely to be small on *a priori* grounds.

Durable purchases represent a small fraction of the consumer budget, 12 percent on average in Israel and 5 percent in Chile, therefore we can assume as an approximation that price shocks do not have a long run impact on non durable consumption.

Similarly, transitory changes in the interest rate which drive substitution shocks have a permanent effects on the long run consumption of both goods, because they have wealth and income effects that affect both current and future consumption in the same direction, and substitution effects that imply a permanent shift of consumption between the future and the present, but in the opposite direction. However, the total magnitude of these two long run effects is likely to be small for transitory shocks in the interest rate.

Consider the magnitude of the impact on consumption of a one percent increase in the relevant interest rate which lasts for just one period. First, compute the long run impact through the wealth and income channel from the intertemporal budget constraint assuming that all financial wealth is invested at short run horizon:

$$\sum_{s=0}^{\infty}\delta(t+s)(X_{t+s}+C_{t+s}) \equiv \sum_{s=0}^{\infty}\delta(t+s)Y_{t+s}+A_t \tag{24}$$

where $\delta(t+s)=\dfrac{1}{(1+r_t)(1+r_{t+1})\ldots(1+r_{t+s-1})}$ is the discount factor.

Taking the derivative with respect to r_t on both sides, we get to the following expression for the income and wealth effect of a transitory increase in the interest rate on total consumption, C_t+X_t:

$$\frac{dln(C+X)}{dr_t}=\frac{A_t/W_t}{1+r_t}$$

The magnitude of the impact depends on the ratio of short maturity outside assets with respect to total wealth, including human wealth. I do not have a direct estimate of this fraction, but could be assimilated to a fraction of the total stock of capital in the economy. At the individual level, short maturity assets correspond mostly to liabilities against the government (money) or the financial system (quasimoney). However, banks and more generally the financial system transform an important fraction of those assets in long term loans which match long term investment projects at firms, therefore at the aggregate level the fraction of wealth invested in short term assets is much smaller. If, for example, short term assets represent a 25% of the capital stock, and the capital stock capital in turn represents approximately one third of total wealth, then the semielasticity above is 0.08, and a 1% increase in the interest rate induces a permanent fall in total consumption of the order of 0.1%. Longer lasting changes in interest rates multiply arithmetically this estimate.

Consider now the size of the permanent effect induced by the substitution channel for the same transitory one per cent charge in the interest rate. As a first order approximation, the long run effect on future consumption corresponds to the annuity value of the change in current consumption. Empirical estimates of the intertemporal elasticity of substitution typically find a small number, of the order of one or two, so a plausible estimate of the size of permanent effect of a substitution shock in future consumption is again on the order of a tenth of a percentage point, but has the opposite sign. Based on these considerations I adopt the assumption that transitory changes in the interest rate have only transitory effects on consumption.

The third restriction comes from assuming that the price trend is exogenous to the substitution shock in the long run. The most restrictive assumption would be to postulate strict exogeneity of the price process from the other two variables. This would be equivalent to estimate the stochastic properties of the (C_t, K_t) vector after partialing out the long run and short run effects of lagged and contemporaneous prices. In the context of this paper, the assumption of absolute exogeneity of the price trend with respect to the substitution shock would be incorrect as rising or falling inventories of durable goods may anticipate actual changes in prices that are expected by consumers but are not known by the econometrician who uses an incomplete information set. The set of identifying assumptions described above allows this anticipatory role of durable goods.[1]

The three identification assumptions imply the following 3 restrictions on the coefficients of matrix F:

$$C(1)_{11}F_{12} + C(1)_{12}F_{22} + C(1)_{13}F_{32} = 0$$

$$C(1)_{11}F_{13} + C(1)_{12}F_{23} + C(1)_{13}F_{33} = 0$$

$$C(1)_{21}F_{13} + C(1)_{22}F_{23} + C(1)_{23}F_{33} = 0$$

(24)

c. Estimation

First, we estimate parameters Σ and A(L) in (20) after imposing the long run cointegration relationship between the elements of Y_t. From A(L), the impulse response function C(L) that appears in (22) is derived. From C(L) we identify the polynomial lag D(L) that defines the system dynamics associated to structural innovations e_t.

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[1] An implicit assumption in the empirical strategy described above is that all changes in the real interest are transitory or their permanent component have a relatively small variance compared to the other structural shocks in the system. A large variance on permanent changes in the real interest rate would misspecify the model described above, because these kind of shocks would be confused in the other three shocks invalidating the decomposition strategy. The total effect of a permanent change in the interest rate on the vector [C_t, K_t] can be analytically decomposed in three separate channels. The first channel includes the traditional wealth and income effect of changes in the interest rate, that affects current consumption and future consumption of both goods in the same direction. This part is not problematic for the procedure because it would be picked by the structural shock e_{wt}. The second channel is the intertemporal substitution effect that shifts expenditures across time and has significant long run effects on the level of consumption, this channel is not captured by the empirical model described above and it is likely that it would bias the estimated dynamics of both the wealth shock and the substitution shock. The third effect accounts for the impact of permanent changes in the real interest rate on the long run user cost of durable goods. This is a relative price effect that affects the allocation of expenditures across durable and non-durable goods in each period. Although the econometric framework described above does not incorporate this channel, the empirical strategy described above is robust to this possibility, because the presence of these shocks would add a third stochastic trend to the system that would become evident at the time of estimating the cointegration vector.

First, we obtain the moving average representation of the VAR process estimated above:

$$\Delta Y_t = \underbrace{(I - A(L))^{-1} F}_{D(L)} e_t \quad ,$$

Define the matrix of permanent impulse responses with respect to structural shocks as $\overline{D}$:

$$\overline{D} = \overline{C}F = \begin{bmatrix} C_{11}(1) & C_{12}(1) \\ C_{21}(1) & C_{22}(1) \end{bmatrix} F .$$

An estimate of $\overline{C}$ is obtained from the unique lower triangular Choleski decomposition of the variance of permanent level innovations on Y_t with respect to u_t; where the variance term is $\overline{D}Var(u_t)\overline{D}'$. Then an estimate of F is obtained from $\overline{C}^{-1}\overline{D}$.

The identification assumptions allow us to compute the typical dynamic response of consumption and purchases of durables and consumption of non-durables to price, wealth and substitution shocks, and also to recover the underlying history of shocks that have affected an economy.

One way to check the adequacy of the identification assumptions is to compare the history of the substitution shock obtained from the model with variables that should be related to it, like the interest rate, the black market premium and other variables from the financial market that reflect expectations about future prices.

4.4 Empirical Results

4.4.1 Israel

The log-series of non-durable consumption, durable purchases and the stock of durables, all detrended by population, are shown in Figure 4.1. Quarterly data cover the period 1978:1-1992:4. Since the original data contains only the series of durable purchases, additional assumptions are needed to obtain a series for the stock of durables. In particular, a constant depreciation rate, 10 percent a quarter, was assumed, that is the half life of the average durable good is around two years and a half, and the initial stock of durables was obtained using perpetual inventory methods.[2] Throughout the paper the

[2]The steady state ratio of the stock of durables with respect to consumption κ is used to estimate its initial value: $\kappa = \frac{\chi}{\delta + \Delta c/c}$, where χ is the ratio of durable purchases to consumption at steady state and $\Delta c/c$ is the steady state rate of growth, both computed from sample averages.

sensitivity of the results was checked for two alternative values of the depreciation rate (5% and 20%).[3]

Durable purchases represent around 12% of total consumption on average, but this fraction is far from stable. There is a secular trend in durable purchases with respect to non-durable consumption mostly explained by the negative trend in the relative price of durable goods. Also durable purchases are far more volatile than non-durable consumption. The standard deviation of log-changes in durable purchases is almost six times as volatile as its equivalent for current consumption. Therefore at the margin, the contribution of durable purchases to total consumption volatility is of a similar order of magnitude than the contribution of current consumption, despite its relatively small size. (Table 4.1)

The behavior of durable purchases contradicts the implications of the Mankiw permanent income frictionless model described in section 4.2. The estimation of an MA(1) process on changes in durable purchases, Δx_t finds a positive coefficient, but statistically not significantly different from 0, instead of coefficient close to minus one as expected from theory. (Table 4.2)

The relative price of durables shows a substantial downward trend throughout the period. The negative trend that is mostly explained by the real trend appreciation of the Israeli Shekel through the sample period. The tradable component of durable goods consumption is very important as revealed by the close correlation of its price index with an index of tradable prices. The cross-correlation of both series in levels is 0.93 and the correlation in first differences is 0.69. In contrast, an index of relative price of durable to non-durable consumption that uses only the imported goods component shows no significant trend through the period. This fact is important because it lends support to the relevance of exchange rate expectations on the behavior of durable goods, at least the anticipation of a devaluation is a major determinant of the user cost of durable goods.

a. Unit roots and cointegration tests:

I begin reporting the results obtained from ADF tests of the null hypothesis that each series in Y_t follows a unit root process. The alternative hypothesis are in turn that these series are stationary around a constant and a deterministic trend. Table 4.3a shows that neither test can reject the null hypothesis of a unit root in any of the three variables: nondurable consumption, relative price and the stock of durables, nor in durable purchases. Table 4.3a also includes test results for the ex-post measure of the relevant interest rate on the durable good. All of them, except the ADF test without trend, support the stationarity hypothesis.

Table 4.3a also checks the stationarity of the first difference of each variable. All the results, except those of Δk_t, support the stationarity of growth rates. The apparent nonstationarity of Δk_t is

[3] Data on consumption and deflator series for Israel have been kindly provided by Rafi Melnick of the Bank of Israel.

troublesome as it invalidates the assumptions used to derive the I(0) cointegration relationship. It could be a consequence of problems with the imputed stock of durables. Using the wrong level for the initial stock, or a depreciation rate which is too small could induce a trend on the imputed stock of durables. However, using the 20% a quarter depreciation rate does not solve the problem. Since the problem could be related to the imputed durable stock, we investigate the cointegration hypothesis using directly the flow measure.

Theory predicts the existence of at least one cointegrating vector, interpreted as the long run demand for durable goods. The existence of a cointegration vector is tested using the Engle and Granger (1987) approach and the Johansen's MLE approach. Since the initial value for the stock of durable goods is not available, but only an imputed value from the perpetual inventory method, computations are performed truncating the first two years of observations in order to reduce the influence of any error on the initial stock value. An alternative procedure is to conduct the cointegration test directly on durable purchases instead of the durable stock. Under the assumptions of stationarity of the depreciation rate and of the rate of growth of the (actual) durable stock, log-durable purchases should cointegrate with its stock (in logs) and the test based on durable purchases should be equivalent to the test based on the true stock of durables.

Table 4.4a presents the results of a battery of tests of cointegration on the relationship between K_t, C_t and P_t; and between durable purchases, X_t, and C_t and P_t. The critical values for these tests come from Engle and Yoo (1987) and Johansen and Juselius (1990). The results are mixed: those based on the imputed durable stock tend to reject the cointegration hypothesis, while the results base on durable purchases are more supportive. The p-values of the maximal eigenvalue and the trace test based on the MLE procedure reject the hypothesis of no cointegration relationship with p-values of 0.80 and 0.95 respectively, while results based on DF and augmented DF tests are unable to reject the no cointegration hypothesis at the 10% significance level. Tests based on durable purchases are more supportive for the alternative hypothesis of one cointegration relationship, the p-values for the maximal eigenvalue test and the trace test are 0.90 and 0.95 respectively, but the values of the DF and augmented DF are below the 0.90 p-value.

b. Dynamics:

Since the existence of cointegration is not clear, three alternative models are studied in this section. The first model includes the durable stock, current consumption, and the relative price; and imposes the MLE cointegration relationship estimated in Table 4.4a. The second model includes the same three variables without imposing the cointegration relationship, while the third model uses durable purchases instead of the durable stock and imposes the cointegration relationship estimated in Table 4.4a (model III). The cointegration relationship is imposed by replacing one of the variables in first

differences by the residual of the long run relationship. If the cointegration relationship is imposed two lags are included, while six lags are allowed when the model does not include the cointegration relationship in order to capture long term relationships between variables.

b.1 Model I

Table 4.5a summarizes some of the results of the VAR system for the first model. Non-durable consumption, C_t, appears to follow a martingale, no lagged variable appears significantly on its equation, therefore Granger causality tests are rejected. Prices changes are more predictable, lagged values of changes in C_t and P_t appear significantly in the price equation. The third variable, the error correction term is highly predictable, due to the gradual adjustment of the durable stock to the shocks in the system.

The matrix of residuals, not shown, indicates that there is significant contemporaneous correlation across equations, so the set of identification assumptions used to disentangle the disturbances is key to interpret them.

Figure 4.3 shows the impulse response functions for the set of identification assumptions described in section 4.3, where price shocks are restricted to have no long run impact on non-durable consumption, C_t, and substitution shocks are restricted to have no long run impact on either non-durable consumption or its relative price. A confidence band of ±2 standard deviations is also included to asses the robustness of the results.[4] There are 3 columns and 4 rows in Figure 4.3, each column represents the impact of one of the shocks -- e_{wt}, e_{pt}, and e_{st} respectively--, and each row represents one of the four variables -- P_t, C_t, K_t and $\dot{X}_t$-- respectively.

The response of non durable consumption with respect to the wealth shock is almost immediate, and indeed is the only shock that elicit some type of response in non-durable consumption. This was expected because none of the variables in the VAR system had any predictive power for consumption growth. Durable purchases respond contemporaneously to the wealth shock by 3.2% as compared to 2.1% in non durable purchases, but continues to increase to 7.2% on the next quarter and stays above the 2% level for the next 6 quarters. Therefore, there is an agglomeration of durable purchases at the beginning of adjustment period which partially explains its high volatility with respect to the rest of consumption. However, the stock of durables builds up slower than would be implied by the frictionless model. The point estimates of the adjustment process of K_t indicate it takes about six to eight quarters to complete most of the stock adjustment.

Looking at the variance decomposition of series in Table 4.7, the wealth shock accounts for most of the variance in non-durable consumption, and a significant component of the variance in the durable stock and durable purchases. However, for the latter variables the fraction varies according to the

[4] Confidence bands are obtained through bootstrapping techniques (500 draws)

horizon: in the short run, it accounts for approximately 30% of the conditional variance of each variable, but in the long run it accounts for nearly 80% of the unconditional variance of these variables.

The wealth shock induces a permanent response on prices, which, however, is not statistically different from 0 at the 5% significance level. One explanation of this effect is that price shocks are closely correlated with movements in the real exchange rate that in turn are associated to important macroeconomic developments like changes in the terms of trade, changes in government expenditure and others that on itself have significant wealth effects.

A price shock of approximately 4% has no effect on non-durable consumption at any horizon. In the case of durable purchase, the effects start after a few quarters and they affect negatively durable purchases in minus 3%. The durable stock declines gradually towards its long run value. Most of the variance of the price variable is accounted by its own shock, and very little of the variance in the other variables is accounted by this shock.

Finally, the substitution shock on durable purchases identifies surges or depressions in durable purchases not accompanied by changes in C_t. It accounts for most of the short run -- conditional-- variance in durable purchases and the durable stock, 70%, while unconditionally only a 10% and 15% of the variance respectively is accounted by this shock. Interestingly enough, the substitution shock anticipates changes in relative prices, that is booms (recessions) in durable purchases give an early warning of future price increases (falls), however the predictive power is not significant as revealed by the variance decomposition series. Only a 7% of the variance is explained by this component. (Table 4.7).

b.2 Model II

The impulse response functions associated to the second model, that includes the same variables than model I, but does not impose the cointegration relationship appear in Figure 4.3. The identification of the shocks is achieved using a triangular decomposition of contemporaneous disturbances, that is the

price shock has no contemporaneous effect on C_t, and the intertemporal substitution shock has no contemporaneous effect on P_t nor in C_t. The impulse response functions associated to the wealth shock identified this way are very similar to those in Figure 4.3, they look more unstable because they include more lags than those in Figure 4.3, and they do not include a long run relationship. The adjustment of the durable stock is slow, but still durable purchases agglomerate in the first part of the adjustment period.

The price shock induces a once for all increase in the relative price, and durable purchases decline slowly to reach a trough by the second year and then slightly recover towards their original level. Correspondingly, the stock of durables declines slowly too.

The third shock identified here as a shock that affects durable purchases without affecting contemporaneously P_t nor C_t, turns out to be very similar to the e_{st} shock estimated in model I using long run restrictions. As in model I, it anticipates increases in prices and its effects on X_t and K_t is mostly transitory. The last characteristic is important since in contrast to model I, this is not imposed to the data in model II. However, the substitution shock is now associated to a permanent negative effect on non durable consumption, while in model I it was restricted to have no permanent effect.

b.3 Model III

Figure 4.5 shows the results associated to model III. The difference is that in this case the VAR is estimated directly on durable purchases instead of changes in the imputed durable stock, so the results are not contaminated by specification errors in the depreciation rate or in the initial stock of durables. The dynamics identified by the system are almost identical to those appearing in model I, so they look robust to the assumptions used to construct K_t.

Summarizing the results, the empirical dynamics show that the adjustment of durable goods to permanent shocks is relatively slow and is characterized by a period of overshooting in durable purchases, that reflects the stock adjustment process. It takes between four to six quarters to complete most of the adjustment. Also, the model identifies important transitory fluctuations in K_t and X_t, that help to explain why the volatility of durable purchases is much larger than that of C_t. Overall, the estimated dynamics seem to be robust and error bands are narrow despite a relatively short sample (56 quarters), the sampling variability of durables and non-durables purchases compensates the short length of the estimation period.

Where do the transitory fluctuations identified by the model come from? As discussed in Section 4.3, they may be explained by transitory fluctuations in the interest rate relevant for durable goods that shifts intertemporally durable purchases, but there are other explanations too: stationary taste shocks or stationary measurement error.

One independent test of the adequacy of this identifying assumption is obtained running a regression of the substitution shock against other variables related to the expected interest rate. In the standard model, the expected interest rate would be a sufficient statistic to capture substitution effects. In practice, the available measure of the interest rate is a noisy ex-post measure of this variable, particularly large fluctuations in the inflation rate make very hard to obtain an estimate of the expected rate. The expected measure is obtained instrumenting the ex-post measure on lagged variables of itself, the black market premium and a measure of capital flight obtained from Pesach and Razin (1992). The inclusion of innovations to the black market premium and capital flight attempts to capture devaluation expectations which are important since the tradable component of durable goods is large.

The results of the regression in Table 4.8 are encouraging, coefficients have the expected signs,

and although they are not individually significant because they are correlated through the sample, overall they are very significant, explaining the 33% of the variability of the substitution shock. In contrast, running the same regression but replacing the substitution shock as the dependent variable by the wealth shock and the price shock respectively, shows no significance at all. In conclusion, exchange rate expectations are important to understand the behavior of durable purchases, and the substitution shock identified above is related to them.

c. Durable purchases and the 85' stabilization plan

The complexity of the dynamics revealed by the empirical estimates indicates how difficult is to provide the right account of the developments in durable purchases just from looking to its series. The structural model described above provides a more adequate tool to disentangle the particular shocks hitting the economy in any given period. In particular, we use the model to provide an historical account of the boom observed after the stabilization effort started in 1985:3.

After more than a decade of scalating inflation and recurrent balance of payments crisis, in July 1985 the Israeli government started an stabilization effort to reduce inflation. One of the key elements of the program was the peg of the exchange rate after an initial compensatory devaluation, as well as the use of other nominal anchors on wage and credit growth, price controls, and more structural measures to reduce the fiscal budget deficit. Inflation declined rapidly from the 300 percent level in annual terms exhibited until the second quarter of 85, but stayed at the 20% level, while the nominal exchange rate was pegged implying a trend real appreciation of the Israeli Shekel. Soon after the stabilization effort started, instead of a recession there was a big increase in consumption, 14% from 1985 to 1986, particularly concentrated on durable purchases and inventory accumulation of imported goods. Bruno(1988, 199x) attributes part of this boom to expectations of price increases, particularly on imported goods, after the partial relaxation on price controls initiated through 1986. After a decade of experience with recurrent balance of payment crisis and revaluation/devaluation cycles, it was natural to expect that as the exchange rate appreciated and competitiveness eroded, the government would be forced to devalue the nominal exchange rate once again.

Many authors have noticed the massive increase in the imports of durables through exchange rate based programs. Dornbusch (1986) suggest it was crucial in explaining the peso collapse in Chile in the early 80's. Calvo (1986) and Calvo and Vegh (1990) examine the implications for consumption and activity of exchange rate freezes and trade reforms that are not fully credible. He shows that intertemporal substitution effects induced by expected movements in the exchange rate can explain the pattern of expansion/depression found in ERBS.

Drazen (1990) focuses particularly on durable goods. He presents data on durable imports for Argentina, Chile, Israel and Mexico through the eighties when each of these countries implemented an

ERBS, showing that in each case there is a large increase a few quarters after the program stabilization starts. Then he builds a model where intertemporal substitution effects are crucial to explain the dynamics of durable consumption. If the stabilization program is not fully credible, and for simplicity is expected to collapse at some definite date there will be a run just before the collapse. This may be the result of hedging against devaluation when there is no free access to foreign exchange or in anticipation to the imposition of import restrictions following a Balance of Payments crisis. Introducing uncertainty about the timing of the collapse will explain a wave of speculation instead of a single run. He suggest as evidence of the relevance of intertemporal substitution effects the correlation between the black market premium and the surge in durable imports in mid 87, but the linkage is not assessed formally.

A different hypothesis is suggested by De Gregorio, Guidotti and Vegh (1993) which suggest that the wealth effect associated to inflation reduction leads to an aggregate consumption boom as all consumers replenish their stock of durables at the beginning of the period, leading to an agglomeration of purchases. The agglomeration effect is amplified because transaction costs lead to infrequent and large adjustments at the consumer level. The macro wealth shock coordinates all consumers to go at the same time to the market, and once they have replenished their stock, a recession comes.

Figure 4.6 shows the historical decomposition of the shocks hitting the system between 85:3 and 88:4, the solid line represent the actual series, the long dashed line represent the expected evolution of the variable and the short dashed line represent the effects of the shock in the system. The estimates for this figure come from model III, but very similar accounts are obtained from the other two models.

The estimates indicate that most of the expansion observed in durables from 86 on is a consequence of wealth shocks, which in practice correspond roughly to the white noise innovation to consumption of non-durables. Durable purchases and non-durable consumption adjust simultaneously to the wealth shock as identified by model III. However, towards the second half of 1986, there is a surge in durable purchases of approximately 15%, which corresponds to innovations associated to the intertemporal substitution shock, and interestingly they precede the devaluation of the Shekel in January of 1987, the first one since the program started in July 1985. Through 1987 and 1988, dynamics associated to the substitution shock start playing a more important role in the evolution of durable consumption. Purchases of durable goods stay high during these two years and even continue increasing despite the dynamics associated to wealth shocks would predict them to stay constant or decrease. The continuation of the build up of durable stocks is associated to the transitory or substitution shock, and it is consistent with the abandonment expectation hypothesis stressed by Calvo (1986, 1991, 1992) and Drazen (1990). Particularly, the large increase in durable purchases through the second semester of 1988 is fully explained by intertemporal substitution shocks, and precedes the new devaluation of the Shekel determined on December of 1988.

Substitution effects are important in a later stage as the government delayed for political reasons a necessary and expected devaluation. As described by Bruno and Meridor(199x): "...the Bank of Israel advocated another alignment of 6-7% in March 1988,... However, with elections approaching, the Minister of Finance adopted a "wait and see" attitude: at no stage during most of 1988 was it made clear to the business sector that there would be no devaluation. At the same time no alignment was in fact made until after elections, in December 1988,...and only after very heavy capital outflows." Devaluation expectations explain why it took longer for durable purchases to return to normal levels as compared to other episodes of wealth shocks.

4.4.2 Chile

The log-series of non-durable consumption, durable purchases and the stock of durables, all detrended by population growth, are shown in Figure 4.2. Quarterly data cover the period 1980:1-1994:1.[5] Since the original data contains only the series of durable purchases, the same methodology than in the case of Israel was used to obtain a series for the stock of durables. However, the results were unsatisfactory, similarly to the case of Israel, the stock of durables was estimated to be an I(2) process, so we continued working with the flow measure only.

Durable purchases represent a 5% of total consumption on average, however the range of fluctuations is enormous from 2% to 15% of total consumption. The sample period starts with the consumption boom of 81, when durable purchases reached peak levels, and then shows the severe impact on durable purchases of the recession starting towards the end of 1981. The durable stock fall continues until the second quarter of 1986, when both durable purchases and current consumption start showing a steady recovery. Durable purchases are far more volatile than non-durable consumption, the standard deviation of log-changes in durable purchases is almost five times as volatile as its equivalent for current consumption, so despite its relatively small size, the contribution of durable purchases to total consumption volatility is significant.

As in the case of Israel, the relative price of durables moves in parallel with the real exchange rate. The period starts with a substantial increase in the relative price of durable goods associated to the real depreciation of the Chilean peso after the abandonment of the peg against the dollar in mid-82, the positive trend continues until 1986 and becomes slightly negative in 1987. Prices fall strongly in 1988 as the peso started appreciating and import taxes were reduced, this negative trend continues until 1989.

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[5] The original data used in this section has been constructed by S. Lehmann (1991) for the 1980-1989 period, and extended until 1994:1. Unfortunately, it has not been possible to extend the sample before 1980, due to the lack of dissagreagated data on consumption before 1980:1.

a. Unit roots and cointegration tests:

ADF tests cannot reject the null hypothesis that each series in Y_t follows a unit root process. Table 4.3b shows the results of these tests and none of them can reject at the 10% level the null hypothesis of a unit root.

Table 4.4b shows the results of the two step Engle and Granger (1987) approach and the Johansen's MLE approach. The results are mostly consistent with the existence of a cointegration relationship linking X_t, C_t and P_t. The p-values of the maximal eigenvalue and the trace test based on the MLE procedure reject the hypothesis of no cointegration relationship with p-values above 99% , while the p-values of the DF and augmented DF tests are marginally significant at the 10% level.

One problematic aspect is the difference of the elasticities estimated by the MLE procedure and the two step procedure. As shown in table 4.4b the consumption elasticity obtained from the MLE approach doubles that from the two step procedure, while the MLE price elasticity is one half of the two step price elasticity. Since the results based on the MLE procedure for durable purchases are more sensible than those based on the two step procedure, I only report them.

b. Dynamics

Table 4.9 summarizes some of the results of the VAR system for a lag order of two. Fluctuations in durable purchases and relative prices, ΔP_t and ΔX_t, are highly predictable through lagged values, showing that the adjustment of the durable stock towards its long run relationship is slow. Estimation of an MA(1) model for ΔX_t finds a positive and significant coefficient, instead of a coefficient close to minus one as expected from the simple Mankiw model. The matrix of innovations shows that there is significant contemporaneous correlation across equations, so the set of identification assumptions used to disentangle the disturbances is key to interpret them.

Figure 4.6 shows the impulse response functions for the set of identification assumption described in section 4.2, that allows wealth shocks to have long run effects on P_t. The adjustment of non durable consumption is almost immediate and permanent, while the adjustment of durable purchases shows some evidence of overshooting as the stock adjustment proceeds. Purchases reach a peak two quarters after the wealth shock is observed and stay high for the next four quarters, gradually declining towards its long run level. The effect is sizable, a 3% increase in nondurable consumption is associated with an increase of the order of 20% in durable purchases, however the total effect includes both a wealth and a price effect. Indeed, there is a strong price effect which we attribute to the correlation of wealth shocks and other events in the economy like terms of trade improvements that simultaneously appreciate the currency in real terms and increase permanent income. The wealth shock accounts for almost 100% of the consumption variance, and close to 68.2% of the variance of durable purchases in the long run, but a smaller fraction in the short run: 38.4%.

The price shock has almost no impact on non-durable consumption and cause an immediate fall in durable purchases, with a mild evidence of overshooting, but overall the implied stock adjustment is very slow. The price shock accounts for a 30 percent of the unconditional variance of durable purchases, and 41 percent of the conditional 1-step variance. Finally, the substitution shock, e_{st}, accounts for a 21% of the conditional 1-step variance of durable purchases, but it is short lived and after a year, two thirds of the original shock have disappeared. One intriguing aspect of this shock is that the increase in durable purchases is accompanied by a contemporaneous and transitory - by construction- increase in P_t, so it anticipates a decrease in the relative price of durable goods. Obviously, this is at odds with the interpretation of the identification assumptions given in section 4.3.

The regression of the substitution shock against financial variables-- the interest rate (expected) and the black market premium on foreign currency-- has the expected pattern of signs, and overall explain approximately 27% of the variability of the substitution shock. (Table 12) In contrast, the same variables are not significant in a similar regression replacing the wealth shock and the price shock as the dependent variables.

Unfortunately, in the case of Chile data is not available to investigate durable purchases dynamics through the 1979-82 ERBS episode. A later surge in durable purchases is observed towards the end of the eighties, and simultaneously an increase in the black market premium. The boom coincides with the shift of power to the newly elected democratic government, which until then had been very critical of economic policies put in place by the military administration, creating some uncertainty about the future course of economic policy, and particularly about trade import taxes.

4.5 Conclusions

This paper has characterized the behavior of durable consumption in Chile and Israel using a structural VAR approach. It has shown that durable purchases are much more volatile than non durable consumption, and volatility comes from the dynamics of stock adjustment with respect to wealth shocks and substitution shocks. The speed of adjustment on the stock of durables is shown to be slow, much slower than predicted by the standard model with no adjustment costs (Mankiw (1985)), because durable purchases appear to be positively correlated in the long run, contradicting the negative correlation predicted by the standard model. Furthermore, the substitution shock, which in practice corresponds to surges or depressions in durable purchases not accompanied by changes in non-durable consumption, is shown to be associated to financial variables like the black market premium and measures of capital flight showing the importance of speculative factors in the timing of durable purchases. This lends support to explanations of the boom in durable purchases that acompanies ERBS based on abandonement expectations. The application of the empirical model to disentangle the behavior of durable purchases after the Israeli

stabilization effort of 1985 shows that "substitution" effects play an important role in the dynamics of durable purchases, particularly through the second half of 1986 and 1988, both episodes preceding expected devaluations.

Table 4.1
Non Durable (c) and Durable (x) Consumption Basic Statistics

Statistic	Israel	Chile	Mexico
$E(\Delta c)$	0.5%	0.4%	0.5%
$E(\Delta x)$	2.1%	-1.5%	0.4%
$\sigma(\Delta x)$	11.5%	24.8%	5.0%
$\sigma(\Delta x)/\sigma(\Delta c)$	5.2	7.5	2.2
$\rho(\Delta c_t, \Delta c_{t-1})$	0.18	0.02	0.10
$\rho(\Delta x_t, \Delta x_{t-1})$	0.06	0.30	-0.24
n.obs.	60	53	43

Notes:
(1) Seasonally adjusted data. Per capita.
(2) Durable series for Chile corresponds to durable imports.

Table 4.2
Univariate Process: Δx_t

Model	Israel	Chile	Mexico
ARIMA(0,1,1)			
ma(1)	0.08	0.26	0.09
	(0.58)	(0.13)	(0.16)
ARIMA(1,1,1)			
ar(1)	-0.72	0.31	0.64
	(-0.11)	(0.43)	(0.63)
ma(1)	1.03	-0.10	-0.52
	(0.03)	(0.43)	(0.70)
n.obs.	57	50	42

Table 4.3
Unit Root Tests

a. Israel

Variable	ADF(4)	ADF(4): trend	S-W(4)	S-W(4): trend
c_t	-2.63	-0.68	-12.59	-1.13
Δc_t	-2.92	-2.92	-41.64	-41.64
k_t	-2.14	-0.99	-9.67	-0.97
Δk_t	-1.98	-1.99	-11.93	-11.77
p_t	-3.14	-0.94	-17.77	-1.66
Δp_t	-3.19	-3.25	-70.65	-70.01
x_t	-2.06	-0.91	-12.03	-2.76
Δx_t	-3.62	-3.67	-44.96	-44.83
ik_t	-3.01	-3.02	-34.19	-30.85
Δik_t	-3.26	-3.28	-73.65	-73.52
critical values				
10%	-3.12	-2.57	-24.1	-11.2
5%	-3.41	-2.86	-27.9	-14.1
1%	-3.96	-3.43	-35.5	-20.6

b. Chile

Variable	ADF(4)	ADF(4): trend	S-W(4)	S-W(4): trend
c_t	-2.82	-0.78	-16.42	-0.42
Δc_t	-2.86	-2.63	-57.49	-57.49
p_t	-2.09	-1.65	-5.41	-4.07
Δp_t	-2.41	-1.84	-27.38	-25.06
x_t	-3.04	-1.81	-7.79	-5.43
Δx_t	-2.99	-3.25	-34.53	-32.7
ik_t	-3.03	-2.13	-26.92	-26.93
Δik_t	-5.62	-5.60	-60.25	-60.2
critical values				
10%	-3.12	-2.57	-24.1	-11.2
5%	-3.41	-2.86	-27.9	-14.1
1%	-3.96	-3.43	-35.5	-20.6

Table 4.4
Long Run Properties: Cointegration

a. Israel

	Model I $k_t = \alpha_0 + \alpha_1 c_t + \alpha_2 p_t$		Model II $k_t = \alpha_0 + \alpha_1 c_t + \alpha_2 p_t + \beta t$		Model III $x_t = \alpha_0 + \alpha_1 c_t + \alpha_2 p_t$		Model IV $x_t = \alpha_0 + \alpha_1 c_t + \alpha_2 p_t +$	
	MLE	OLS	MLE	OLS	MLE	OLS	MLE	OL
param.								
α_1	1.27	1.69	-0.321	0.86	1.58	1.72	1.71	2..
		(0.25)		(0.33)		(0.35)		(0.4
α_2	-0.53	-0.43	.147	0.00	-0.34	-0.39	-0.63	-0..
		(0.12)		(0.16)		(0.17)		(0.2
cointegration tests								
λ_{max}	20.80		18.47		19.67		17.57	
trace	31.69		33.76		30.27		35.89	
df		-2.49		-2.47		-2.20		-2.
adf(4)		-2.11		-1.78		-2.31		-2.
n.obs.	60	60	60	60	60	60	60	

b. Chile

	Model III $x_t = \alpha_0 + \alpha_1 c_t + \alpha_2 p_t$		Model IV $x_t = \alpha_0 + \alpha_1 c_t + \alpha_2 p_t + \beta t$	
	MLE	OLS	MLE	OLS
param.				
α_1	2.77	4.37	1.93	7.91
		(0.25)		(0.67)
α_2	-0.77	-0.43	-1.29	0.76
		(0.12)		(0.33)
coint. test				
λ_{max}	20.80		18.71	
trace	31.69		36.24	
df		-2.49		-3.03
adf(4)		-2.11		-2.12

Table 4.5
Short Run Dynamics: VAR(p) results

a. Israel

	Model I			Model II			Model III		
	$\Delta Y_t = A(L)\Delta Y_{t-1}+\theta Z_{t-1}+u_t$			$\Delta Y_t = A(L)\Delta Y_{t-1}+ u_t$			$\Delta Y_t= A(L)\Delta Y_{t-1}+\theta Z_{t-1}+u_t$		
exclussion tests	Δp_t	Δc_t	Δk_t	Δp_t	Δc_t	Δk_t	Δp_t	Δc_t	Δx_t
$\{ \Delta p_{t-1}, \Delta p_{t-2} \}$	0.01	0.79	0.16	0.01	0.75	0.74	0.01	0.64	0.02
$\{ \Delta c_{t-1}, \Delta c_{t-2} \}$	0.05	0.62	0.01	0.05	0.61	0.02	0.04	0.47	0.14
$\{ \Delta k_{t-1}, \Delta k_{t-2} \}$	0.52	0.66	0.00	0.41	0.65	0.00	0.15	0.82	0.42
z_{t-1}	0.38	0.96	0.00	-	-	-	0.09	0.70	0.01
TxR^2	16.71	7.30	53.89	16.07	7.30	53.21	18.13	6.96	9.50
nobs	57	57	57	57	57	57	57	57	57

able 4.6
Impulse Response Function

a. Israel

steps	e_w				e_p				e_s			
	c_t	p_t	k_t	x_t	c_t	p_t	k_t	x_t	c_t	p_t	k_t	x_t
1	.021	-.012	.004	.032	.003	.050	.001	.009	.001	-.014	.006	.052
2	.025	.003	.012	.072	.001	.031	.002	.007	.002	-.005	.011	.042
3	.024	.013	.019	.069	.001	.040	.002	.001	.001	-.005	.013	.030
4	.023	.011	.024	.062	.000	.038	.000	-.013	.001	-.004	.014	.022
5	.023	.011	.028	.052	.000	.040	-.002	-.019	.000	-.004	.014	.014
6	.022	.012	.030	.043	.000	.041	-.006	-.025	.000	-.003	.013	.001
7	.022	.012	.030	.036	.000	.042	-.008	-.028	.000	-.002	.012	.003
8	.022	.013	.030	.030	.000	.043	-.011	-.030	.000	-.002	.010	.000
12	.022	.014	.026	.017	.000	.044	-.019	-.032	.000	.000	.005	-.005
16	.021	.015	.022	.015	.022	.044	-.023	-.028	.056	.000	.001	-.004

Notes: (1) Identification ass.: long run restrictions (e_p has no long run effects on c_t, e_s has no long run effects on c_t, p_t or k_t).

Table 4.7
Forecast Variance Decomposition

a. Israel

steps	c_t				p_t				x_t			
	σ(c)	e_w	e_p	e_s	σ(p)	c_w	c_p	c_s	σ(x)	e_w	e_p	e_s
1	0.05%	97.8	2.0	0.2	0.28%	5.1	88.0	6.9	0.38%	26.9	2.1	71.0
2	0.21%	98.8	0.7	0.4	0.70%	1.2	93.7	5.2	1.99%	54.3	1.3	44.4
4	0.87%	99.4	0.3	0.3	2.63%	0.9	96.2	3.0	7.66%	72.1	0.0	27.8
8	3.32%	99.8	0.1	0.1	11.11%	3.6	95.1	1.4	19.33%	81.1	5.0	13.9
∞	5.07%	99.9	0.0	0.0	18.06%	4.7	94.5	0.8	23.22%	78.9	10.8	10.3

Notes: (1) Identification ass.: long run restrictions (e_p has no long run effects on c_t, e_s has no long run effects on c_t, p_t or k_t).

Table 4.8
Financial Variables and Structural Innovations

a. Israel

innovations	e_w	e_p	e_s
black market premium	-5.28	0.25	2.26
	(5.66)	(4.22)	(3.53)
interest rate	-0.02	4.08	-1.91
	(9.25)	(6.88)	(5.78)
cap flight (x1000)	0.39	0.46	0.69
	(0.64)	(0.48)	(0.40)
R^2	0.023	0.064	0.338
exclussion test (p-value)	0.77	0.68	0.05
n.obs.	21	21	21

Notes: (1) Identification ass.: long run restrictions (e_p has no long run effects on c_t, e_s has no long run effects on c_t, p_t or k_t).

Table 4.9
Short Run Dynamics: VAR(p) results

b. Chile

	Model III		
	$\Delta Y_t = A(L)\Delta Y_{t-1}+\theta Z_{t-1}+u_t$		
exclussion tests	Δp_t	Δc_t	Δx_t
$\{ \Delta p_{t-1}, \Delta p_{t-2} \}$	0.22	0.88	0.41
$\{ \Delta c_{t-1}, \Delta c_{t-2} \}$	0.03	0.62	0.48
$\{ \Delta x_{t-1}, \Delta x_{t-2} \}$	0.13	0.21	0.58
z_{t-1}	0.00	0.91	0.03
TxR^2	23.46	5.50	12.00
nobs	50	50	57

Table 4.10
Impulse Response Function

b. Chile

	e_w			e_p			e_s		
steps	c_t	p_t	x_t	c_t	p_t	x_t	c_t	p_t	x_t
1	2.9%	-0.4%	12.9%	0.0%	2.6%	-13.2%	-0.1%	1.9%	9.5%
2	3.1%	-1.7%	19.0%	-0.6%	3.1%	-16.0%	0.4%	2.5%	6.7%
3	3.5%	-2.6%	23.5%	-0.5%	3.5%	-16.5%	0.4%	1.6%	3.7%
4	3.6%	-3.2%	23.7%	-0.5%	4.0%	-15.4%	0.3%	0.8%	3.2%
5	3.6%	-3.9%	22.8%	-0.4%	4.6%	-13.8%	0.2%	0.6%	3.2%
6	3.5%	-4.6%	21.3%	-0.4%	5.0%	-12.6%	0.2%	0.5%	2.7%
7	3.4%	-5.1%	19.8%	-0.3%	5.3%	-11.6%	0.1%	0.4%	1.9%
8	3.3%	-5.5%	18.6%	-0.2%	5.5%	-10.7%	0.1%	0.3%	1.3%
12	3.1%	-6.2%	15.3%	-0.1%	6.0%	-8.6%	0.0%	0.1%	0.4%
16	3.0%	-6.4%	14.3%	0.0%	6.1%	-8.0%	0.0%	0.0%	0.1%

Notes: (1) Identification ass.: long run restrictions (e_p has no long run effects on c_t, e_s has no long run effects on c_t, p_t or k_t).

Table 4.11
Forecast Variance Decomposition

b. Chile

steps	c_t				p_t				x_t			
	σ(c)	e_w	e_p	e_s	σ(p)	e_w	e_p	e_s	σ(x)	e_w	e_p	e_s
1	0.09	99.9	0.0	0.1	0.10	1.3	62.6	36.1	4.31	38.4	40.7	20.9
2	0.37	98.8	0.8	0.4	0.55	7.6	56.8	35.6	21.33	47.7	39.9	12.3
4	1.76	98.1	1.4	0.6	2.79	22.0	61.2	16.7	105.27	59.5	35.4	5.1
8	7.40	98.6	1.1	0.4	19.23	37.7	58.5	3.9	391.96	66.6	30.7	2.7
∞	-	99.0	0.8	0.3	-	42.0	56.0	2.0	-	68.2	29.8	2.0

Notes: (1) Identification ass.: long run restrictions (e_p has no long run effects on c_t, e_s has no long run effects on c_t, p_t or k_t).

Table 4.12
Financial Variables and Structural Innovations

b. Chile

innovations	e_w	e_p	e_s
black market premium	2.88	2.45	1.30
	(3.27)	(2.66)	(2.24)
interest rate	23.54	-21.46	-38.73
	(11.98)	(12.51)	(10.28)
R^2	0.058	0.058	0.32
exclussion test (p-value)	0.26	0.27	0.00
n.obs.	31	31	31

Notes: (1) Identification ass.: long run restrictions (e_p has no long run effects on c_t, e_s has no long run effects on c_t, p_t or k_t).

Figure 4.1: Israel 1979-1992

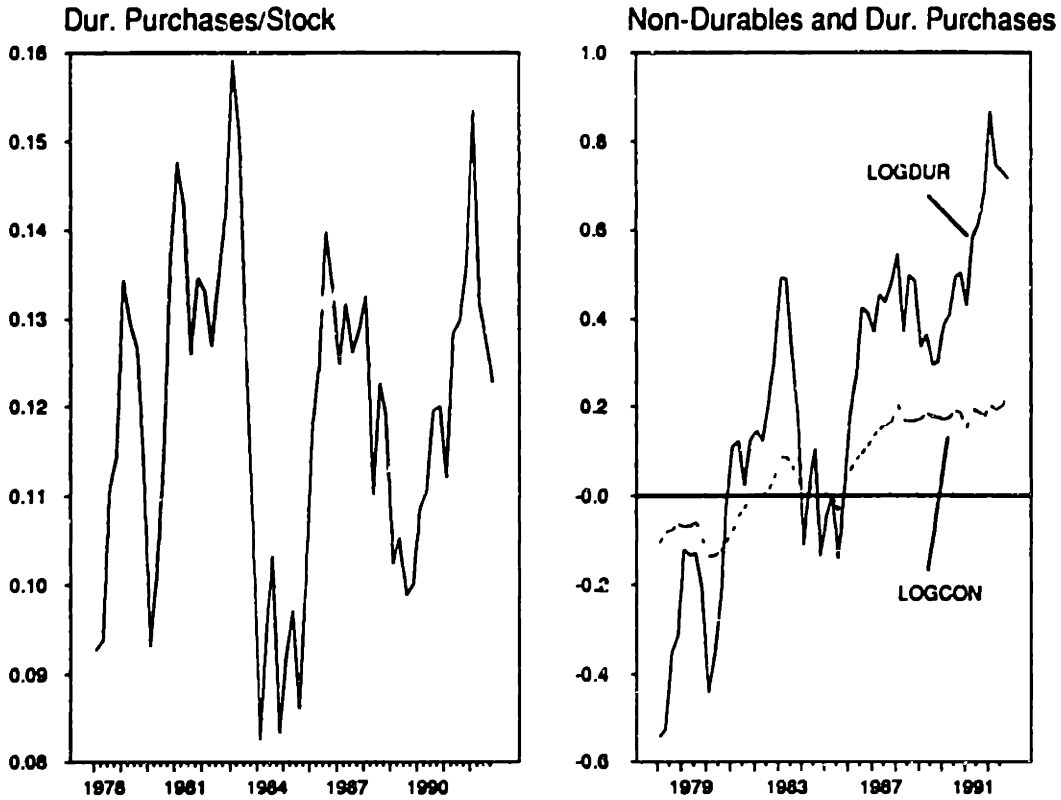


Figure 4.2: Chile 1980-1993

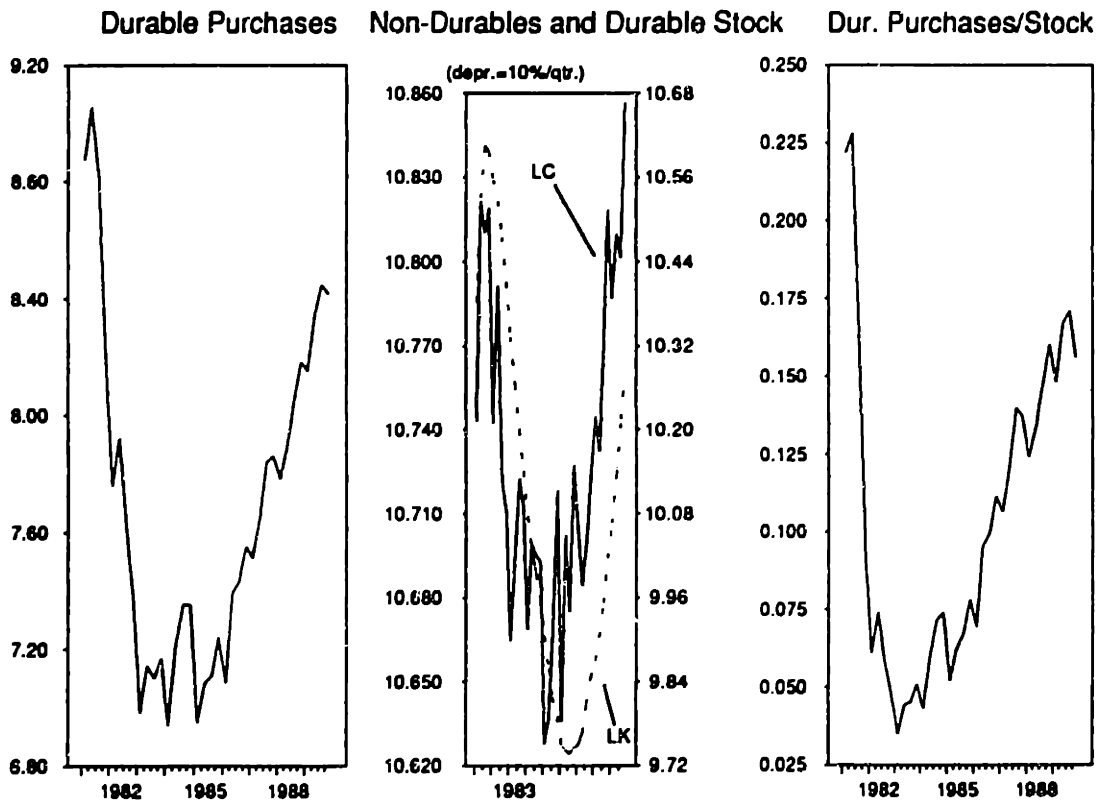


Figure 4.3: Israel
Impulse Response Function Model I

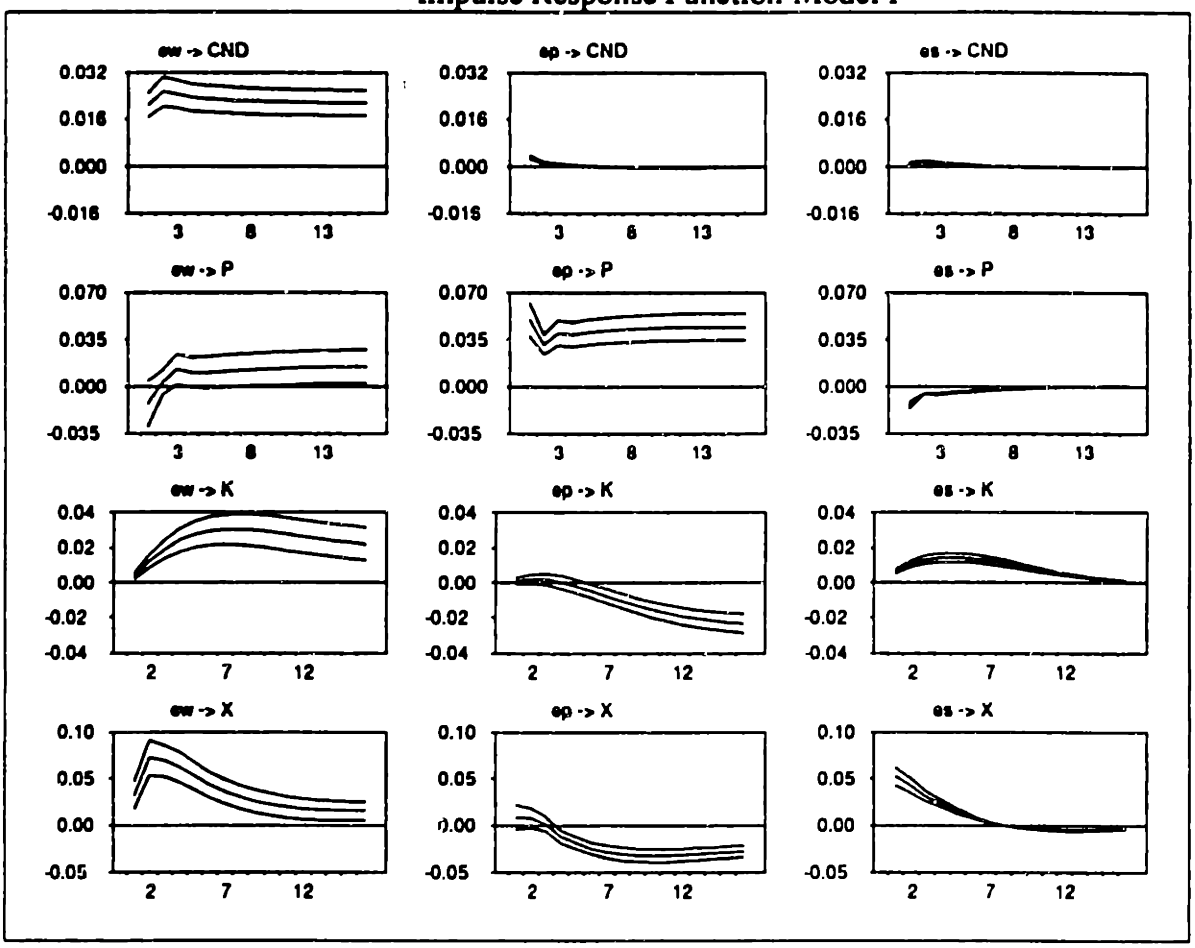


Figure 4.4: Israel
Impulse Response Function Model II

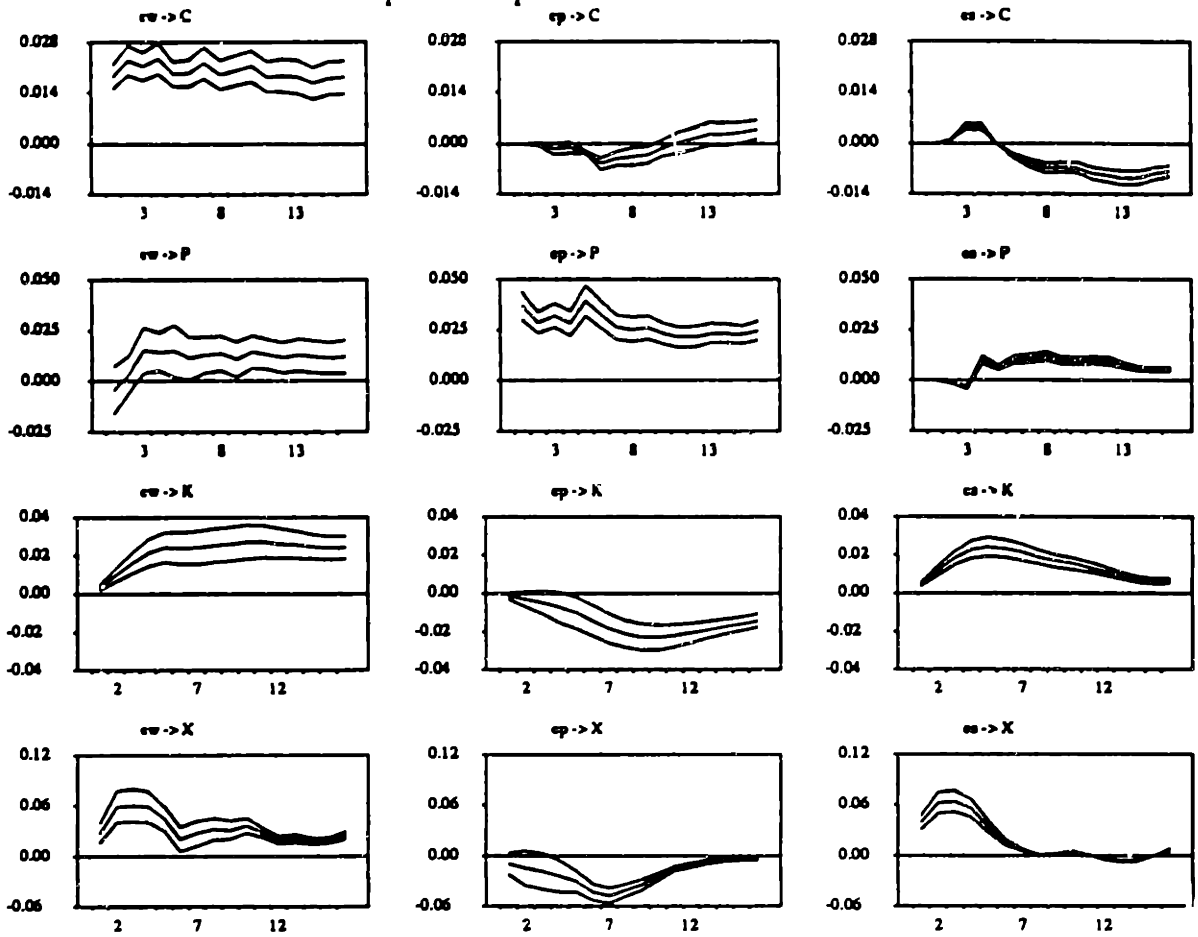


Figure 4.5: Israel
Impulse Response Function Model III

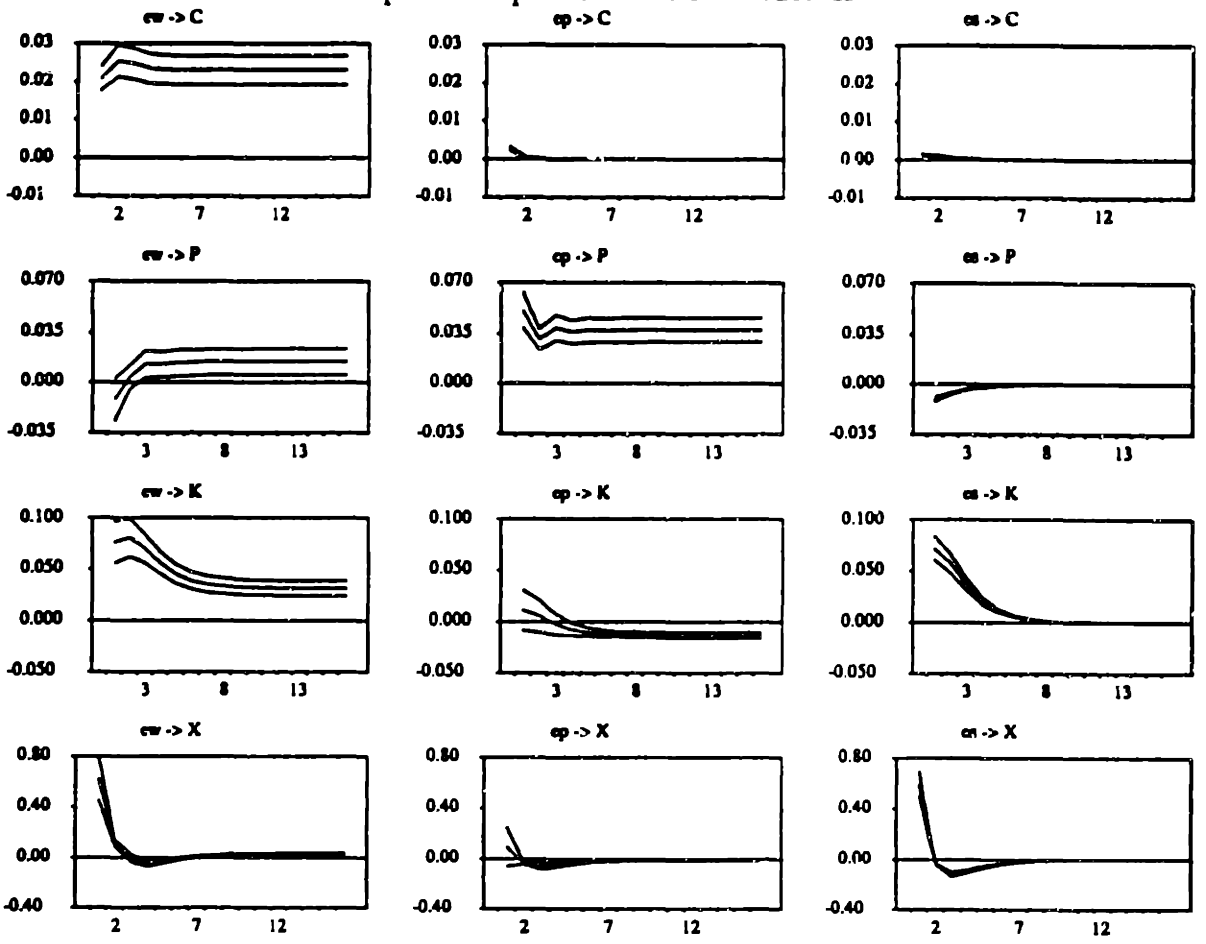


Figure 4.6a: Israel
Durable Purchases: shock history from 1985:3-1988:4
Base Forecast at 1985:2 Model III

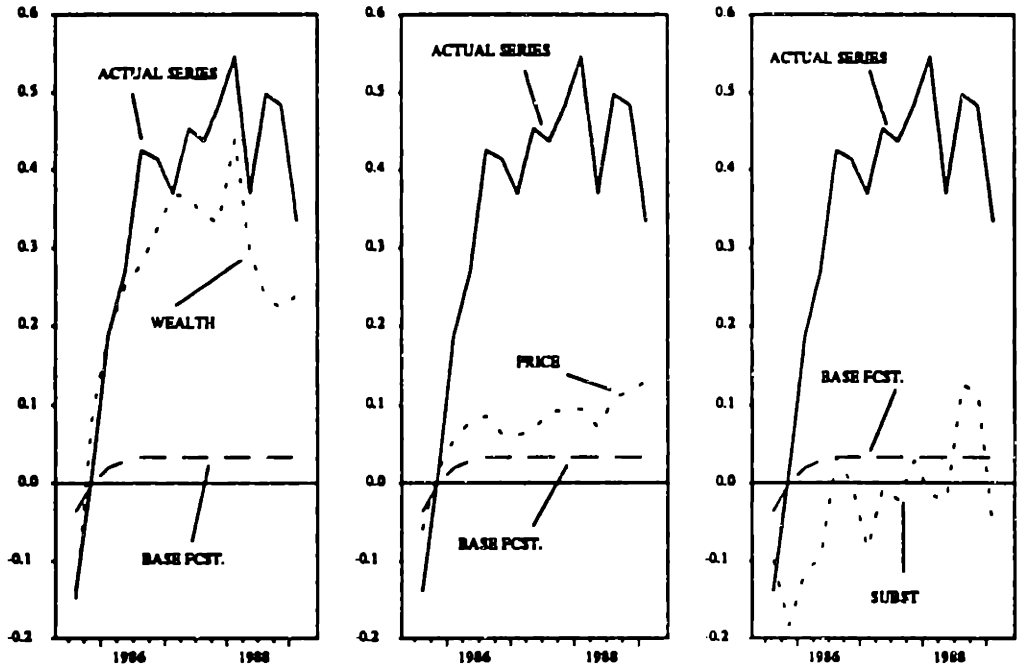


Figure 4.6b: Israel
Durable Purchases: shock history from 1988:1-1988:4
Base Forecast at 1987:1 Model III

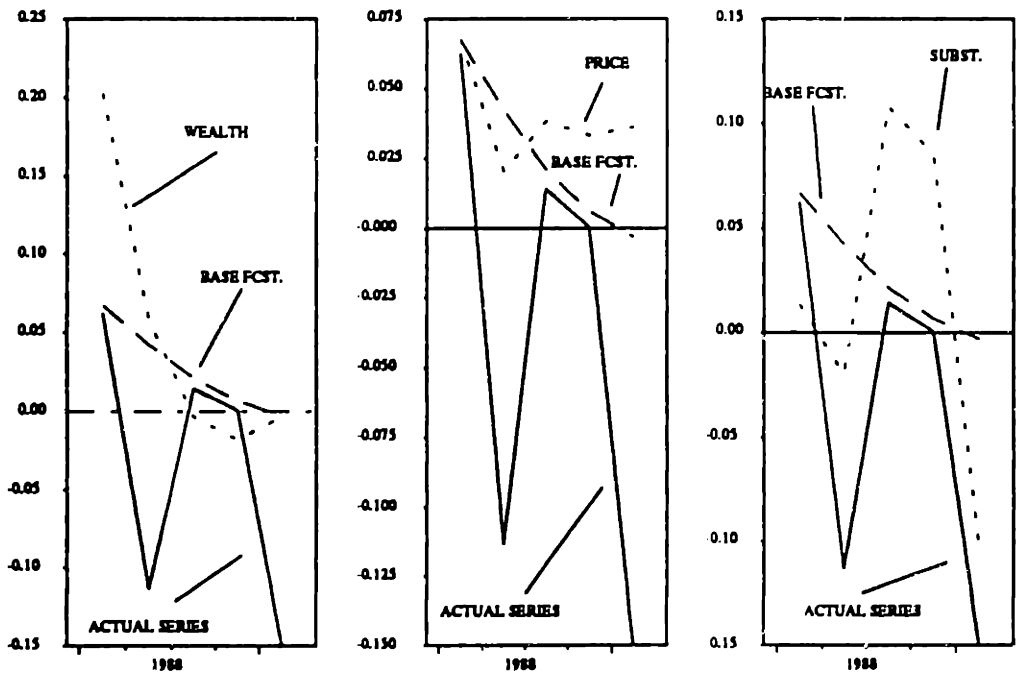
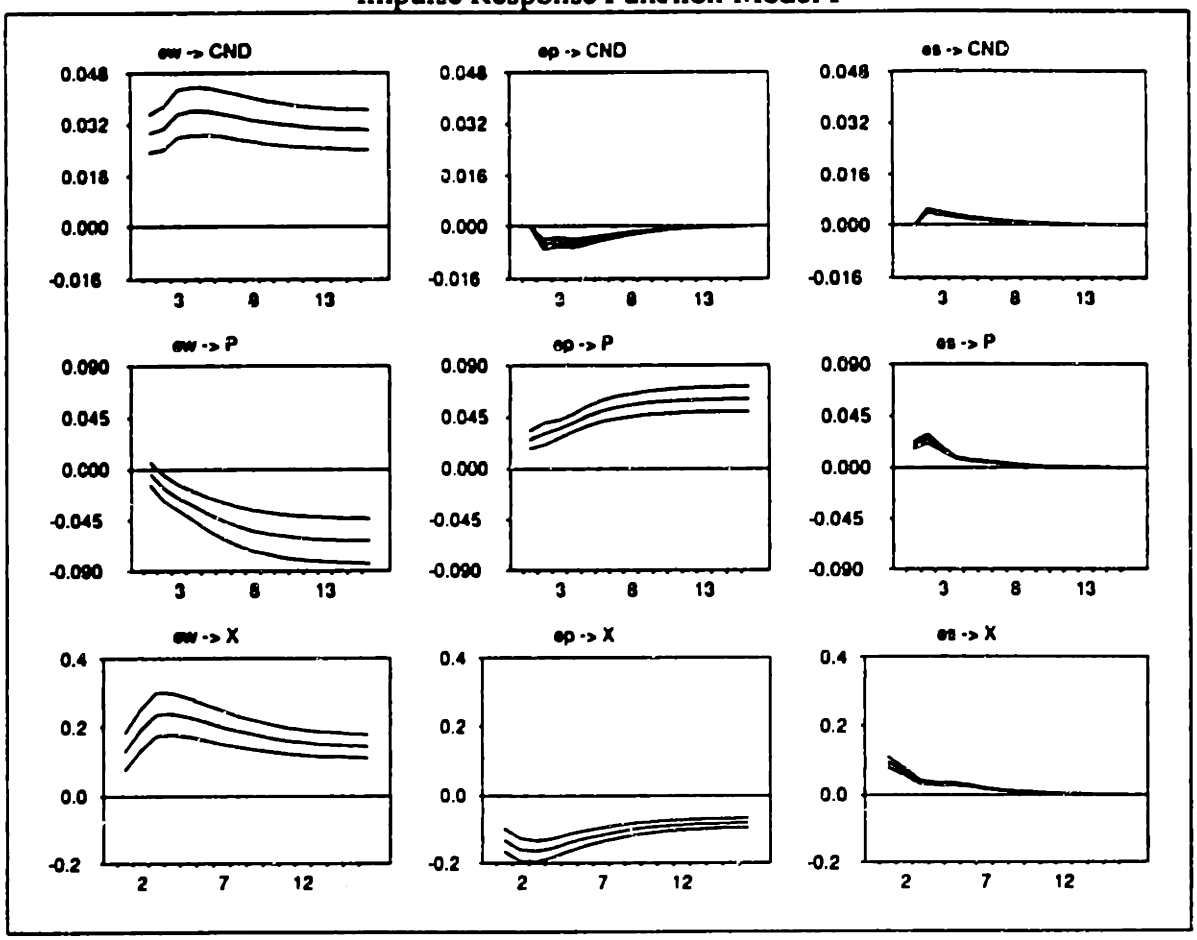


Figure 4.7: Chile
Impulse Response Function Model I



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