Essays on Consumption and the Real Exchange Rate

by

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B.S., Escola Politécnica (1987)

Submitted to the Department of Economics
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 1998

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Abstract

This thesis consists of three essays in International Economics and Macroeconomics. The first essay asks what determines the real exchange rate in the long-run. The second essay explores the role of credit in explaining the consumption booms associated with rapid disinflation programs. The last one studies the duration of real exchange rate deviations.

Chapter 2 analyzes the long-run determination of exchange rates using sectorial data on 24 developing countries and other 14 OECD economies. International productivity differences, terms of trade and trade policy work quite well in explaining lower frequency exchange rate movements. Moreover, after controlling for these real variables, convergence is quick: half-lives of 1 to 2 years were estimated, which are consistent with nominal rigidities. In special, the results strongly support the Balassa-Samuelson effect, and the evidence on the model's underlying assumptions are reassuring to the Balassa-Samuelson theory.

Chapter 3 studies the consumption booms that accompany exchange rate based stabilization plans. Modeling the demand for durable and non-durable goods under varying credit constraints, the role of credit appears in the time variation of the Euler equation coefficients. Besides, whether credit loosening dominates intertemporal reallocation of consumption can be tested using the shadow price of the constraint. Detailed data for Brazil show the predominance of credit in explaining these booms.

Chapter 4 introduces a new empirical approach to study real exchange rate deviations by analyzing the duration of these deviations, instead of their amplitude. First, it sheds new light on Mussa's non-neutrality of exchange rate regime. Contrary to what his findings might have suggested, fixed regimes emerge as more prone to appreciation misalignments. Second, duration regressions results show that higher interest rates, government consumption and GDP growth are associated with longer life to appreciations. For depreciations, on the other hand, higher government consumption and the cumulation of current account surpluses significantly increase the hazard of such spells ending. In addition, the estimated baseline hazards suggest that the pressure for reversion rises along the path of an exchange rate deviation spell.

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Acknowledgments

I gratefully acknowledge financial support from CNPq, which fully covered the four years of my Ph.D. studies. During this period I also benefited from nonpecuniary support of many people who I would like to thank now.

Rudiger Dornbusch provided encouragement, understanding, trust, as well as the broad guidelines that proved to be essential in shaping this dissertation. Both the work I did for him and under his supervision taught me most of the Macroeconomics I learned at MIT, and added to the share I already owed to professors Delfim and Pastore. Jaume Ventura was helpful in organizing the presentation of this material, particularly chapter 3. Roberto Rigobon made useful suggestions that helped clarify several technical points in the three chapters. I also benefited from comments gathered during the job market process and those from the International Breakfast participants.

I am thankful to my colleagues Karl, Larina, Irineu and Max for sharing the stress and distress, as well as for keeping it fun. The last two are also responsible for broadening and deepening my soccer erudition, which by now is worth (at least) a minor field. Marcos Chamon was kind and patient enough to spot numerous typos in previous versions of this dissertation, including this page.

My friends at home were also important. Among them, Edson, Felipe, and Tsuji were there in the good and bad times. I especially thank Luis Fernando for being the friend and the way he is.

Mother Nature deserves an acknowledgment too. By making the Summer so hot and humid and the Winter so cold and dry it kept me indoors most of the time, which considerably lengthened my working hours.

Last, but far from least, my deepest gratitude goes to Paula and to my family, especially my mother Maria do Carmo, my father Drausio, and my sister Claudia. Above all, my parents' unconditional support was my main guidance and I thankfully dedicate this thesis to them.

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Chapter 1

Introduction

This thesis consists of three essays in International Economics and Macroeconomics. The first essay asks what determines the real exchange rate in the long-run. The second essay explores the role of credit in explaining the consumption booms associated with rapid disinflation programs. The last one studies the duration of real exchange rate deviations.

Chapter 2 analyzes the long-run determination of exchange rates. First, a small open economy model is used to summarize the effects of the three long-run determinants of the real exchange rate: lower relative productivity in tradables with respect to non-tradables, worse terms of trade, and trade opening are shown to be unambiguously associated with an equilibrium depreciation of the real exchange rate.

The estimation results using sectorial data on 24 developing countries and other 14 OECD economies confirm that this model works quite well in explaining lower frequency exchange rate movements. Moreover, after controlling for these real variables, convergence to the estimated cointegration relationship is quick: half-lives of 1 to 2 years were obtained, which are consistent with nominal rigidities.

In particular, the results strongly support the Balassa-Samuelson effect, and the evidence on the model's underlying assumptions are reassuring to the Balassa-Samuelson theory. Robustness checks using the relative prices of tradables and non-tradables as a proxy for TFP productivity differentials, and the broad Penn Table data set were all favorable to the Balassa-Samuelson effect.

Chapter 3 studies the consumption booms that accompany exchange rate based stabilization plans. The consumer problem with durable and non-durable goods is set with an intermediary that optimizes lending. The amount of lending enters as a constraint to consumption, but the intermediary also takes into account the balance sheet condition of the consumer. The first empirical implication of modeling demand for both goods under varying credit constraints is that the role of credit appears in the time variation of the Euler equation coefficients. The second important empirical implication derived from this formulation is that the shadow price of the credit constraint is reflected in the relative path of durables and non-durables demand. Whether credit loosening dominates intertemporal reallocation of consumption can be tested using the path of the shadow price of the credit constraint after controlling for interest rates and changes in the relative prices of durables and non-durables. Detailed data for Brazil show the predominance of credit vis-a-vis intertemporal reallocation in explaining these booms.

Chapter 4 introduces a new empirical approach to study real exchange rate deviations. By analyzing the duration of these deviations, instead of their amplitude, this study benefits from the flexible set of statistical tools that comprise duration analysis. First, time at risk and survival functions shed new light on Mussa's non-neutrality of exchange rate regime. Contrary to what his findings might have suggested, fixed regimes emerge as more prone to appreciation misalignments. Not only they concentrate the higher and longer appreciation spells, but also the appreciation time is relatively longer under fixed regimes. Second, a regression approach using the proportional hazard model provides an appropriate estimation technique to further describe these deviation spells. Higher interest rates, government consumption and GDP growth are shown to be associated with longer life to appreciations. For depreciations, on the other hand, higher government consumption and the cumulation of current account surpluses significantly increase the hazard of such spells ending. In addition, the estimated baseline hazards suggest that those covariates do not tell the whole story. In fact, even after controlling for government consumption, interest rate differential, net foreign assets or GDP growth, the pressure for reversion rises along the path of an exchange rate deviation spell.

Chapter 2

The Exchange Rate in the Long-Run

Unless very sophisticated, indeed, PPP is a misleading, pretentious doctrine, promising what is rare in economics, detailed numerical prediction.

(Samuelson, 1964, p.153; the emphasis is ours.)

2.1 Motivation

As the Bretton Woods system collapsed and exchange rates started to float, it became evident that purchasing power parity could not account for the wide fluctuations that ensued. Theorists promptly reacted to the new reality and, before the end of the decade, new exchange rate models had already incorporated price rigidity, monetary and portfolio equilibrium aspects in an attempt to explain what seemed to be so unpredictable. The exchange rate, seen as the price of two goods in the PPP approach, was alternatively formulated as the price of two moneys or the price of two assets.

When it came to the empirical tests, however, none succeeded. The excitement of the 70s was followed by a grim scenario, where fundamentals gave in and international economists were put in a defensive position. The random walk stood out and even chartists were brought to the scene when forecasting at higher frequencies was to be performed.

Nevertheless, it would be unfair to take these results as an overall setback to exchange rate theory. To some extent they just reflect the fact that the ER is a relative price in a general equilibrium setting which, in turn, is difficult to implement empirically[1]. Partial alternatives, as those mentioned above, have indeed come short in successfully forecasting currency movements. But in a setting where expectations, real and financial shocks have each potentially important impacts on the exchange rate, it is unlikely that any partial attempt will.

What we show in this paper is that, as a matter of fact, the scenario is not as grim as our brief introduction to the problem might have suggested. Once we focus on lower frequency movements, we are able to cut through the limitations of partial approaches and the complexity of dealing with the whole system. First, the theory becomes simpler and clearer; second, endogeneity problems that plague this literature are less severe; and third, news, monetary shocks as well as price sluggishness, are less of an issue in the longer run. The picture that emerges is actually far from grim. Theory does a very good job overall in providing good empirical determinants for low frequency ER movements. And, to reconcile theory and data, we do not need a breakthrough or even a major break with the previous literature.

The strategy we follow, both empirically and theoretically, is to first explain long-run ER movements. This will then be the reference to characterize transitory fluctuations. This strategy not only fits naturally in the error-correction model we use in the empirical section, but also allows us to use a less involved theory. In the long run, when prices are flexible, capital and labor are mobile across sectors, one expects real shocks to dominate. We can then build on the work of Samuelson (1964), Balassa (1964), Dornbusch (1974), and Edwards (1989) in identifying terms of trade, trade policy and international productivity differentials in tradables with respect to non-tradables (the Balassa-Samuelson effect) as the determinants of the exchange rate for a small open economy.

Doing so, we are able to tackle three problems in exchange rate analysis. The first is the determination of the long-run ER itself. We show that terms of trade, trade policy and the Balassa-Samuelson effect provide a very good empirical explanation of long-run movements of the real exchange rate. In particular, we find strong support for the Balassa-Samuelson effect. Second, as a by-product, we are able to show that, controlling for those real variables,

[1]Williamson's Fundamental Equilibrium Exchange Rate (FEER) computes the exchange rate as a solution of a macroeconomic model (Williamson, 1994). His results do not seem very promising, however. Any test of the exchange rate theory built in the macro model becomes necessarily a joint test with the macro model itself. And, on top of that, in dealing with expectations, price stickiness, and sustainability issues all at once, strong assumptions have to be made, which makes robustness an important issue.

the reversion to the parity is clearly detected and it is quick; in less than two years, 50% of the deviation is already undone. In other words, we strongly reject non-stationarity in our "augmented PPP" test. Third, we can characterize the departures from and the reversions to the long-run trend[2].

The reason we have clearer results is that we were able to overcome the limitations in the previous literature on three grounds: 1) we use the appropriate econometric technique for long-run estimation; 2) we have a broader sample: besides the 14 OECD countries commonly used in this literature, we have labor productivity data on other 24 developing countries; and 3) we avoid omitted variable bias, which proves essential in capturing the Balassa-Samuelson effect. Many papers share only one of the these components, and a smaller fraction has two of them. But, to our knowledge, none has incorporated all three features. And as we will show, such incompleteness does matter.

Our findings add to the literature, since up to this point the support to the Balassa-Samuelson effect has been weak , trade policy has largely been neglected, and, still after almost 25 years of float and more powerful panel tests, researchers have not yet been able to settle the debate on the stationarity of exchange rates. Moreover, they are important in many ways. First, the existence of an empirically robust long-run relationship for the exchange rate is a key ingredient for open macroeconomics modeling. Second, the knowledge of such an (empirical) equilibrium is a necessary step for those interested in characterizing currency crisis or collapses. Third, they contribute to clarify the long debate around the PPP. Finally, and more controversially, these results may serve as a reference for policy[3].

The paper is organized as follows. In section 2.2 we review the literature and characterize the problem we want to solve. In section 2.3 we outline the theoretical framework that underlies the specification we use to describe the long-run. Section 2.4 presents our empirical approach and basic results, and in section 2.5 we assess how robust these results are. The final section concludes.

[2]In this chapter we limit our attention to the speed of reversion. In a chapter 4, we study the duration of such trips.

[3]And we say controversial, because one cannot ignore that the exchange rate is an endogenous variable and as such its movements reflect the adjustment of the economy. Still, as prices are sticky, a nominal devaluation may be a right choice in shortening the undoing an appreciation.

2.2 Evidence on Long-Run Determinants of the Exchange Rate

That the longer run is a promising ground for empirical work on exchange rates has not gone unnoticed in the literature. Numerous papers have recently been written on the topic. They differ somewhat in sample choice and in specification, but, whenever comparable, the evidence is mixed and not robust. Longer time series, broader panels, or different proxies are enough to considerably change the results.

More to the point, the traditional debate on PPP vs random walk still persists. Besides, those studies that reject stationarity clearly fail to agree on which explanatory variables to include in the model specification. Overall, the evidence for the Balassa-Samuelson effect has been weak, trade policy has largely been ignored, and the terms of trade are important in some papers, but turn insignificant in others. Furthermore, even in the literature that claims to focus on the long-run, the concern with higher explanatory power often leads to the inclusion of many of the partial views of ER determination mentioned before. It is not uncommon to see stationary variables, like interest rate differentials, together with non-stationary variables, like productivity, in the same specification.

In this section, we review this literature in more detail. In order to motivate the empirical approach, we look for possible ways to reconcile the mixed evidence. To do so, we organize the empirical work on long-run exchange rate determination as follows: 1)PPP tests; and 2)long-run determinants, which we further split according to time-series, cross-section, or panel data evidence on the Balassa-Samuelson effect.

2.2.1 PPP Tests

The theory underlying Purchasing Power Parity is goods arbitrage, i.e. the Law of One Price (LOP). Since no one expects it to hold continuously, PPP tests focus on how good it may be as a long-run relationship. The null is that the real ER follows a random walk. If not rejected, this means that the ratio of the price levels at home and abroad is actually the determinant of the exchange rate[4].

[4] Implementing PPP tests in differences introduces the additional difficulty of choosing the base period for computing the deviations. In this case, the base chosen becomes the equilibrium to which the exchange rate convergence is tested.

The history of PPP testing has been dictated by the developments in econometrics of non-stationary time-series and data availability. Given the notorious low power for rejecting a unit-root in short samples, more recent papers have followed two alternative routes in order to increase the power of such tests. The first consists in simply using longer data sets, which, in some cases, span 120 years of data. The second route is to use panel data; by imposing homogeneity on the speed of reversion, the 24 years of floating exchange rates are multiplied by the number of countries included in the panel.

As opposed to the previous literature, these tests tend to reject the unit-root, although the convergence to PPP is very slow. For the long-horizon series tests, the half-life of deviations varies from 3 to 5 years, while the panel results imply half-lives from 4 to 5 years (see Rogoff, 1996 and Obstfeld and Rogoff, 1995). However, these results are far from settling the dispute. First, long-horizon data sets combine two exchange rate regimes, and, hence, two possibly different data generation processes, which, in turn, may affect the power and size of the unit-root test. Second, panel tests that ignored the cross-correlation among exchange rates indeed have biased sizes and lower power than these studies assumed. O'Connell (1997) shows that, once the cross-correlation is taken into account and the power of the test is restored, the situation changes. No evidence is found against the random walk null for panels of up to 64 countries.

For our purposes, more important than whether the unit-root is rejected or not is the pattern that emerges in this literature: PPP deviations, even if stationarity is accepted, are so long-lived that one cannot rely on monetary or portfolio shocks together with price stickiness to justify them. Real, persistent shocks as the Balassa-Samuelson effect, terms of trade or trade policy changes are more likely to be behind these findings.

Results reported in Rogoff (1996) and Obstfeld and Rogoff (1995) suggest other reasons to think so:

a) broader panel cointegration tests tend to reject stationarity, while panels covering OECD countries tend to accept it. As technology and productivity disparities are smaller for OECD countries, we would expect to detect trend differentials more easily when countries in very different stages of development are compared;

b) cointegration tests of PPP that do not constraint the inflation differential to be unit (i.e.

weak versions that allow for eventual real trends) tend to accept stationarity more often;

c) tests of the Law of One Price (LOP) which are limited to tradables or use wpi's tend to reject non-stationarity; those including non-tradables or cpi based real exchange rates tend to not reject it. This is consistent with the source of the unit-root lying in non-tradables, as in Balassa-Samuelson model.

To sum up the evidence on PPP as the long-run determinant of the exchange rate, we borrow Rogoff's (1996, pp.648) PPP Puzzle:

> The purchasing power parity puzzle then is this: How can one reconcile the enormous shot-run volatility of real exchange rates with the extremely slow rate at which shocks appear to dampen out? ...consensus estimates for the rate at which PPP deviations damp, however, suggest a half-life of three to five years, seemingly far to long to be explained by nominal rigidities.

As we will show in the empirical section, once we control for real shocks, the puzzle disappears: half-lives of one to two year are obtained, which are consistent with price stickiness.

2.2.2 Long-Run Determinants

From the long-run determinants we introduced in section 2.3, international productivity differences across tradables and non-tradables have received most of the attention as an explanation to the persistent deviations from the PPP. The findings on the Balassa-Samuelson effect reported in the literature are mixed. Nonetheless, after organizing them in cross-section and time-series evidence, they are telling in terms of where to look for it. We summarize our view below.

Balassa-Samuelson in Cross-Section

Originally, Balassa (1964) provided cross-section evidence for the relationship between the real ER (defined as the relative price levels at home and abroad) and real income per capita. The very significant upward slope he estimated suggested that PPP was a poor benchmark for exchange rate determination across countries in different stages of development. More recently, Balassa's study was extended to cover more countries by Summers, Heston and Nuxoll (1994), and many others. Their results have confirmed Balassa's finding that richer countries have a higher price level, and, overall, the evidence for the Balassa-Samuelson effect is clearly stronger the more heterogeneous the panel is in terms of income levels.

In fact, when countries are grouped according to their income levels, the within group evidence for the Balassa-Samuelson effect turns out to be insignificant. In the limit, when relative price levels and income per capita are run individually, the results are poor. Even fast growing countries do not necessarily show appreciation. As argued in Isard and Ito (1997), some of the fastest growing Asian countries, in fact, do not show the Balassa-Samuelson effect.

Balassa-Samuelson in Time-Series and Panel Data

The evidence for the Balassa-Samuelson effect is much weaker in time-series, although it is still supported for some industrialized countries, specially Japan. In many studies, productivity differentials are not always significant and, sometimes, the coefficients do not make economic sense.

Panel data results reported recently are more promising. De Gregorio, Giovannini and Wolf (1994) were the first to use sectorial data for a panel of 14 OECD countries to test the effect of productivity differentials on the relative price of tradables and non-tradables. Although they find that the effect is significant, they do not really look at the effect of productivity differentials on the relative price of tradables and non-tradables at home vis-a-vis foreign countries, which is the essence of the Balassa-Samuelson effect. Focussing on home variables only, they actually find evidence for Baumol-Bowen effect[5]. Asea and Mendoza (1994), on the other hand, try to detect both, but they only find support for the Baumol-Bowen effect. De Gregorio and Wolf (1994), working with the 14 OECD countries, find evidence for the effect of productivity differentials and terms of trade on effective real exchange rates. A problem in interpreting their results is that they do not compute productivity differentials at home with respect to foreign countries, but still use them to explain the changes in the real effective exchange rates.

A common feature of all these papers is that all regressions are done in first differences. We know that the first difference operator works as a high pass filter. Hence, to capture long-run

[5]The Baumol-Bowen effect is the positive effect of higher productivity in tradables on the relative price of non-tradables - using only domestic sectorial data.

relationships this is not the appropriate data transformation. Exceptions are Chinn and Johnson (1996) and Canzoneri, Cumby and Diba (1996) who use data in levels. Working with the same 14 OECD countries, Chinn and Johnston estimate a panel cointegration regression with bilateral real exchange rates, total factor productivity differentials, and government consumption as a share of GDP and find a highly significant cointegrating relationship. And, it is important to note, these results were obtained including many countries for which the estimation in first differences rejected the Balassa-Samuelson model. Canzoneri, Cumby and Diba have a similar structure, but they use the relative price of tradables and non-tradables as the independent variable, i.e. they actually test the Baumol-Bowen effect.

Summing up, the evidence on the Balassa-Samuelson effect we note that: 1)it is easier to detect the Balassa-Samuelson effect when countries in different stages of development are compared, i.e. heterogeneity matters; 2)from the individual and within-group results obtained in time-series and in cross-section studies, income per capita is possibly a poor proxy for productivity; 3)omitted variable bias may be important, since most studies neglect terms of trade and/or trade policy; and 4)to capture the long-run, one needs to look at levels, not differences.

Therefore, a more complete specification that brings in more heterogeneity to the sample and uses panel cointegration seems to be the natural way to capture the long-run determinants of the ER. Besides, the associated Error-Correction Model (ECM) makes it easier to control for medium run effects (like demand effects or cumulated current account imbalances), and to detect whether or not convergence to the long-run relationship is present.

These remarks set the stage for the empirical work in section 2.4. In reviewing long-run alternatives to the PPP, Rogoff (1996) asserts that models incorporating real factors "...are not nearly as robust or universal enough to fully supplant PPP as a theory of long-run exchange rate". We will show the opposite.

2.3 Exchange Rate Determination in a Small Open Economy

International productivity differences, terms of trade, and trade policy have already been explored in detail in the literature (see, for example, Dornbusch (1973), Balassa (1964), Samuelson

(1964), and Edwards (1989)). In this section, we use a common version of the Balassa-Samuelson model in order to highlight the effects we will be looking for in the empirical part. Since we also want to capture terms of trade and trade policy effects, traded goods are incorporated as imported and exported goods (see also De Gregorio and Wolf (1994), and Kahn and Ostry (1992)).

2.3.1 Long-Run

The assumptions of a small open economy and that in the long-run capital is perfectly mobile allow a drastic simplification in the determination of the equilibrium exchange rate: relative prices are determined by supply alone; demand just determines the relative sizes of tradable and non-tradable sectors.

This a very strong prediction of the model and it forms the basis for the long-run empirical specification we use. One can argue that such strong prediction comes at the high cost of restrictive assumptions like perfect capital mobility and just two factors of production, but this is not the case. In fact, as discussed in Obstfeld and Rogoff (1996), the model is robust to the relaxation of both assumptions[6].

We assume that the economy produces non-tradables (N) and the exportable good (X), but the importable good (M) is just consumed. Both X and M are traded without frictions other than import tariffs. Capital (K) and labor (L) are combined according to a Cobb-Douglas[7] function to produce N and X:

$$y_x = a_x L_x^{\beta} K_x^{1-\beta} \tag{2.1}$$

$$y_n = a_n L_n^{\alpha} K_n^{1-\alpha} \tag{2.2}$$

where a is a productivity factor, and we assume that $\alpha \succeq \beta$, since non-tradables tend to be more labor intensive.

[6] In footnote 8, we sketch how to relax both by allowing imports to be produced at home.

[7] The assumption of a Cobb-Douglas production function may sound too simple or restrictive, but generalization here does not pay off. Diamond, McFadden and Rodriguez (1978) show that it is impossible to disentangle factor-augmenting technological change and the form of the production function.

Capital and labor are mobile across sectors, but just capital can move freely across countries. Labor mobility implies that wages are equalized across sectors. Capital mobility fixes the interest rate at home as given by the rate of interest in the rest of the world (and an exogenous risk premium)[8].

As the return of capital is determined exogenously in the exportables sector and prices are given by world prices, the wage rate is pinned down as:

$$w = \beta P_x a_x \left[\frac{r}{(1-\beta) P_x a_x}\right]^{\frac{1-\beta}{\beta}} \tag{2.3}$$

where r is the interest rate at home, and P_x is the price of exportables.

From the first order condition in the non-tradable sector and 2.3:

$$P_n = r^{\frac{\beta-\alpha}{\beta}} \frac{(P_x a_x)^{\frac{\alpha}{\beta}}}{a_n} \frac{\beta^{\alpha}(1-\beta)^{\alpha(1-\beta)}}{\alpha^{\alpha}(1-\alpha)^{\beta(1-\alpha)}} \tag{2.4}$$

For empirical implementation, we define the real exchange rate (RER) as the ratio of the CPI's at home and abroad expressed in the same currency:

$$RER = \frac{(EP_x^*)^{\theta}(EP_m^*)^{\gamma}(EP_n^*)^{1-\theta-\gamma}}{P_x^{\theta} P_m^{\gamma} P_n^{1-\theta-\gamma}} \tag{2.5}$$

where P's are the sectorial price indexes, and the exponents are their weights, which we assume the same at home and abroad for simplicity; E is the nominal exchange rate. Note that an increase in RER means a real depreciation.

A tariff ($T = 1+t$) introduces a wedge in the price of imported goods, such that $P_m = EP_m^* T$, and the Law of One Price makes $P_x = EP_x^*$. The RER then becomes:

$$RER = \frac{1}{T^{\gamma}}\left(\frac{EP_n^*}{P_n}\right)^{1-\theta-\gamma} \tag{2.6}$$

[8]It is important to emphasize that the assumption of perfect capital mobility is maintained here just to simplify the presentation of the model. If we allowed imported goods to be produced at home, the return on capital would be determined exogenously (by foreign prices) even without perfect capital mobility. To see that, use the first order conditions to solve for K/L in both sectors M and X; plug it in the wage equations, and solve for r to get: $r = f(p_x, p_m, \beta)$, if we choose the same sector shares (β) for both M and X. In other words, one does not really need the unrealistic assumption of perfect capital mobility. Trade and factor price equalization (corrected for productivity) suffice to pin down r. And, as shown in Trefler (1993), factor price equalization is an empirically sound assumption when international differences in productivity are controlled for.

If we assume that factor shares abroad are the same as at home, P_n^* is expressed as 2.4, but with a_n^*, a_m^*, r^*, P_m^* instead of a_n, a_x, r, P_x. Plugging 2.4 and the analogous expression for the foreign country in 2.6, we get:

$$RER = \frac{1}{T^\gamma}\left[\left(\frac{P_m^* \frac{a_n}{a^*_n}}{P_x^* \frac{a_x}{a^*_m}}\right)^{\frac{\alpha}{\beta}}\right]^{1-\theta-\gamma} \tag{2.7}$$

where $\frac{P_x^*}{P_m^*}$ is the terms of trade, and $\frac{\frac{a_x}{a^*_m}}{\frac{a_n}{a^*_n}}$ is the international difference in productivity .

It is now easy to see how the real exchange rate responds to trade policy (T), terms of trade, and international differences in productivity. Ceteris paribus, the higher (lower) the productivity in tradables (non-tradables) with respect to the rest of the world, the lower, i.e. the more appreciated, is the equilibrium RER in the home country. Besides, if a tariff is imposed, an equilibrium appreciation follows. Finally, a negative terms of trade shock (a decrease in $\frac{P_x^*}{P_m^*}$) means a real equilibrium depreciation.

These clear cut implications come from the model's perfectly elastic supply in the long-run[9]. Otherwise, opposing substitution and income effects would be at work, bringing in ambiguity to terms of trade shocks effects and an asymmetry between tariff imposition and trade liberalization. In any case, the evidence in the long-run literature on each of these shocks clearly conforms to the predictions of the model just outlined.

2.3.2 Dynamics

Although in the long-run only supply determines the equilibrium exchange rate, in the medium and short runs demand does play a major role. If capital and labor are not perfectly mobile across sectors, supply is not perfectly elastic anymore and demand shocks change relative prices. Moreover, as prices are sticky, monetary shocks become another forcing variable for the exchange rate. To capture demand and monetary shocks in the dynamic specification of our long-run empirical model, we use government expenditure and real interest rates. Government expenditure is a convenient variable to explain demand shocks. First, it falls more heavily on

[9] Which, as mentioned before, can be obtained either from capital mobility or from trade and productivity corrected factor price equalization for a small economy.

non-traded goods[10]. Second, a government expenditure shock can be big enough to change the relative price of these goods. To capture monetary shocks, the choice of interest rates is backed by the overshooting model (Dornbusch, 1976). If interest rates are high relatively to the world, we should see the exchange rate depreciating.

But this is not the end of the story. It may still be the case that a country experiences no monetary or demand shock, but its initial condition is of cumulated current account imbalances. In other words, its net foreign assets position may be off the desired (steady-state) level, so that a transfer abroad will have to be made. Since the current account is the difference between savings and investment, cutting consumption would obviously be a way to transfer resources abroad. However, if the propensity to consume home goods is higher than the propensity to spend on foreign goods, lower savings will eventually balance trade, but it will bring with it internal imbalance. In this case, a change in relative prices will be needed to effect this transfer, and this is what we have in mind in the empirical section when we include NFA or cumulated CA in the dynamics. We expect to see the real exchange depreciating after successive current account deficits.

2.4 Basic Results

Since numerous papers have been written on this topic and a great deal of disagreement in their findings persists, we want to be able to contrast our specification with previous ones and to check the robustness of our results. With that in mind, in this section we present our main results and, in section 2.5, we test how robust these results are.

Evidence Using Labor Productivity

Panel cointegration is the natural technique to assess the determinants of the exchange rate in the long-run. First, cointegration is meant to capture the long-run. Second, if cross-sectional heterogeneity matters, a panel is necessary. Third, through the ECM representation, it is easy to assess the deviations from the long-run (empirical) equilibrium.

[10]This becomes evident when analyzing sectorial and disaggregated Penn Table price data: government expenditure related prices clearly behave as non-tradables.

For our purposes, the third point is more important in reassuring the long-run relationship itself than in characterizing the dynamics around it. Because, even if the cointegration is not rejected, it does not necessarily follow that it is a useful empirical equilibrium reference. It may well be the case that the deviations are so persistent that the estimated long-run relationship becomes meaningless.

To see more clearly the importance of including non-OECD countries in the sample, we run two separate panels. One consists of the usual 14 OECD countries that have been used in the literature. The other panel comprises 24 countries whose data was obtained from the United Nations Industrial Yearbook (see data appendix). We name them OECD and UN, respectively. The countries in each panel are listed in appendix 1.

2.4.1 Integration and Cointegration

The first step is to determine the stochastic properties of the variables considered in section 2.3. Ultimately, integration and cointegration tests will determine which candidates will be included in the long-run relationship and which ones will be confined to the dynamics.

Unit-root tests were run individually and for both panels (OECD and UN), where the panel tests are based on Levin and Lin (1993). The results are presented in more detail in table 2.A.1. It is clear from individual tests that non-stationarity is rejected more often for government consumption and real interest rate differentials than for the other variables, but the results are far from being unanimous. This is not surprising, though, given the low power to reject the unit-root with just 20 years of data. Using the more powerful panel tests, however, a unit-root cannot be rejected for terms of trade, effective relative labor productivity, real exchange rate, and net foreign assets. On the other hand, the unit-root is clearly rejected for government expenditure and real interest rate differentials, which is consistent with the pattern observed in the individual tests. Moreover, these results make economic sense. Productivity shocks are expected to be persistent, and terms of trade comprises the price of commodities that are actively traded in stock and futures markets. As regards the NFA, though, non-stationarity is a matter of debate.

To test for cointegration, the Levin and Lin critical values are used in the two-step procedure: first, the cointegration model under test is estimated; second, the residuals are used in the fixed effects panel below:

$$\Delta\varepsilon_i = \eta_i + \gamma\varepsilon_i + \nu_i \tag{2.8}$$

where ε_i are the residuals for country i. The test is then performed using the t-statistic estimated for γ[11]. Results are reported at the bottom of table 2.1.

Even if NFA does not appear in the long-run model of section 2.3, we consider it in the cointegration tests, because non-stationarity could not be rejected for this variable. However, as shown in table 2.1 for both OECD and UN panels, we cannot reject *no*-cointegration when NFA is included. On the other hand, we do reject the no-cointegration null when NFA is excluded from the model. Therefore, the accepted cointegration model includes only the variables considered in the theoretical model, namely real exchange rate, terms of trade, international productivity differences and the Sachs-Warner trade policy dummy.

2.4.2 Panel and Individual Results

We run panel regressions constraining all the coefficients to be equal (the basic homogeneous model 2.9), as well as heterogeneous panel regressions, where some or all of the coefficients are allowed to be country specific. As we will see, although qualitatively the results are similar, the estimates can change considerably across countries.

The basic model is:

$$RER_i = \alpha_i + \beta_1 PROD_i + \beta_2 TOT_i + \beta_3 DOPEN_i + \beta_4 D8085 + \varepsilon_i \tag{2.9}$$

where[12]:

RER is the real exchange rate;

PROD is the international effective tradable/non-tradable productivity differential;

TOT is terms of trade;

DOPEN is the Sachs and Warner dummy, which assumes one in an open economy;

D8085 is a dummy to control for the sharp appreciation of the dollar in the period 1980-85.

[11] A future version of this paper will incorporate Monte Carlo critical values for the panel cointegration test.

[12] A ER regime dummy could not be included due to its multicolinearity with the fixed effects. ER regime will be explored in detail in chapter 4, though. See data appendix for a detailed description of these variables.

The inclusion of D8085 is intended to purge from the results the effects of the monetary targeting in US (1980-83) and the fiscal expansion that followed. The idea is to avoid an eventual bias that persistent demand and interest rate shocks may cause to the long-run estimation. However, its inclusion is not responsible for the favorable results we present. In fact, excluding the dummy almost always strengthens our findings, as we discuss below and in the robustness section.

According to the definitions, an appreciation means a decrease in RER, a higher TOT denotes better terms of trade, and an increase in PROD means faster relative productivity growth in tradables with respect to the world.

OECD Panel

Since OECD countries were always open according to the Sachs and Warner dummy, DOPEN had to be excluded, otherwise it would be perfectly colinear with fixed and random effects. For the homogeneous panel, the results are presented in table 2.1. To save space, we omit the heterogeneous panels' printouts.

As shown in table 2.1, the homogeneous panel results support the model. Both terms of trade and the Balassa-Samuelson effect are significant and have the right signs. Terms of trade are not only highly significant, but also quantitatively important. A 10% improvement in TOT is accompanied by an appreciation of approximately 5%. Besides, these results are basically unaltered by removing the D8085 dummy.

When we allow for country specific coefficients (the heterogeneous panel), the terms of trade coefficients remain significant, correctly signed, and their magnitudes are not far off the panel estimate. However, as we will discuss in more detail in the Individual Results subsection below, the same is not true for PROD. For the correctly signed coefficients, the magnitude of the Balassa-Samuelson effect is considerably higher than the panel estimate indicates, which suggests that, even for OECD countries, sample heterogeneity is an issue.

As regards the speed of convergence to the PPP, the reversion to the long-run relationship is fast in the homogeneous panel and even faster in the heterogeneous one. From the ECM results below, the implied half-life of deviations from the heterogeneous model is 1.2 years, which is consistent with nominal rigidities. If one fits an AR(1) model to the residuals of the heterogeneous panel, the coefficient is 0.62 (14.0)[13], which implies a half-life of 1.8 years.

UN Panel

As seen in table 2.1, panel results for UN countries are also supportive of the model: all coefficients are significant and correctly signed. However, heterogeneity is more severe than in the OECD panel. In the homogeneous panel, a 10% increase in TOT is accompanied by a 2.5% appreciation, but, in the heterogeneous results, many specific coefficients imply a real exchange rate response to terms of trade twice as high. When country-specific results are compared, TOT coefficients are still highly significant and of the same order of magnitude as OECD ones. Moreover, when the Balassa-Samuelson effect is allowed to be country specific, heterogeneity shows up even more clearly. As it will seen in more detail in the next subsection, the panel estimate considerably underestimates its impact on real exchange rates.

In terms of convergence to PPP, the results are similar to those for the OECD panel. The reversion in the heterogeneous panel according the ECM is quick: 1.8 years. Also, fitting an AR(1) to the residuals of the heterogeneous panel, the coefficient is 0.53 (12.4), i.e. a half-life of 1.5 years.

Since many UN countries experienced trade reforms after 1973, DOPEN could be estimated this time. The coefficient obtained for the panel is sensible: trade liberalization is followed by an average 12% depreciation. Furthermore, an interesting pattern emerges when we split the sample in countries that experienced a real depreciation after trade liberalization (a negative DOPEN coefficient) and those that did not: the depreciating countries experience higher growth in the aftermath of the depreciation; in the other group, the opposite happened (see table 2.2). Although we do not want to overemphasize this result without adding a growth equation to our model, we believe that the finding that countries who failed to devalue in the aftermath of a trade liberalization experienced slower growth deserves further study.

When we remove the D8085 dummy, the results are even more favorable. The Balassa-Samuelson effect increases to -3.148 (-2.9); TOT becomes -0.218 (-20.2); DOPEN rises to 11.655 (16.5); and, as before, cointegration cannot be rejected.

[13] t-statistic in parenthesis.

Individual Results

The reason to look at the results individually is to assess the importance of sample heterogeneity and check whether the panel results just reported are not spurious. To do so, we run 2.9 for each country separately. As seen in tables 2.3 and 2.4, interesting results emerge.

First, looking at the results on the right hand side of the tables, we observe that the individual coefficients are higher in absolute value, specially for PROD. For example, PROD's coefficient raises from 5 in the homogeneous panel to an average of 80, if we consider only those countries with the right sign. And for UN, it jumps from 2 to an average 38. This means that a 10% productivity differential shock has an average impact of 4-8% on real exchange rates, much higher than the homogeneous panel results suggested.

Second, the Balassa-Samuelson effect shows up much more clearly in UN than in the OECD countries. In contrast to UN countries, where fluctuations in the RER as well as in PROD and TOT have a high amplitude, there was not much activity in these variables for some OECD countries, so that even the explanatory power of their regressions was limited.

As a final remark, all the results in the previous subsections do not change qualitatively and change quantitatively little when cpi/wpi real exchange rates are used.

2.4.3 Error-Correction Representation

In tables 2.5-2.8 we report ECM's estimates for OECD and UN, where:

CGOV is government spending;

CCA is 4 year cumulated current account;

RRINT is real interest rate differential with respect to US.

Government spending has the right sign only when we exclude CCA, which is possibly due to multicolinearity. CCA, in turn, shows that previous cumulated deficits (surpluses) are followed by a depreciation (appreciation), which is consistent with the discussion in section 2.3. Finally, RRINT, when high, predicts a depreciating real exchange rate, as the overshooting model would predict[14].

[14]CCA is chosen in the specifications, because it does a better job than NFA in terms of fitting. Qualitative, both give similar results.

But, most interesting for our purposes is the strength of the reversion to the cointegration relationship. The error-correction term captures this feature well. For the homogeneous panels, the error-correction term implies half-lives of only 2.5 and 2.2 years for OECD and UN, respectively. These values are even lower if the error-correction comes from the heterogeneous panels: just 1.2 years for OECD, 1.8 years for UN.

This strengthens the model. Not only the long-run specification estimated supports the theory, but it also tracks real exchange rate movements well. The deviations from this empirical long-run equilibrium are far from persistent.

2.5 Robustness

The mixed evidence reported in the literature, specially when dealing with the Balassa-Samuelson effect, raises three main concerns regarding the results just presented. The first is whether our findings are an artifact of the sample we selected; the second comes from the productivity proxy we used; the third is whether the Balassa-Samuelson theory in fact underlies the significant productivity coefficient we estimated.

With that in mind, these three concerns will deserve special attention. First, we check if the previous results can be extended to a broader panel. Second, we ask if, indeed, labor productivity is a good proxy for the Balassa-Samuelson effect. Third, since the failure to detect the Balassa-Samuelson effect is normally blamed on the failure of the Law of One Price (LOP) or on the lack of competitive pricing, we analyze whether these assumptions hold. We assess each of them in turn.

2.5.1 Broader Panel

Do the previous results hold in a broader panel?

The Penn Table is the widest panel in the literature and it has already been successfully used to test the Balassa-Samuelson effect. Surprisingly, no attempt has been made to extend the specification to study the effect of terms of trade and trade liberalization on the exchange rate.

Although data is available for over 100 countries, we limit our sample to countries whose data quality is C or higher, except for China and some oil producers, as listed in appendix 1. As before, the basic model is:

$$RER_i = \alpha_i + \beta_1 RGDP_i + \beta_2 TOT_i + \beta_3 DOPEN_i + \beta_4 D8085 + \varepsilon_i \tag{2.10}$$

where:

RER is the real exchange rate as defined in the Penn Table (see data section);

$RGDP_i$ is the real GDP per capita in country i relative to real GDP in USA;

TOT is terms of trade;

DOPEN is the Sachs and Warner dummy, which assumes one in an open economy;

D8085 is a dummy to control for the sharp appreciation of the dollar in the period 1980-85[15].

Note that, now, an appreciation means an increase in RER.

Following the same steps as in the previous section, we first test for non-stationarity. As shown in table 2.A.2, using more powerful panel tests we cannot reject a unit-root in RER, RGDP and TOT. Next, as shown in the bottom of table 2.9, we reject the null of *no*-cointegration for 2.10. This is, hence, the specification we choose. Table 2.9 reports the main results for the homogeneous panels. The heterogeneous estimates are omitted.

Homogeneous Panel

As shown in table 2.9, the Balassa-Samuelson effect proxy (RGDP) is very significant and has the right sign. Besides, at variance with the previous literature, it shows up strong even when the sample is split into low and high income groups.

As regards terms of trade and trade policy, the results are qualitatively and quantitatively similar to those presented before for the UN and OECD panels. A 10% improvement in terms of trade implies a 2.0-3.0% appreciation in the float period. For countries that opened up, mean(RER)≈44, i.e. opening is followed by a 8-17% depreciation.

Finally, if the Bretton Woods period is included, both TOT and DOPEN coefficients are

[15] The inclusion of the dummy D8085 may be even more important here, because US is the reference country in the Penn Table. Again, it is important to stress that this variable is not responsible for the favorable results we got. Removing D8085, table 9 estimates are even more supportive of the model. B&S and TOT have slightly higher coefficients, and their significance is basically the same. DOPEN becomes less important quantitatively, but qualitatively the results are unaltered.

lower and less significant, which suggests, not surprisingly, that the exchange rate becomes more responsive to its determinants during the float period.

Heterogeneous Panel

As Wald tests reject homogeneity of RGDP and TOT, we allow them to be country specific. Unfortunately, cointegration tests for heterogeneous panels like this are not yet available.

With TOT and RGDP country specific, we find that, although the overall fit is good (the adjusted R^2 is 90%) and most of TOT coefficients are significant and of the right sign, many RGDP coefficients are not. When we run the extreme case in terms of coefficient specificity, i.e. a SUR system with all coefficients unconstrained, results in a country-by-country basis show a poor fit. $\bar{R}^2 \preceq 50\%$ is obtained for most countries, and RGDP is incorrectly signed or insignificant for many of them.

To assess PPP convergence we fit an AR(1) model to the residuals of the heterogeneous panel. The coefficient estimate of -0.400 (-15.75), is again suggestive of a strong reversion. It implies a half-life of just 1.2 years.

Summarizing, the findings in this subsection confirm our previous results. First, terms of trade and trade policy remain important determinants of the exchange rate. Second, when we include these variables, the Balassa-Samuelson proxy remains significant even within income groups, which shows that the specification is robust[16]. Third, heterogeneity in the coefficients is important so that one should not overemphasize results from homogeneous panels. Fourth, after controlling for real shocks, deviations from the cointegration equation become short lived.

Finally, and also important, unless one is interested in cross-section results only, the RGDP is a poor proxy for the Balassa-Samuelson effect. When constrained to have the same coefficient across different countries, RGDP captures well productivity disparities, since countries at very different stages of development are lined up. But, when allowed to be country specific, i.e.

[16]This is also important, because Bhagwatti (1984) relied on the failure to detect the Balassa-Samuelson effect within groups as an evidence against the Balassa-Samuelson model.

Bhagwati's proposed an alternative model where the failure of factor price equalization (FPE) was used to explains why lower income countries have lower price of services when compared with richer countries. If FPE fails, his theory goes, countries with more labor than capital will produce labor intensive goods as services relatively cheaper.

when the time-series dimension is allowed to become important, RGDP turns out to be a weak explanatory variable, as the SUR results confirm.

Part of the negative evidence on the Balassa-Samuelson effect builds on RGDP time-series results. Our findings suggest that this is not appropriate. To capture the Balassa-Samuelson effect, one cannot avoid the more data intensive productivity computations.

2.5.2 Proxy for Productivity

Even if, as shown above, labor productivity is a better proxy for the Balassa-Samuelson effect than real GDP per capita, is it indeed a good proxy?

As shown in section 2.3, theory predicts that Total Factor Productivity (TFP) should be used. This is feasible for OECD, but not for UN countries, since sectorial capital stock data are not available for these countries.

But, even for OECD countries, TFP values are not necessarily precise. It is well known how sensitive are Solow residuals to sector shares. In addition, as shown more recently (see, for example, Burnside, Eichenbaum, and Rebelo (1997)), TFP calculations can also be very sensitive to the rate of capital utilization.

We can get around these problems if we assume competition. In that case, prices and marginal costs commove and the relative price of tradables and non-tradables can be used to proxy TFP. That is what we do in this section. But, in order to flesh out the non-tradable aggregation we used, we run a panel for each of the subsectors that comprise the non-tradable sector separately. The real exchange rate used here is the bilateral rate with respect to USA. We split the sample in three panels: a)OECD, b)APEC, and c)UN, were the countries are listed in appendix 1. Table 2.10 summarizes the results.

As can be seen, the Balassa-Samuelson effect is again confirmed and the results hold uniformly across all non-tradable sectors. TOT and DOPEN remain significant and have the right sign. Contrary to Ito, Isard and Symansky (1997), the evidence for the Balassa-Samuelson effect is also strong in the APEC region.

2.5.3 The Assumptions Underlying Balassa-Samuelson: LOP and Competition

It is common in the literature that rejects the Balassa-Samuelson effect to blame it on the weakness of the assumptions used to derive the model, namely competition and LOP. As a consequence, this literature tends to reject the model as inappropriate for exchange rate determination. We argue that this attitude is precipitated.

First, it is very difficult to test the LOP for tradables. Transport costs prevent full arbitrage, and, furthermore, even highly traded goods incorporate retailing and storage services that make these goods behave, to some extent, as non-tradables. With few exceptions, like gold, for example, it is hard to find strictly tradable goods. In this case, it is difficult to say whether traded goods' prices disparities across countries mean that arbitrage fails or whether they just reflect the non-tradable component incorporated to these goods.

Second, and more important, to implement the Balassa-Samuelson model empirically, one does not really need full arbitrage in tradables. The real exchange rate is a *relative* price and, as such, it can be affected by different productivity growth differentials across sectors as long as they are reflected in the *relative* price of non-tradables vis-a-vis tradables. Therefore, if non-tradables are more responsive than tradables to sectorial productivity differences and this effect translates into real exchange rate movements, the Balassa-Samuelson theory will, in fact, be at work. It is important to say, though, that if tradable prices are not arbitrated, i.e. if the system is not anchored, the theory will be a weak guide to equilibrium ER determination, but it will remain useful in explaining ER movements[17].

Third, our findings suggest that prices commove with marginal costs. Again, as long as we are interested in explaining ER movements, this evidence is reassuring to the Balassa-Samuelson model.

In the following, we present evidence suggesting that tradables prices are, indeed, less responsive than non-tradable prices to sectorial productivity differences and, as already mentioned, that sectorial prices and marginal costs commove.

[17]If LOP does not hold in tradables, the Balassa-Samuelson theory becomes questionable as a reference for equilibrium exchange rate determination. Although a shortcoming, this problem is not a limiting factor for our work. After all, when using real exchange rate indexes we are not able to say much about equilibrium levels, anyway. We can still trace equilibrium movements, though, and that is what we do here.

LOP in Disaggregated Penn Table Data

The Penn Table provides a unique data set on price levels for comparable goods[18]. For each of these goods we ran a panel with their prices as the dependent variable and the real GDP per capita as the explanatory variable. We found that even comparable traded goods and commodities have higher prices in richer countries[19]. For the LOP to be verified in the tradable sector, however, the prices of tradable goods would have to be the same for all income levels, which is clearly not the case.

But an interesting pattern shows up when we ran a slightly different panel: instead of the absolute price as the dependent variable, we use the relative price of each good with respect to the GDP price level (see also Summers, Heston and Nuxoll, 1994). As seen in table 2.11, non-tradables prices are still higher in richer countries, but the price of tradables become negatively correlated with real GDP. Since the GDP price level is an average of tradable and non-tradable prices, this means that non-tradables are definitely more responsive to real GDP per capita than tradables. This suggests that the higher price level typically found in richer countries can be traced back to the higher price of non-tradables vis-a-vis tradables, a pattern that conforms to the Balassa-Samuelson theory.

It is true that, if one wants to use the model for determining the equilibrium level of the exchange rate, the LOP has to hold, otherwise the system has no anchor. To speculate whether this may be the case, in table 2.11 we show separately those goods where retail and transportation costs are likely to account for a small share of the final price: machinery, electrical equipment, and vehicles. Note that, now, the *absolute* price levels are insensitive to the income level. LOP holds strictly for these goods.

Competition and LOP in Sectorial Price Data

In table 2.12, we run the non-tradable/tradable price ratio on the tradable/non-tradable labor productivity ratio. As shown, the positive coefficient is positive and highly significant. If we

[18]These data were kindly provided by Betti Aten, which also called our attention to previous work using this data set, as Summers, Heston and Nuxoll (1994). Our findings builts heavily on theirs. Countries are listed in appendix 1.

[19]We also found evidence that transport costs (tc) are in part responsible for no-arbitrage. Splitting the sample in low and high transport costs countries, tradable prices become much more sensitive to income (from two to three times) in the high tc countries.

accept that labor productivity across sectors is a good proxy for marginal cost, this results support competitive pricing behavior. It still may be the case that there is a constant mark-up wedge between them, but, as discussed before, their comovement is already enough to support the Balassa-Samuelson theory if we are concerned about explaining ER movements.

Also, using sectorial prices, we confirm that pattern already observed for disaggregated Penn Table data: although tradable prices respond to our labor productivity measure, they are less sensitive to it than non-tradable prices. The Baumol-Bowen effect is clearly present across all sectors.

2.6 Conclusion

We found a strong relationship between effective exchange rates and international effective productivity differences, terms of trade and trade policy. Overall, such a relationship was confirmed for broader panels, country-by-country, and when sectorial prices proxied international productivity differences. In addition, these results were robust across sectors and to different definitions of exchange rates.

The existence of such a robust relationship explaining long-run real exchange rates makes us confident in studying the deviations from it. In this chapter, we limited the characterization of these trips to the speed of convergence of the real exchange rate. After controlling for its long-run determinants, we found support for a quicker reversion than reported in the PPP literature, and more so when heterogeneous panels were used. Moreover, the values obtained are not a puzzle as in Rogoff (1997), but instead they are totally consistent with nominal rigidities. In chapter 4, we use duration models to study the real ER deviations from the long-run.

Each of the long-run determinants received strong support from the data. The Balassa-Samuelson effect in particular was strongly supported across different data sets. We also further investigated the assumptions underlying the Balassa-Samuelson effect. There is evidence of competitive pricing and that the price of tradables are constrained by international trade. Moreover, tradables do show weaker response to productivity differences than non-tradables.

Finally, as regards trade policy, most countries that opened up their economies experienced an exchange rate depreciation, which hovered around 10-20%.

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Data Appendix

According to the exchange rate and productivity definitions used, the data can be split in three different sets: 1)Penn Table; 2)Labor Productivity; and 3)Sectorial Prices data. See appendix 1 for countries included in each of them.

1) Penn Table

The exchange rate is defined as the relative price level of home goods with respect to the price of a comparable bundle in the United States, all converted to the same currency. These prices are derived from the International Comparison Program (ICP). Note that, since the exchange rates are obtained from price levels, no choice of base period is necessary, which makes them suitable for equilibrium RER assessment. As a proxy for productivity, the real GDP per capita is used. There are five different real GDP per capita definitions in the Penn Table. We choose RGDPCH, because it is more appropriate for years other than 1985. For a more precise definition of the variables see Summers and Heston (1991). The oil dummy and transportation costs were obtained from Carvalho (1997).

2) Labor Productivity

Here, the real exchange rate is defined as the effective rate, computed using CPI's and 1985 trade weights from IFS Directions of Trade. Nominal rates and price indexes are from IFS Statistics, monthly. Real effective exchange rates were averaged from real effective monthly rates. For robustness checks, WPI's abroad were also used to compute a tradable/non-tradable version of the real exchange rate. Bilateral rates were computed using in the same way, i.e. using WPI's abroad.

Labor productivity is computed by the ratio of value added and employment. First, sectorial productivity was calculated for each country. The sectors, as well as tradable and non-tradable sectors definition, are listed in appendix 2. For the countries other than OECD, due to data availability problems, we used just manufacturing and transport, storage and communications as the aggregated tradable sector. The tradable and non-tradable productivity values were aggregated by taking geometric averages after scaling all sector values to be 100 in 1990. The weights were the sectorial shares in industry total value added. After obtaining tradable and non-tradable productivity for each country, the aggregated productivity values were weighted in the same way as the exchange rate to get effective labor tradable and non-tradable productivity. All variables are annual. Value added was obtained from United Nations Industrial Statistics Yearbook and OECD Intersectoral Data Base. Sectorial employment was obtained from International Labor Office (ILO), United Nations, and OECD Intersectoral Database.

3) Sectorial Prices

The exchange rates are the same as above. Productivity, however, is proxied by the ratio of the relative price of tradables and non-tradables at home and abroad. Prices are obtained from sectorial nominal and real value added series used in labor productivity calculations.

Common to these three data sets are:

- Terms of trade, from IFS;
- Interest and inflation rates from IFS, where, depending on availability, lines 60, 60b, or 60l were used;
- Net foreign assets and current account, both expressed as a share of GDP, from the World Bank;
- Government expenditure as a share of GDP, from the World Bank;
- Openness Dummy, from Sachs and Warner (1995).

Appendix 1

Penn Table				Sectorial Price Data			Labor Productivity Data	
Aggregated Data		**Disagregated Data**		**OECD**	**UN**	**APEC**	**OECD**	**UN**
ARG	ISR	ARG	ITA	AUS	BOL	AUS	AUS	BOL
AUS	ITA	AUS	JAM	BEL	AUS	CAN	BEL	BWA
AUT	JAM	AUT	JPN	CAN	BWA	CHL	CAN	CHL
BEL	JPN	BEL	KEN	DEU	CHL	IDN	DEU	CRI
BOL	KEN	BGD	KOR	DNK	COL	JPN	DNK	ESP
BRA	KOR	BOL	LKA	FIN	ECU	KOR	FIN	GTM
BWA	LKA	BRA	MAR	FRA	IDN	MEX	FRA	HKG
CAN	MAR	BRB	MEX	GBR	IND	NZL	GBR	IDN
CHE	MEX	BWA	MYS	ITA	JAM	PHL	ITA	IND
CHL	MYS	CAN	NGA	JPN	KEN	SGP	JPN	ISR
CHN	NLD	CHL	NLD	NDL	KOR	THA	NDL	JAM
CMR	NOR	CMR	NOR	NOR	MEX	USA	NOR	KEN
COL	NZL	COL	NZL	SWE	NZL		SWE	KOR
CRI	PER	CRI	PAK	USA	PHL		USA	LKA
DEU	PHL	DEU	PAN		PRY			NZL
DNK	PRT	DNK	PER		SGP			PAK
DOM	PRY	DOM	PHL		SLV			PHL
ECU	SEN	ECU	PRT		THA			PRY
ESP	SGP	ESP	PRY		TUR			SGP
FIN	SLV	FIN	SEN		URY			SLV
FRA	SWE	FRA	SLV		VEN			THA
GBR	THA	GBR	SWE		ZAF			TUR
GRC	TUN	GRC	SYR					URY
GTM	TUR	GTM	THA					VEN
HKG	TZA	HKG	TUN					
HND	URY	HND	TUR					
IDN	USA	IDN	TZA					
IND	VEN	IND	URY					
IRL	ZAF	IRL	USA					
IRN		IRN	VEN					
		ISR	ZWE					

Appendix 2

Sector Classification
International Standard Industrial Classification of All Economic Activities and International Sectoral Data Base, OECD.

Mnemonic	Description
Tradable	
AGR	Agriculture, Hunting, Forestry and Fishing
MIQ	Mining and Quarrying
MAN	Manufacturing
TSC	Transport, Storage and Communications
Non-Tradable	
CONSTR	Construction
RETAIL	Wholesale and Retail Trade and Restaurants and Hotels
PERSONAL	Community, Social and Personal Services
FINANCIAL	Financing, Insurance, Real Estate and Business Services
GOVERN	Producers of Government Services

Table 2.1
Long-Run RER Determination - Labor Productivity Evidence from Homogeneous Panels
B&S is proxied by effective labor productivity as defined in section 2.4 and data appendix.
Dependent variable is CPI real exchange rate (RER): an increase in RER means a real depreciation.

	OECD	UN
Estimation	**Fixed Effects**	**Fixed Effects**
	SUR	**SUR**
Sample	**1973-94**	**1973-94**
B&S	-5.412	-2.652
	(-7.6)	(-2.0)
TOT	-0.484	-0.226
	(-33.4)	(-18.7)
DOPEN	---	10.762
		(14.2)
D8085	0.138	-7.205
	(0.4)	(-9.5)
DW	0.7	0.6
$\mathbf{R^2}$	51	60
Cointegration	-7.40	-7.54
$\mathbf{H_0}$**: no coint.**	reject at 5%	reject at 1%
Cointegration	-5.38	-6.30
(Including NFA)	can't rej. at 1%	can't rej. at 5%

UN: Mean(B&S)=1.0; mean(TOT)=112; mean(RER)=87.0
OECD: Mean(B&S)=1.1; mean(TOT)=100; mean(RER)=105
Critical values interpolated from O'Connell (1997):
N=20, T=20: -7.52 (1%); -6.88 (5%); -6.54 (10%).

Table 2.2
GDP Growth Before and After Trade Liberalization
Four and three years average GDP growth for countries that devalued and those that did not devalue after liberalization.

Depreciated					Did not depreciate				
	4 YEARS AVG		3 YEARS AVG			4 YEARS AVG		3 YEARS AVG	
	Before	After	Before	After		Before	After	Before	After
BWA	10.1	11.7	13.9	10.3	**BRA**	3.7	1.5	2.2	1.5
CHL	-3.7	8.3	-4.7	8.3	**JAM**	2.0	2.2	4.1	2.5
COL	2.4	4.3	2.8	4.3	**NZL**	2.4	0.6	2.5	0.9
CRI	1.1	4.4	3.8	4.9	**SLV**	2.0	4.5	1.9	4.0
GTM	1.7	3.9	2.5	4.0	**TUR**	6.6	6.0	7.1	5.4
ISR	2.9	3.7	2.1	4.7					
LKA	5.8	5.8	4.6	5.9					
PHL	-1.7	2.3	0.1	2.9					
PRY	3.7	2.8	3.6	2.5					
URY	4.5	3.8	3.1	3.8					
VEN	4.0	5.6	5.3	7.6					
Average	2.8	5.1	3.4	5.4	**Average**	3.3	3.0	3.6	2.9

Depreciation is defined as a positive coefficient of the openness dummy variable in table 4.

Table 2.3
Individual Results for OECD Countries
Dependent variable is cpi-based real exchange rate

	PROD	TOT	D8085	F	R^2
AUS	-98.720	-0.215	---	31.3	75
	(-4.8)	(-2.0)			
BEL	-19.720	-0.855	---	13.7	55
	(-2.7)	(-2.5)			
CAN	-104.734	-1.005	---	17.9	62
	(-2.7)	(-5.4)			
DEU	-7.195	-0.302	9.259	10.1	67
	(-0.7)	(-1.7)	(4.1)		
DNK	14.890	-0.581	6.681	27.1	80
	(1.2)	(2.4)	(3.1)		
FIN	-60.359	-2.053	-19.619	25.3	78
	(-2.9)	(-8.8)	(-6.6)		
FRA	23.991	-0.274	---	4.0	22
	(1.2)	(-1.9)			
GBR	-1.618	-1.580	---	20.3	65
	(-0.1)	(-4.7)			
ITA	31.284	-0.803	---	29.7	76
	(4.1)	(-6.37)			
JPN	-267.244	0.521	17.152	23.7	76
	(-5.1)	(1.6)	(2.0)		
NDL	39.944	-0.324	---	1.3	4
	(1.3)	(-1.3)			
NOR	-4.402	-0.233	12.263	2.6	30
	(-0.7)	(-1.1)	(1.6)		
SWE	-161.775	-0.557	10.200	1.9	12
	(-1.1)	(-0.6)	(4.2)		
USA	-13.292	-0.426	-12.229	20	73
	(-1.0)	(-2.6)	(-6.7)		

Newey-West standard errors; around 22 observations for each country.
For NLD, NOR and USA, a dummy for 1979 was significant.
SWE has a structural break in 1976.

Table 2.4
Individual Results for UN Countries. Dependent Variable is CPI-Based RER.

	PROD	TOT	DOPEN	D8085	F	R^2
BOL	-79.514	-0.489	-7.15	---	4.2	34
	(-1.4)	(-1.7)	(-0.6)			
BWA	9.24	-0.0249	17.698	-24.211	8.0	62
	(0.8)	(-0.2)	(4.4)	(-4.7)		
CHL	-91.561	-0.141	4.845	-49.084	14.0	73
	(-2.4)	(-0.6)	(0.7)	(-5.6)		
CRI	-81.470	-0.447	19.736	11.702	14.2	76
	(-2.7)	(2.2)	(2.6)	(1.4)		
ESP	93.964	-0.690	---	3.595	5.8	45
	(2.4)	(-1.1)		(0.3)		
GTM	-24.472	-0.290	15.878	-16.503	12.7	77
	(-1.3)	(-1.2)	(1.5)	(-2.7)		
HKG	-15.385	0.352	---	-14.302	2.2	21
	(-2.3)	(2.0)		(-2.7)		
IDN	-71.489	-0.880	---	14.948	7.0	53
	(-3.8)	(-1.5)		(0.5)		
IND	211.898	-1.094	---	-41.231	20.3	74
	(3.5)	(-3.5)		(-6.5)		
ISR	-11.876	0.161	6.304	21.000	5.6	47
	(-0.9)	(0.6)	(1.7)	(3.8)		
JAM	139.252	-0.156	-5.667	-6.626	9.6	66
	(5.4)	(-1.0)	(-0.5)	(-1.1)		
KEN	-30.890	-0.459	---	-12.531	25.0	80
	(-3.5)	(-4.8)		(-4.8)		
KOR	-10.144	0.269	---	-3.476	1.6	1
	(-1.8)	(1.0)		(-0.7)		
LKA	-10.741	-0.364	59.572	-6.223	56.3	92
	(-1.9)	(-2.5)	(9.5)	(1.8)		
NZL	-67.929	-1.0523	-15.386	-9.050	3.6	40
	(-3.8)	(-4.8)	(-4.5)	(-3.2)		
PAK	-38.902	-0.601	---	-26.687	30.6	84
	(-1.3)	(-4.3)		(-5.2)		
PHL	-37.664	-0.262	9.182	-18.933	9.1	70
	(-1.7)	(-1.5)	(2.2)	(-7.8)		
PRY	-28.420	-0.141	38.178	-19.417	32.4	89
	(-3.8)	(-2.0)	(29.0)	(-7.5)		
SGP	-59.410	-0.298	---	-10.646	8.8	61
	(-3.4)	(1.0)		(-3.0)		
SLV	-198.227	0.633	-20.033	-24.825	18.2	80
	(-3.6)	(4.1)	(-3.9)	(-3.2)		
THA	-19.835	-0.199	---	-6.953	10.0	42
	(-2.0)	(-1.7)		(-1.8)		
TUR	-56.157	-0.748	-1.600	-17.387	6.1	49
	(-1.9)	(-1.9)	(-0.1)	(-1.0)		
URY	-3.051	-0.388	3.245	-17.423	1.9	19
	(-0.7)	(-3.6)	(1.6)	(-2.0)		
VEN	-33.577	0.0525	20.037	-23.330	26.3	85
	(-2.6)	(0.4)	(2.4)	(-1.5)		

Newey-West standard errors.
A dummy for the first 4 years of stabilization was used in the case of ISR.

Table 2.5
Error-Correction Model - OECD Panel
Error-Correction (EC) from Homogeneous Panel Model
Dependent variable is the first difference of the real exchange rate (RER)
SUR estimation
Sample: 1973 1994. Panel Observations: 216

Variable	Coefficient	Std. Error	t-Statistic
EC(-1)	-0.2601	0.0275	-9.47
D(RER(-1))	0.2829	0.0472	5.99
D(RER(-4))	-0.226	0.0386	-5.86
D(PROD(-1))	6.6731	4.5085	1.48
D(PROD(-2))	-1.4129	4.4444	-0.32
D(PROD(-3))	-17.024	3.3413	-5.1
D(TOT(-1))	0.0267	0.0268	0.99
D(TOT(-2))	0.083	0.0252	3.29
D(RRINT(-1))	0.3192	0.0455	7.01
D(RRINT(-2))	0.1861	0.0539	3.45
D(CGOV(-1))	1.1609	0.2074	5.6
D(CGOV(-2))	0.7368	0.2124	3.47
D(CGOV(-3))	0.6737	0.1761	3.83
D(CCA(-1))	0.1652	0.0592	2.79
D(CCA(-2))	-0.0247	0.071	-0.35
D(CCA(-3))	-0.0216	0.077	-0.28
D(CCA(-4))	0.1556	0.0644	2.42

Unweighted Statistics:

Adjusted R-squared	0.268	Mean dep. var.	0.110
S.E. of regression	5.569	S.D. dep. var.	6.509
Durbin-Watson stat.	1.885	Sum sqr resid	5768.113

Table 2.6
Error-Correction Model - OECD Panel
Error-Correction (ECHT) from Heterogeneous Panel Model
Dependent variable is the first difference of the real exchange rate (RER)
SUR estimation
Sample: 1973 1994. Panel observations: 216

Variable	Coefficient	Std. Error	t-Statistic
ECHT(-1)	-0.5841	0.0381	-15.3
D(RER(-1))	0.4184	0.0377	11.1
D(PROD(-1))	15.06	3.7153	4.05
D(PROD(-2))	6.7046	3.8467	1.74
D(PROD(-3))	-13.297	2.9804	-4.46
D(PROD(-4))	-3.8015	2.5672	-1.48
D(TOT(-1))	0.0486	0.0249	1.95
D(TOT(-2))	-0.0195	0.0237	-0.82
D(RRINT(-1))	0.34	0.0545	6.24
D(RRINT(-2))	0.2705	0.0613	4.42
D(CGOV(-1))	0.7797	0.2499	3.12
D(CGOV(-2))	0.4629	0.2519	1.84
D(CGOV(-3))	0.3878	0.2174	1.78
D(CCA(-1))	0.1127	0.0485	2.33
D(CCA(-2))	0.077	0.0579	1.33
D(CCA(-3))	-0.2304	0.0586	-3.93
D(CCA(-4))	0.0971	0.0538	1.8

Unweighted Statistics

Adjusted R-squared	0.336	**Mean dep. var.**	0.110
S.E. of regression	5.304	**S.D. dep. var.**	6.509
Durbin-Watson stat.	1.958	**Sum sqr. resid**	5233.075

Table 2.7
Error-Correction Model - UN Panel
Error-Correction (EC) from Homogeneous Panel Model
Dependent variable is the first difference of the real exchange rate (RER)
SUR estimation
Sample: 1973 1994. Panel Observations: 306

Variable	Coefficient	Std. Error	t-Statistic
EC(-1)	-0.3166	0.0249	-12.7
D(RER(-1))	0.1256	0.0444	2.83
D(PROD(-1))	9.1206	1.6358	5.58
D(PROD(-2))	1.1138	1.6403	0.68
D(PROD(-3))	-4.2642	1.6562	-2.57
D(TOT(-1))	-0.0085	0.0157	-0.54
D(TOT(-2))	0.0841	0.0152	5.54
D(CGOV(-1))	-0.1398	0.1265	-1.11
D(CGOV(-2))	0.5386	0.1347	4
D(CGOV(-3))	-0.1436	0.1214	-1.18
D(RRINT(-1))	0.0448	0.0142	3.16
D(RRINT(-2))	-0.0112	0.0135	-0.83
D(RRINT(-3))	0.0214	0.0132	1.62
D(CCA(-1))	0.2307	0.0339	6.81
D(CCA(-2))	-0.1286	0.0426	-3.02
D(CCA(-3))	0.1307	0.0408	3.2
D(CCA(-4))	0.1544	0.0336	4.6

Unweighted Statistics

Adjusted R-squared	0.119	**Mean dep. var.**	1.307
S.E. of regression	9.562	**S.D. dep. var.**	10.188
Durbin-Watson stat	2.057	**Sum sqr. resid**	24413.470

Table 2.8
Error-Correction Model - UN Panel
Error-Correction (ECHT) from Heterogeneous Panel Model
Dependent variable is the first difference of the real exchange rate (RER)
SUR estimation
Sample: 1973 1994. Panel Observations: 306

Variable	Coefficient	Std. Error	t-Statistic
ECHT(-1)	-0.3839	0.0274	-14.0
D(RER(-1))	0.1261	0.0423	2.98
D(PROD(-1))	8.6116	1.6737	5.15
D(PROD(-2))	-0.2589	1.6697	-0.16
D(PROD(-3))	-6.0443	1.6348	-3.70
D(TOT(-1))	-0.0104	0.0145	-0.72
D(TOT(-2))	0.0699	0.0141	4.97
D(CGOV(-1))	-0.1486	0.1207	-1.23
D(CGOV(-2))	0.3753	0.1241	3.02
D(CGOV(-3))	-0.1209	0.1198	-1.01
D(RRINT(-1))	0.0286	0.0173	1.65
D(RRINT(-2))	-0.0118	0.0161	-0.73
D(RRINT(-3))	0.0244	0.0154	1.59
D(CCA(-1))	0.2442	0.0329	7.42
D(CCA(-2))	-0.0908	0.0411	-2.21
D(CCA(-3))	0.1183	0.0378	3.13
D(CCA(-4))	0.1255	0.0322	3.90

Unweighted Statistics

Adjusted R-squared	0.131	Mean dep. var.	1.307
S.E. of regression	9.498	S.D. dep. var.	10.188
Durbin-Watson stat	2.068	Sum sqr resid	24088.990

Table 2.9
Long-Run RER Determination - Broader Panel Evidence
B&S is proxied by GDP_i/GDP_{USA}
Dependent variable is real exchange rate (RER): an increase in RER means an appreciation.

	All Countries				Low Income		High Income	
Estimation	**Fixed Effects**	**Random Effects**	**Fixed Effects**	**Random Effects**	**Fixed Effects**	**Random Effects**	**Fixed Effects**	**Random Effects**
Sample	**1973-92**	**1973-92**	**1960-92**	**1960-92**	**1973-92**	**1973-92**	**1973-92**	**1973-92**
B&S	25.765	84.096	87.150	87.522	104.684	90.223	25.822	57.995
	(3.2)	(15.7)	(14.6)	(19.5)	(7.5)	(6.7)	(2.5)	(4.3)
TOT	0.153	0.175	0.0450	0.0538	0.121	0.132	0.297	0.242
	(10.8)	(9.6)	(5.1)	(3.8)	(9.2)	(7.5)	(5.6)	(3.9)
DOPEN	-6.790	-3.678	-1.448	-1.108	-5.995	-5.522	---	---
	(-6.5)	(-2.6)	(-2.0)	(-1.0)	(-6.1)	(-4.1)		
D8085	-2.251	-5.260	0.0967	-1.478	1.356	0.145	-10.434	-13.810
	(3.9)	(-6.2)	(0.2)	(-1.7)	(2.0)	(0.2)	(-8.5)	(-9.5)
F	5696.9	---	5367.0	---	890.4	---	735.1	---
DW	0.6	0.5	0.3	0.3	0.6	0.6	0.6	0.5
R^2	84	84	74	75	63	63	72	74
Countries	60	60	60	60	34	34	26	26
Cointegration	-12.47	-12.60	-11.31	-11.31	-10.64	-10.70	-8.07	-8.23
H_0: no coint.	reject-1%	reject-1%	reject-5%	reject-5%	reject-1%	reject-1%	reject-10%	reject-5%

For full sample: mean(RER)=72.2; mean(TOT)=110.3; mean(B&S)=0.38. For low income countries: mean(RER)=51.1; mean(B&S)=0.23. Low Income: RGDP < 6000 in 1992 (34 countries).

Fixed Effects estimation with cross-section weighting. R^2 from unweighted fit.
Critical values interpolated from O'Connell (1997):
N=60, T=20: -11.97 (1%); -11.33 (5%); -10.99 (10%);
N=30, T=20: -8.76 (1%); -8.12 (5%); -7.78 (10%);
N=60, T=30: -11.90 (1%); -11.25 (5%); -10.93 (10%).

Table 2.10
Long-Run RER Determinants - B&S Proxied by Relative Prices of Tradables and Non-Tradables (P_T/P_{NT}) at Home and Abroad(*)
Dependent variable is the real exchange rate.
B&S is $(P_{NT}/P_T)/(P_{NT}/P_T)^*$.

OECD Panel

NT Sector	B&S	TOT	D8085	R^2
CONSTR.	-6.411	-0.104	24.332	37
	(-5.6)	(-4.0)	(15.5)	
RETAIL	-26.123	-0.309	28.339	45
	(-13.7)	(-11.5)	(15.5)	
PERSONAL	3.527	-0.236	24.916	44
	(2.8)	(-8.4)	(16.6)	
FINANCIAL	-2.052	-0.151	26.376	42
	(-1.8)	(-4.8)	(16.9)	
GOVERN	-15.027	-0.248	28.5	47
	(-2.7)	(-10.9)	(16.5)	

APEC Panel

NT Sector	B&S	TOT	D8085	R^2
CONSTR.	-14.349	-0.113	10.684	56
	(-11.8)	(-5.4)	(10.0)	
RETAIL	7.446	-0.135	6.983	53
	(5.3)	(-6.2)	(6.5)	
PERSONAL	-2.444	-0.134	8.489	53
	(-1.9)	(-5.6)	(7.1)	
FINANCIAL	-15.385	-0.133	11.992	53
	(-12.1)	(-6.5)	(11.7)	
GOVERN	-24.599	-0.111	14.404	64
	(-22.0)	(-5.9)	(10.1)	

UN Panel

NT	B&S	TOT	DOPEN	D8085	R^2
CONSTR.	-8.168	-0.0950	0.159	2.642	56
	(-6.6)	(-13.8)	(0.4)	(3.9)	
RETAIL	-4.739	-0.0958	0.172	1.224	56
	(-2.5)	(-12.8)	(0.4)	(1.7)	
PERSONAL	-22.175	-0.0964	0.348	7.938	57
	(-12.0)	(-13.6)	(0.9)	(7.9)	
FINANCIAL	-39.815	-0.112	1.426	15.087	59
	(-15.8)	(-14.0)	(3.5)	(12.8)	

Countries are listed in appendix 1, and sectors are defined in appendix 2; T is defined in section 4.
Bilateral real exchange rate with respect to USA (CPI/WPI*).
For APEC panel, most countries are open during the period.
SUR estimation. Mean(B&S)~100.

Table 2.11
Evidence on Balassa-Samuelson Assumptions:
LOP in Penn Table Disaggregated Price Data

$P_{good}/P_{GDP} = C_0 + C_1 \cdot RGDP$

Good	C_1	t	Good	C_1	t
Beverage	-8.4	(-3.4)	**Constr.**	0.86	(1.8)
Clothing	-6.3	(-0.6)	**Govern.**	4.2	(5.7)
Commod.	-2.5	(-2.8)	**Personal**	1.5	(1.4)
Pharma.	-4.9	(-1.9)	**Other serv.**	4.4	(6.4)
Tobacco	-0.9	(0.7)	**Health serv.**	4.0	(3.5)
Machinery	-11.7	(-7.3)	**Pers. serv.**	1.0	(1.7)
Vehicles	-15.8	(-4.7)	**Recreation**	5.1	(6.0)
Elec. equip.	-11.0	(-4.4)	**Rent**	-4.4	(-2.8)
Transport.	-27.0	(-5.2)	**Hotel/restaur.**	-2.3	(-0.2)
Tradables	-2.5	(-3.4)	**Services**	3.3	(6.2)
			Non-trad.	2.7	(4.6)

$P_{good} = C_0 + C_1 \cdot RGDP$

Good	C_1	t
Machinery	-0.86	(-0.9)
Vehicles	-2.4	(1.4)
Elec. equip.	-0.74	(-0.5)

RGDP is real GDP per capita; RGDPCH in Penn Table definition.
Random effects estimation.

Table 2.12
Evidence on Competitive Pricing
The relative price of tradables/non-tradables (T/NT) vs. relative labor productivity NT/T:

$$P_T/P_{NT} = C_0 + C_1 \cdot a_{NT}/a_T$$

OECD Panel - C_1 estimates

Sector	T		
NT	MAN	MIQ	AGR
CONSTR.	0.274	0.444	0.130
	(39.7)	(5.7)	(2.9)
RETAIL	0.397	0.482	0.166
	(31.0)	(8.7)	(4.2)
PERSONAL	0.357	0.621	0.241
	(15.2)	(7.8)	(4.8)
FINANCIAL	0.523	0.752	0.314
	(38.7)	(13.6)	(8.1)
GOVERN	0.575	0.647	0.525
	(58.3)	(10.8)	(13.0)

APEC Panel - C_1 estimates

Sector	T		
NT	MAN	MIQ	AGR
CONSTR.	0.163	0.366	0.489
	(4.7)	(2.9)	(6.3)
RETAIL	0.201	-0.159	0.0717
	(8.9)	(-1.6)	(2.2)
PERSONAL	0.508	0.419	0.511
	(6.6)	(4.1)	(9.4)
FINANCIAL	0.277	0.422	0.560
	(5.3)	(3.9)	(13.4)
GOVERN	0.272	0.251	0.485
	(3.9)	(1.7)	(4.7)

UN Panel - C_1 estimates

Sector	T		
NT	MAN	MIQ	AGR
CONSTR.	0.192	0.402	0.378
	(2.1)	(2.7)	(3.7)
RETAIL	0.370	0.638	1.316
	(2.1)	(2.3)	(11.1)
PERSONAL	0.354	1.543	0.198
	(2.8)	(3.2)	(3.8)
FINANCIAL	0.356	0.619	0.364
	(2.8)	(4.6)	(3.5)

SUR estimation. See appendix 2 for sector definition. Countries are listed in appendix 1.

Table 2.A.1
Individual and Panel Unit-Root Tests
UN and OECD panels used in section 2.4

	Individual Tests	Panel Tests	
Variable	**ADF - rejections at 10%**	**OECD**	**UN**
RER-CPI	AUS, FIN, NOR, NZL, PAK, SGP	-5.31	-5.34
RER-CPI/WPI	AUS, FIN, JAM, PAK	-4.31	-6.65
B&S	ISR	-3.74	-6.18
TOT	GBR, HKG, ISR, LKA	-5.69	-7.28
NFA	PAK, SWE, VEN	-3.47	-5.4
CCA	DEU, ISR, ITA, KEN, MYS, NLD, VEN	-2.71	-7.06
RRINT	BEL, BWA, FIN, IDN, JPN, PRY, SGP, SWE, THA, VEN	-7.59	-18.77
CGOV	AUS, BWA, CAN, CRI, DEU FIN, GBR, JPN, KOR, NLD, ZAF	-6.92	-9.13

Individual tests: constant and trend included.
B&S is effective labor productivity; RRINT is real interest rate relative to the USA; CGOV is government expenditure as a share of GDP.
Critical values from O'Connell (1997):
N=20, T=20: -7.52 (1%); -6.88 (5%); -6.54 (10%).

Table 2.A.2
Individual and Panel Unit-Root Tests
Penn Table panel used in section 2.5

	Individual Tests	Panel Tests
Variable	**ADF - rejections at 10%**	**t-stat.**
RER	FIN, GBR, IND, IRL, ISR, JPN, NZL, PAK	-12.25
B&S	MYS, URY, USA, SEN	-1.78
TOT	GBR, HKG, ISR, LKA, MAR, PRT, TZA	-11.71

Individual tests: constant and trend included.
B&S is effective real GDP_i/GDP_{USA}
Critical values from O'Connell (1996):
-12.72 (1%), -12.10 (5%), -11.76 (10%);

Chapter 3

Credit in Consumption Booms: The Case of Brazil

3.1 Introduction

Consumption booms have been key in the failure of exchange rate based (ERB) stabilization plans and a threat even to the successful ones. The real appreciation of the exchange rate and the sudden return of indexation as demand pushes prices up are main concerns of policy-makers in the aftermath of stabilization attempts.

In the case of Brazil, six stabilization programs were launched in a period of eight years, starting with the Cruzado in 1986. The extent of the intervention as well as the structure of the plans differed somewhat, but in all of them a rapid disinflation was obtained through the use of nominal anchors. The response of consumption also varied in intensity, but in all cases it followed the typical path of ERB programs: a rapid growth succeeded by a later collapse as inflation resumed.

Several explanations for this behavior have been proposed in the literature. Credibility seems to be the most widely accepted one, and a priori a sensible story for the Brazilian case. According to this version, since credibility is impossible to be assured and consumers believe that the low inflation period will not last, it becomes cheaper to consume while inflation is lower[1].

[1] In Calvo and Vegh (1993), as it is common in this literature, a cash in advance constraint implies a lower "effective" price of consumption goods while inflation is low. This is so, because the nominal interest rate, i.e.

Therefore, the basic mechanism underlying this explanation is the intertemporal reallocation of consumption.

We have reasons to believe that this is an incomplete story. What will be argued in this paper is that, instead of "let's buy now because it is cheaper," a better description of consumers attitude would be: "let's buy now because there is cash and credit to do so." In other words, we claim that loosening credit constraints dominates intertemporal reallocation in explaining the non-smooth path of consumption observed in this period.

The reasons that make us think so can be divided in two groups:

1. *As far as the credibility explanation is concerned:*

a. During the lower inflation periods that followed the stabilization attempts, prices of durables and nondurables (deflated by the wholesale price index) actually increased (figure 3.1);

b. We found no evidence of high intertemporal elasticity of substitution in consumption with respect to interest rate;

c. While consumption was booming, real interest rates were often higher than before (see figure 3.2). When this is the case, the user cost of durables is high and should drive consumption to the future, as far as intertemporal reallocation is concerned;

d. If credibility is an important issue, prudent consumers are expected to save more when inflation is low. Why consume the windfall gains or sink them in illiquid durables if the future is dark?

2) *As to the role of easier credit in lower inflation periods, we observe that:*

a. Data on credit and casual evidence show that credit markets close when inflation increases. Stores get less credit from banks and lend less to consumers;

b. There is strong evidence of credit constraints;

c. Durable goods, which are more sensitive to financing conditions than nondurables, are also more responsive during consumption booms.

To assess the concerns raised above, our strategy is to focus on the consumer problem and

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the opportunity cost of holding money for transactions, is also lower.

derive testable implications that allow us to confront credibility and credit based explanations. In doing so, we first set up the consumer's problem for nondurables in order to test the "there is cash to do so" part of the argument. We find that a large fraction of the population (around 70%) is constrained, and that this fraction increases with unemployment and inflation. Since both unemployment and inflation decrease as stabilization sets in, we conclude that the fraction of constrained consumers drops during stable periods.

Second, we analyze the consumer problem with durables, nondurables, and an intermediary in order to measure how liquidity constraints react to changes in the economic situation. An important result derived in section 3.2 implies that liquidity constraints can be revealed through the relative expenditure on durables vis-a-vis nondurables: the higher it is, the looser is the credit constraint. In other words, ceteris paribus, the higher is durables expenditure with respect to nondurables, the lower is the shadow price of the constraint. Looking at the data, after controlling for changes in interest rates and the relative price of durables and nondurables, we find that the shadow price of the credit constraint is indeed lower during the Cruzado and Real plans, the two major ERB stabilization attempts in Brazil. However, this is not the case in the Collor plan, which was characterized by a significant credit crunch.

The paper is organized as follows. In section 3.2, a brief digression on the stabilization programs in Brazil is presented. In section 3.3, we deal with nondurables only to measure the fraction of consumers that are constrained and how this fraction changes in time. As by-products, we estimate the intertemporal elasticity of substitution, and the coefficient of precaution. Putting it differently, in section 3.3 we look at reasons (1.b), (1.d) and (2.b) mentioned above. In section 3.4, we set the problem with durables, nondurables and a financial intermediary in order to observe indirectly the conditions in the credit market. Finally, in section 3.5, we summarize our findings and conclude.

3.2 A Brief Introduction to Stabilization Plans in Brazil

A remarkable feature showed by the inflationary process in Brazil before 1986 is that inflation clearly evolved by steps. Averaging 20% a.a. in the two decades that preceded the first oil shock, it was already hovering around 40% during 1976-79. When the second oil shock hit Brazil, it jumped again, now to the level of 90%. Finally, in 1983, the debt crisis caused inflation to climb one more step and reach 200% a.a.

As the military period ended and democracy was restored in 1986, this process changed considerably. Democratization brought with it conflicting claims for income redistribution that were ultimately accommodated by inflation. 1986 also inaugurated a period of massive and repeated interventions in the economy in order to stabilize prices. Six economic plans were launched in eight years: 1)Cruzado (February, 1986), 2)Bresser (July, 1987), 3)Summer (January, 1989), 4)Collor 1 (March, 1990), 5)Collor 2 (January, 1991), and 6)Real (June, 1994). The result was a period of highly variable inflation and economic conditions. As a rule, short periods of stable prices were succeeded by rapid acceleration of inflation that ended in another intervention.

In retrospect, the Cruzado, Collor 1, and Real plans can be considered as the three main interventions. The Summer plan can be seen as a reedition of the failed Cruzado, but with higher interest rates to prevent the flight from liquid assets to consumption observed during the first months of the Cruzado. Finally, the Bresser and Collor 2 plan aimed basically at realigning relative prices distorted by previous price freezes.

Since inertia was diagnosed as responsible for inflation setting at a higher equilibrium, nominal anchors were used in all but the Bresser and Collor 2 plans. In the Cruzado and Summer plans, prices and the exchange rate were frozen. But, as far as prices are concerned, with the exception of the first months of the Cruzado, compliance to the freeze was decreasing in time. In the Real plan, after the economy was open to trade, the exchange rate was used as the sole anchor, backed by a huge stock of foreign reserves. Finally, the Collor 1 stands out as the only attempt to use the money supply as the nominal anchor. Exchange rates were allowed to float and, to avoid the flight from short term liquid assets to consumption mentioned above, financial assets were frozen for two years.

As to monetary policy in this period, it is important to avoid the identification of tight money with high real interest rates. In the Summer plan, for example, high real interest rates also applied to reserves, since policy-makers were concerned with bankruptcy in the banking system. Besides, government deficits were easily financed through the Treasure's account in the Banco do Brasil. On top of that, monetary policy was always accommodative, with the Central

Bank repurchasing government bonds on the yield curve to minimize creditor's risk of capital loss.

The behavior of consumption in this period is shown in figure 3.1. Most strikingly in the Cruzado and Real plans, consumption followed the typical path of ERB plans. This was also true in the Collor 1 plan, but the magnitude was considerably lower. At this point, the natural question to ask is what happened to credit in this period. In figure 3.4 we show total credit to individuals, excluding housing. Ignoring the fluctuations, it is remarkable how expenditure on durables commoves with credit. This strong relationship between credit and consumption does not establish the causality running from the former, though. However, the fact that in the Collor 1 Plan credit was crunched, and the response of consumption was much lower than in the other interventions, when credit increased sharply, is suggestive that consumption was actually constrained.

3.3 Credit Constraints and Nondurable Consumption

In what follows, we assess the links between credit and consumption more systematically. In this section, we look at nondurables consumption only. This simpler framework is appropriate to focus on the income distribution aspects of stabilization plans, i.e. the "cash to consume" part of our explanation. In section 3.4, we introduce durables in order to emphasize changes in financing conditions that emerge as inflation falls.

In the case of *durables*, adjustment cost and the aggregation issues that follow, as well as the fact that *durables* can be used as a store of value, make the analysis more involved. Considering *nondurables* separately provides a way to get around these problems and measure the impact of credit constraints through a simpler Euler equation.

Campbell and Mankiw (1989) provide a shortcut to do so. By assuming that a fraction λ of income goes to consumers that are liquidity constrained, they obtain, for quadratic preferences, an aggregate Euler equation where λ can be estimated as the coefficient of changes in income. One can then go a step further and test if λ is sensitive to the implementation of a stabilization plan (Copelman, 1994). If it decreases during the stabilization period, this is evidence of a loosening constraint, i.e. a higher share of income goes to unconstrained consumption.

We follow a similar strategy. Instead of assuming that a fraction λ of income goes to liquidity constrained consumers, though, we assume that a fraction λ of them are constrained. As it will be shown below, this permits the use of more general utility functions and, hence, the introduction of precautionary savings. This is important for our purposes for two reasons. First, precautionary savings work as a self imposed liquidity constraint that can bias the estimation of λ. Second, if prudence is in fact an issue, we should expect less intertemporal allocation of consumption driven by credibility (uncertainty) reasons.

To test if λ changes with stabilization, we relate it to variables that are likely to affect liquidity such as unemployment and inflation, and that also change systematically as the plans are implemented. As can be seen in figures 3.3 and 3.5, both inflation and unemployment consistently fall with stabilization. We expect that, as seignorage falls unevenly on low income individuals, an increase in inflation should lead to higher λ. Also, as it becomes more difficult to get credit for those without a job, λ should increase with unemployment as well. Therefore, through these channels, we should observe less constrained consumers as stabilization sets in and, hence, more consumption.

Summing up, by using this framework we will be able to gather evidence on the relative strength of both credibility and credit based explanations. On the one hand, the Euler equation allows us to estimate how strong intertemporal reallocation and precautionary savings are in the behavior of consumers. On the other hand, we can measure whether liquidity constraints matter. If, on average, the fraction of constrained consumers is high, and, in the margin, it shrinks as a plan is implemented, we will have reasons to believe so.

We next describe the consumption problem and present the empirical results.

3.3.1 Model

There are two types of consumers. Consumer type 1, a fraction $1 - \lambda$ of the population, is not constrained and solves the standard intertemporal maximization problem. The Euler equation, after assuming that $R(1+\eta)^{-1} = 1$,[2] becomes:

$$E_t \left[u \left(c_{t+1} \right) \right] = u \left(c_t \right) \tag{3.1}$$

[2] We will relax this assumption below.

or:

$$u(c_{t+1}) = u(c_t) + \xi_{t+1} \tag{3.2}$$

where:

$R = (1 + r)$ is the interest rate;

η is the subjective discount rate;

ξ_{t+1} is orthogonal to information dated t.

Expanding $u(c_{t+1})$ in Taylor series is a convenient way to obtain the precautionary savings term. In special, if we expand it around C_t (Dyna, 1993), we can express the Euler equation 3.2 in growth terms as:

$$\hat{C}_{t+1,1} = \frac{\gamma}{2}\hat{C}^2_{t+1,1} + \xi_{t+1,1} \tag{3.3}$$

where:

γ is coefficient of prudence, i.e. $\gamma = -\frac{Cu'''(C)}{u''(C)}$.

Consumer type 2 is constrained; (s)he is bounded from above by income growth. We assume, however, that consumer type 2 still can keep a savings buffer for precaution. As in 3.3, this adds the self-imposed constraint term $\frac{\gamma}{2}\hat{C}^2_{t+1,2}$ to the Euler equation. Hence:

$$\hat{C}_{t+1,2} = \hat{Y}_{t+1,2} + \frac{\gamma}{2}\hat{C}^2_{t+1,2} \tag{3.4}$$

Assuming $\hat{Y} = \hat{Y}_1 = \hat{Y}_2$, since $C = C_1 + C_2$, we get:

$$\hat{C} = (1 - \lambda)\hat{C}_1 + \lambda\hat{C}_2$$

From 3.3 and 3.4:

$$\hat{C}_{t+1} = \frac{\gamma}{2}\hat{C}^2_{t+1,a} + \lambda\hat{Y}_{t+1} + \eta_{t+1} \tag{3.5}$$

where $\hat{C}^2_{t+1,a}$ is the λ weighted average of $\hat{C}^2_{t+1,1}$ and $\hat{C}^2_{t+1,2}$, which we proxied by $\hat{C}^2_{t+1}$ in the regression. From this regression we can estimate λ.

However, if λ changes the above equation is misspecified... As discussed above, we test for that by assuming that λ is a function of lagged inflation and unemployment. Since inflation is integrated of order 1, we actually use inflation acceleration to avoid spurious results. We assume, then:

$$\lambda_t = \alpha_1(\pi_{t-1} - \pi_{t-2}) + \alpha_2 u_{t-1} \tag{3.6}$$

where:

π: inflation, and;

u: unemployment rate.

Before we move to estimation, though, we need an additional step. Since we are also interested in the intertemporal elasticity of substitution, we allow for variable interest rates in 3.3, instead of assuming $R(1+\eta)^{-1} = 1$. We then get for the unconstrained consumer:

$$\hat{C}_{t+1,1} = \frac{\gamma}{2}\hat{C}^2_{t+1,1} + \frac{1}{\rho}\frac{r_t - \eta}{1 + r_t} + \xi_{t+1,1} \tag{3.7}$$

where:

ρ is the coefficient of relative risk aversion, i.e. $\rho = -\frac{Cu''(C)}{u'(C)}$.

For consumer type 2, although (s)he can reduce consumption as interest rate increases, (s)he cannot reallocate future consumption to the present as the interest rate falls if the constraint is binding. This brings in aggregation problems in rewriting 3.5 for variable interest rates. Since we do not have micro data, and ultimately we just want to measure the response of aggregate consumption to interest rates instead of the individual elasticity of substitution, we include $\frac{r-\eta}{1+r}$ in our regression and interpret the coefficient obtained as an "aggregate" elasticity of substitution.

Therefore, after incorporating this term and substituting 3.6 in 3.5, the equation describing aggregate consumption becomes:

$$\hat{C}_{t+1} = \frac{\gamma}{2}\hat{C}^2_{t+1,a} + \alpha_1(\pi_{t-1} - \pi_{t-2})\hat{Y}_{t+1} + \alpha_2 u_{t-1}\hat{Y}_{t+1} + \theta\frac{r_t - \eta}{1 + r_t} + \zeta_{t+1} \tag{3.8}$$

3.3.2 Empirical Results

We ran an equation similar to the one above. Besides the regressors in 3.8, we include seasonal dummies, as well as inflation acceleration at time t in order to capture Deaton's (1977) involuntary savings. The price of nondurables deflated by the wpi was also included, but turned out to be insignificant. As the regressors may be correlated with the disturbance, instruments were used in the estimation. The estimates, as well as the instruments, are presented in table 3.1.

We can summarize the results as follows[3]. First, the estimate of the intertemporal elasticity (θ), and of the coefficient of prudence (γ) are below one and around nine, respectively[4]. For the credibility effect to be important, we should expect high intertemporal elasticity and low prudence, exactly the opposite of the results obtained. Second, the estimated fraction of constrained consumers (not shown) is around 70%. In addition, the fraction of constrained consumers is sensitive to income and inflation acceleration, as seen by the interaction terms α_1 and α_2, which are positive, as expected.

To conclude this section, the combined evidence of higher prices and higher interest rates during stabilization, the low elasticity of substitution, as well as the high coefficient of prudence suggests that the credibility based explanation has weak empirical support. The high and changing λ indicates a high sensitivity of consumption to changes in income and a loosening constraint following stabilization, respectively. With lower inflation, not only unemployment goes down, but also income tends to recover (see figure 3.5). As a result, two effects fuel consumption. First, higher income translates into higher consumption. Second, more consumers are incorporated into the market.

How strong can these effects be? To get an idea about the numbers involved, we use recent data on households from IBGE's PNAD. Two years after the implementation of the Real Plan there was a 17% decrease in the share of the population classified as social classes D/E; also,

[3]This results are robust to: a) more parsimonious specifications; b) the use of quarterly data; c) the use of overnight or CD's rates; d) the introduction of dummies for the stabilization plans (not significant, though); and e) different sample ranges.

[4]The literature considers 1 to 5 a reasonable range for γ, although higher risk aversion estimates were not unusual in the empirical study of preference parameters carried out by Barsky, Juster, Kimball and Shapiro (1997). Using individual data, these authors also find low intertemporal elasticy of substitution; their average estimate is only 0.18. As regards η, their results suggest a negative subjective discount rate, although the estimates are close to zero. In the regressions we used $\eta = 0$.

household income grew as much as 21% in the poor southeast states of Brazil.

In the following section, we extend this analysis in order to have a closer look at credit market conditions. As it will become clear, the introduction of durables in the consumer problem turns out to be very convenient in pointing out the role of credit in consumption booms.

3.4 Credit Constraints with Durables and Nondurables

If liquidity is an issue for nondurables, it is even more so for durables. However, measuring the fraction of constrained consumers as above does not provide a fair characterization of the credit market situation that the potential consumer of a durable good faces; durables can in principle be more easily financed, since they can also serve as collateral. In this case, even those in the constrained group according the measure of the previous section could still qualify to pay small installments in the purchase of a house appliance, for instance.

This does not mean that durables can make up for borrowing constraints. In fact, as asymmetry of information is likely to be pervasive, durables are imperfect as collateral, so that a lender would rather avoid a distress liquidation of these goods. Under these circumstances, it is then reasonable to expect that market situations that change the risk of default have a direct impact on financing conditions, and, hence, on durables expenditure.

If we could observe these changes in credit market conditions and how they restrict consumption, we would then be in a position to test our claim that credit matters. In particular, if the constraint becomes "less binding" when inflation is low and consumption is booming, this would indicate that consumers can then afford it, even if it is more expensive to do so.

That credit is lower during high inflation times is apparent in figure 3.4, which shows credit to individuals. Anecdotal evidence also supports the view that retail credit markets reopen as inflation is reduced. Motivated by a larger number of lower, fixed installments, lower income consumers became eligible to financing house appliances, and even cars[5].

[5]Consumers are, indeed, very sensitive to the number of installments. As can be seen in figure 3.1, in March 1995 the expenditure on durables plunged after the government limited the number of installments to three. Later in the year when these restrictions were lifted, durables expenditure sharply increased again. It is worth mentioning that this policy was motivated by an external shock, so that the change in credit conditions can be considered totally exogenous to consumption.

However, the fact that credit and expenditure on durables are correlated does not add any information regarding causality. Simply including credit on the right hand side of a consumption regression would raise serious identification problems, which would be difficult to circumvent with the data available.

What we will show in this section is that, when liquidity constraints, durables and non-durables appear together, credit conditions can be observed indirectly through the relative movements of durables with respect to nondurables[6]. Technically, this comes from the fact that, by including both goods in the consumption problem, we can solve for the shadow price of the constraint, which is what we need. The shadow price will then reflect whether credit dominates intertemporal substitution in explaining consumption booms. If it is lower when consumption increases, it is a sign that the supply of loans is expanding faster than demand, i.e. credit is looser.

Intuitively, since durables can be can be used as collateral and they can also be transferred to the future as an asset, two situations unfold. First, under easier credit conditions, say a low risk of default, even if a consumer cannot finance *nondurables*, (s)he can still purchase *durables* based on the fact that these goods can be used as collateral to escape the constraint. Second, if financing is very limited, durables can be liquidated to make up for a temporary income decrease, and, hence, indirectly finance nondurables consumption. In other words, if credit loosens, durables expenditure should increase with respect to non-durables, while the opposite is expected if credit conditions deteriorate.

To make the problem more realistic, instead of just assuming that assets have to be non-negative, we introduce an intermediary that chooses how much to lend. This allows us to make credit supply dependent on the balance sheet condition of consumers, which includes liquid assets and collateral. As it will be shown shortly, besides making the problem more realistic, the inclusion of the intermediary provides an additional way to assess credit conditions. In this case, they can also be traced through the time variation in the coefficients of the Euler equation.

[6]Chah (1990) has an extensive discussion on how the behavior of durables and nondurables are related under credit constraints. He shows that if consumption is liquidity constrained, durable can be used to predict nondurable expenditure. This implication was later used by Chah, Ramey, and Starr (1993) to test for liquidity constraints.

In what follows, we describe the consumer problem and its empirical implementation. We split the exposition in three subsections for clarity. In the first one, we introduce the intermediary. In the second subsection, the consumer maximization problem itself is solved, and, in subsection 3.4.3, the empirical implementation is discussed.

3.4.1 Intermediary

That consumers are strongly affected by retail credit conditions became apparent in March 1995, when consumption plunged in response to the limitation of the number of installments to three, and increased again when that restriction was lifted. But not only legal restrictions affect the supply of credit. In fact, during high inflation episodes, retail credit runs short. Financing a durable good in up 36 to installments, as seen these days, is unlikely in inflationary times even with widespread indexation. In this sense, the reason to include an intermediary in the consumer's problem is to make explicit the variables that, besides policy decisions, affect the supply of loans and, hence, pose a constraint to consumption.

The intermediary we consider in this section is meant to capture the situation in the retail credit market. As such, it is affected by the solvency of its debtors, as well as by the supply of resources from the creditors. The intermediary is affected then through both sides of its balance sheet. On the liabilities side, if policy measures or economic conditions restrict the availability of credit to retailers, credit to consumers is also expected to be affected. On the assets side, if the balance sheet of consumers deteriorates, the risk of default increases, and the intermediary may be forced to cut on loans according to its profit maximization.

On the liabilities side, credit to commerce was 60% lower between the Cruzado and Real plans, while inflation was high and volatile. This behavior may reflect either policy measures to fight inflation or the disintermediation that accompanies the lower degree of monetization in the economy. However, we believe that even more important than that, is the fact that the banking system makes higher profits from seignorage while inflation is high. Instead of supplying funds to commerce, banks allocate most of their resources in deposit accounts, which provide a low risk and high return investment. When inflation is curbed and this source of revenue dries up, the banking system is forced to redirect its activities and increase the supply of credit.

On the assets side, the reasons that make us think that the financial situation of consumers matters and that it is linked to inflation and its variability are the following. First, the system is accessible to low income and low collateral individuals. Those are the least protected from inflation; their real income is severely affected when inflation is unstable, since indexation on the labor market adjusts slowly; in addition, their buffer stock of liquid assets has a higher share of money. Second, monitoring is low. Low income consumers are attracted by small installments, and they become highly indebted as stabilization sets in. When interests are raised, or when inflation accelerates and erodes real income, those exposed debtors are hit, and debt overhangs follow (see figure 3.6). Finally, consumption of durables is depressed during high inflation periods, creating room for debt to increase at the onset of stabilization.

In order to capture these features, we introduce a very simple version of the intermediary. We build on the work of Sandmo (1971), who analyzes the effect of price uncertainty on production. We assume that the intermediary faces perfect competition in the loans market, and that it can be affected in the liabilities side by higher reserves requirement or simply higher interest rates.

On the assets side, we assume that loans are risky, and that risk depends on the balance sheet situation of consumers (debtors). The intermediary lends to a pool of consumers and knows that, as economic conditions turn worse, the fraction of consumers defaulting increases, so that risk increases. It is always exposed to such a risk, since collateral is imperfect. The intermediary assesses the risk of default by observing aggregate variables as the level of debt, liquidity in the economy, and interest rates. It is assumed that, the lower is collateral (K), the lower is the stock of liquid assets (A), and the higher is inflation (π) and, hence, its variability, the higher is the risk of default.

The intermediary's problem is then:

$$\max_{L_t} E\left[u\left(\tilde{r}_L L_t - r_B B_t - F(D_t)\right)\right] \tag{3.9}$$

where:

$D_t = L_t + B_t + Q_t - E_t$

$\tilde{r}^L$: return on loans; we assume its volatility reflects risk of default;

L : loans;

B : government bonds;

Q : reserves (rate q); $Q = qD$;

E: equity;

$F(D_t)$: cost of raising funds, i.e., CD's and time deposits issued to finance investment in B, and L.

We assume $F(D) = r(D)D$, with $r'(D) \succ 0$, and $r"(D) \succ 0$; but making r independent of D does not affect the results. In other words, the intermediary faces a rising cost of raising funds, which we believe to be more realistic.

The FOC for L is given by:

$$E\left[u'\left(r_L L_t - r_B B_t - F(D_t)\right)\left(r_L - \frac{F'(D)}{1-q}\right)\right] = 0 \qquad (3.10)$$

To analyze the effect on L of an increase in risk (in the Second Order Stochastic Dominance sense), we consider $\frac{\partial L}{\partial \gamma}$ after substituting $\gamma\tilde{r}_L + \theta$ for $\tilde{r}_L$ above. θ changes according to $\frac{\partial \theta}{\partial \gamma} = -E[\tilde{r}_L]$ to make it just a mean preserving increase in risk.

It is shown in the appendix that $\frac{\partial L}{\partial \gamma} \prec 0$ for an increase in risk around $E[\tilde{r}_L]$[7]. Since we assumed risk is increasing in π and decreasing in K and A, this pins down the supply of loans for a given policy stance[8].

We summarize the comparative statics results by writing $L_t = L(\underset{+}{A_t}, \underset{+}{K_t}, \underset{-}{\pi_t})$. We expect higher collateral and more assets to facilitate credit. On the other hand, as inflation increases, the risk of default also increases, which drives loan supply down.

Now, we consider how this behavior feeds back in the consumer's maximization problem.

3.4.2 Consumer's Maximization Problem

Consumers derive utility from the consumption of nondurables and the services of the stock of durables. They can accumulate debt as long as they can finance it with loans. However, loans are conditional on the intermediary's choice of how much to lend, given the observed balance sheet situation in the economy. The consumer, in turn, takes loan supply as an exogenous

[7] A sufficient condition for $\frac{\partial L}{\partial \gamma} \prec 0$ is a non-increasing relative risk averse intermediary. This is not necessary, though.

[8] To complete the exposition, we note that interest rates had an ambiguous effect on L. Empirically, the literature on this so called Lending Channel has failed to detected any strong effect of interest rates on loans. In Brazil, it is likely that the link between interest rates and loans was even weaker in the period, since banks were allowed to keep very short-term government bonds as part of their reserves. As interest rates went up, so did the yield on part of the required reserves.

constraint and does not consider the impact of his decisions on the aggregate supply of loans. The problem for the representative consumer is:

$$\max_{C,K} E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[U(C_t) + V(K_t) \right] \right\} \tag{3.11}$$

s.t.:

$$K_t = d_t + (1-\delta)K_{t-1} \tag{3.12}$$

$$L_t = L_{t-1} + l_t \tag{3.13}$$

$$A_t = A_{t-1} + a_t \tag{3.14}$$

$$W_t = A_t - L_t \tag{3.15}$$

$$A_t - L_t = y_t + R^A A_{t-1} - R^L L_{t-1} - C_t - Pd_t \tag{3.16}$$

$$A_t + L_t \geq 0 \tag{3.17}$$

$$L_t = L(A_t, K_t, \pi_t) \tag{3.18}$$

where:

K: durables stock;

C: nondurables;

P: relative price of K with respect to C;

L: liabilities;

l: borrowing;

A: liquid assets;

a: savings;

W: net worth;

δ: depreciation rate;

d_t: purchase of durables;

π: inflation;

$R^i = 1 + r^i$: real interest rate.

The first three constraints are the accumulation equations for durables, liabilities and assets, and equation 3.15 is just the consolidation of the last two. Equation 3.16 is the budget constraint of the consumer, where $R^A - R^L$ is the spread on loans. Finally, equations 3.17 and 3.18 introduce credit market imperfections. Equation 3.17 says that the consumer can run debts as long as (s)he can finance them, while equation 3.18 restraints this financing according to the intermediary's maximization problem. In short, the consumer faces easier credit conditions if the intermediary loosens credit, which happens when collateral and assets stocks are high and inflation is low, so that the uncertainty about consumer's real income stream is low.

To get the first order conditions, we substitute for C_t and maximize the following Lagrangian:

$$\mathcal{L}(A, L, K, \mu) =$$
$$E_0 \left\{ \sum_{t=0}^{\infty} \left[\begin{array}{c} \beta^t \left[\begin{array}{c} U\left(y_t - PK_t + P(1-\delta)K_{t-1} + R^A A_{t-1} - R^L L_{t-1} - A_t + L_t\right) \\ +V(K_t) \end{array} \right] \\ +\mu_t (A_t + L_t) \end{array} \right] \right\}$$

With $P = 1$, for simplicity, and $\beta R^A = 1$, the FOC's are[9]:

$$E_t\left[\beta R^L U_c(t+1)\right] = U_c(t) \tag{3.19}$$

After the envelope theorem on L_t :

[9]The solution for the more general case with price and interests changing in time is shown in the appendix. The results are qualitatively equivalent, but difficult to be implemented empirically given the complexity of the non-linearities introduced. Therefore, we keep the model in its simpler formulation to emphasize the credit related variables. We control for changes in interest rates and in the relative price of durables and non-durables in the estimation, though.

$$E_t\left[U_c\left(t+1\right)\right]=U_c(t)-\mu_t(1+L_{A_t}) \tag{3.20}$$

$$U_K(t)=U_c(t)-E_t\left[\beta\left(1-\delta\right)U_c(t+1)\right]-\mu_t L_{K_t} \tag{3.21}$$

Complementary slackness:

$$\mu_t(A_t+L_t)=0 \tag{3.22}$$

Equation 3.20 becomes the standard Euler equation for consumption if the constraint is not binding. Otherwise, the marginal utility of consumption of nondurables at t is greater than its value at $t+1$, indicating that consumption at t is lower than desired.

More interesting results come from playing with equations 3.20 and 3.21. Note first that, without credit imperfections, the relationship between C_t and K_t is simply given by:

$$U_K(t)=U_c(t)\left(1-\beta\left(1-\delta\right)\right)=U_c(t)\left(\frac{r^A+\delta}{R^A}\right) \tag{3.23}$$

which means that the marginal rate of substitution equals the user cost of durables[10]. Now, with credit imperfections, using 3.20 in 3.21, we get:

$$U_K(t)=U_c(t)\left(1-\beta\left(1-\delta\right)\right)-\mu_t(1+L_{A_t})\left(\varphi_t-\beta\left(1-\delta\right)\right) \tag{3.24}$$

where:

$\varphi_t=\frac{L_{K_t}}{1+L_{A_t}}$ is a function of A_t, K_t, π_t as obtained from the intermediary's problem above.

We see then that credit constraints affect the equilibrium relationship between durables and nondurables. If φ_t is less than $\beta\left(1-\delta\right)$, the marginal utility of durables is greater than in the unconstrained case, i.e. the stock of durables is lower than desired. Moreover, the lower is φ_t, the higher is U_K with respect to U_c[11].

[10] See appendix for the more general case with time-varying P and R^A.

[11] Note that, if $\varphi_t=\beta\left(1-\delta\right)$, durables could actually be used to get around the constraint. However, we want to rule out the possibility that φ_t rises to this point, because it is incompatible with durables being imperfect as collateral, as argued before. This possibility was not ruled out formally, because, when modeling the intermediary, we did not impose enough structure on $L(.)$ by fleshing out the contract aspect of the problem.

The interesting point is that we can interpret φ_t as an indicator of the financing conditions in the credit market. Note first that it is obtained from the intermediary's maximization problem and it reflects the response of loan supply to changes in the balance sheet situation of the consumer.

Although we cannot show it formally without a more complete model of intermediation, intuitively we can relate φ_t to the fraction of new expenditure on durables that the consumer can cover with loans.

In the lines of the arguments presented in the previous section, since durables are imperfect as collateral, the lender wants to avoid a distress liquidation of these goods. Under circumstances of high risk of default, liquid assets would be very welcome as collateral, so that the supply of loans should be very sensitive to them, i.e. L_{A_t} should be high. On the other hand, durables would not be as valuable to the lender, given that they are not as liquid, i.e. L_{K_t} should be low. Either way, as credit conditions deteriorate and loans run short, α_t should decrease.

An estimate of φ_t would then provide an indirect measure of credit conditions and how they change during stabilization programs. To get such an estimate, we need first to solve for μ_t. Doing so in equation 3.24, and plugging the result in 3.20 leads to[12]:

$$E_t\left[U_c\left(t+1\right)\right]-U_c(t)=\frac{1}{\left(\varphi_t-\beta\left(1-\delta\right)\right)}\left[U_K(t)-U_c(t)\left(1-\beta\left(1-\delta\right)\right)\right] \qquad (3.25)$$

To estimate 3.25, however, it is necessary to parameterize it. Before we move to this task, though, we want to introduce a more direct way of assessing the credit situation in the economy.

By differencing 3.24, we can solve for $\left[\Delta\mu_t\left(1+L_{A_t}\right)\right]$ as a function of durables and non-durables consumption, and $\phi_t=\left[\frac{(\varphi_t-\beta(1-\delta))}{(1-\beta(1-\delta))}\right]$, which can be estimated from the parameterized version of 3.25, equation 3.33 below. Now observe that $\mu\left(1+L_{A_t}\right)$, which we call ζ, is the wedge introduced by the borrowing constraint. To see this, just go back to equation 3.20 and note that, without the constraint, we would have gotten $E_t\left[U_c\left(t+1\right)\right]=U_c(t)$ instead.

As discussed above, the shadow value of the constraint is a key variable in assessing the

[12]Note that, with liquidity constraint, consumption of nondurables is not a martingale any more. Information contained in the relative movement of K_t with respect to C_t can now be used to predict C_{t+1} (see also Chah, 1990, and Chah, Ramey and Starr, 1994).

importance of credit in consumption booms. If $\varphi_t \prec \beta(1-\delta)$, i.e. if credit markets are not perfect, an increase in the consumption growth of durables vis-a-vis nondurables reveals a loosening constraint, since from 3.24, $\Delta\zeta_t \prec 0$. This is intuitive, since durables are expected to be more sensitive to credit conditions than nondurables. Therefore, if we can estimate $\Delta\zeta_t$ and φ_t, we will be able to indirectly measure credit stance, and, hence, contrast it to credibility based explanations. We will show how to do it in the subsection that follows.

In summary, formulating the consumer problem with durable and nondurable goods under constrained borrowing provides a method of observing credit conditions through two variables: $\Delta\zeta_t$, and φ_t. Since these variables are derived from the consumer maximization problem, this approach avoids serious identification problems that would result from the use of credit as a regressor in the consumption equation.

What we do next is to parameterize the model and describe its empirical implementation.

Parameterization We assume CRRA utility functions, allowing for non-homotheticity ($\alpha \neq \gamma$): $U(C) = \frac{C^{1-\rho}}{1-\rho}$, and $V(K) = \frac{K^{1-\gamma}}{1-\gamma}$

Rewriting equation 3.20 with ε_{t+1} orthogonal to information dated t, we get:

$$\frac{C_{t+1}^{-\rho}}{C_t^{-\rho}} = 1 - \frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}} + \varepsilon_{t+1} \tag{3.26}$$

From 3.19 and 3.20, we note that:

$$E_t\left[\beta\left(R^L - R^A\right)U_c(t+1)\right] = \mu_t(1+L_{A_t}) \tag{3.27}$$

or:

$$E_t\left[\frac{\mu_t(1+L_{A_t})}{C_{t+1}^{-\rho}}\right] = \beta\left(R^L - R^A\right) \tag{3.28}$$

Since, from 3.20, we expect $C_{t+1}^{-\rho} \preceq C_t^{-\rho}$, and from 3.28 we know that the right hand side is small, $\frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}}$ should be even smaller, so that we can take logs and approximate 3.26 as:

$$\rho\Delta\ln C_{t+1} = \frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}} - \varepsilon_{t+1} \tag{3.29}$$

Now, in parameterizing 3.24, we first rewrite it as:

$$\frac{U_K(t)}{U_c(t)\,(1-\beta\,(1-\delta))} = 1 - \frac{\mu_t(1+L_{A_t})}{U_c(t)}\frac{(\varphi_t - \beta\,(1-\delta))}{(1-\beta\,(1-\delta))} \tag{3.30}$$

or:

$$\frac{K_t^{-\gamma}}{C_t^{-\rho}\,(1-\beta\,(1-\delta))} = 1 - \frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}}\phi_t \tag{3.31}$$

where:

$\phi_t = \left[\frac{(\varphi_t - \beta(1-\delta))}{(1-\beta(1-\delta))}\right]$

Using the log approximation[13]:

$$-\gamma \ln K_t = -\rho \ln C_t + \ln\left(1-\beta\,(1-\delta)\right) - \frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}}\phi_t \tag{3.32}$$

Since we do not have data on the stock of durables, we solve 3.29 and 3.32 for $\frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}}$ and work with differences to get[14]:

$$\Delta \ln K_t = \phi_t \frac{\rho}{\gamma} \Delta \ln C_{t+1} + \frac{\rho}{\gamma}\,(1-\phi_t)\,\Delta \ln C_t - \eta_{t+1} \tag{3.33}$$

where:

$\eta_{t+1} = \frac{\phi_t}{\rho}\Delta\varepsilon_{t+1}$

3.4.3 Empirical Implementation and Results

We first estimated 3.33 using instruments for $\Delta \ln C_{t+1}$ and $\Delta \ln C_t$, and dummies for the stabilization programs, price freezes, and seasonality. We also controlled for the relative price of durables with respect to nondurables and interest rate movements, as the more general model in the appendix 1 suggests. The results are shown in table 3.2[15].

[13] The estimated ϕ_t 's are less than one in absolute value.

[14] We assume small $\Delta\phi_t$ to obtain 3.33. This assumption was confirmed in the estimation. Another important observation is that the differencing of 3.29 introduces a unit root in the MA process followed by η_{t+1}. This does not bias the coefficients, though. To obtain meaningful t statistics, however, we used the Newey-West procedure.

[15] Technically, this is not a correct estimation procedure, since the coefficients are time-varying. We introduced dummies to minimize structural breaks, and so get a first look at the results. The qualitative results do not change in the estimation with time-varying parameters, though.

Again, the interest rate does not play a big role in explaining durables expenditure. In addition, the coefficients of $\Delta \ln C_{t+1}$ and $\Delta \ln C_t$ have opposite signs, as the model predicts, although they are not very significant. These coefficients suggest that credit conditions are not close to perfect, so that $\varphi_t - \beta(1-\delta) \prec 0$ as shown by the negative $\hat{\phi}$ and the positive $\left(1-\hat{\phi}\right)$[16].

Although encouraging, we should be careful not to take these results too far. One has to keep in mind that endogeneity may still be an issue in this estimation, since we were limited to the use of lagged variables as instruments. We cannot resolve this issue without better instruments, though, and we leave it as a caveat[17].

The time variation of ϕ As discussed above, the time variation of ϕ_t also conveys important information for our argument. If ϕ_t goes down, this means that φ_t is decreasing, i.e. credit conditions are deteriorating. To obtain the path of ϕ_t, we wrote 3.33 in state-space form, with ϕ_t following a random walk. The Kalman filter estimation result for this process is graphed in figure 3.7. In few words, credit conditions are better in the Cruzado and Real plans, and deteriorates in between, which includes the credit crunch during the Collor Plan.

Again, as a word of caution, the same caveat of the previous subsection applies here as well. However, the evidence on the shadow price of the constraint that we present next is less affected by eventual estimation problems, since it follows directly from the relative movements of durables and nondurables.

The shadow price of the credit constraint We now move on to measure the shadow price of the constraint. This is key for our claim that credit matters for consumption booms. As discussed before, we use $\zeta = \mu(1 + L_{A_t})$ as our measure. To trace ζ_t, a linear approximation is implemented, i.e. the model is parameterized with quadratic utilities. We do not think that the results will be very sensitive to this limitation, though. As can be seen in equation 3.24, as long as durables move with respect to nondurables, we should be able to observe changes in ζ for any sensible utility parameterization. In particular, if durables expenditure increases vis-a-vis the consumption growth of nondurables, this is a sign that the constraint becomes less

[16] We cannot reject that the coefficients satisfy the restriction implied by equation 3.33.

[17] Note that the Hausman test rejects endogeneity. However, this result depends on the validity of the instruments.

binding. And, in fact, this is the pattern detected by the linear approximation of $\Delta\zeta_t$.

For the quadratic utility case, it is assumed that $U(C) = -\frac{bC^2}{2}$, and $V(K) = -\frac{b\sigma K^2}{2}$, where σ is a parameter for the services of the stock of durables.

Using these functional forms in 3.24, and taking differences[18]:

$$\Delta\zeta_t = \frac{1}{\alpha\phi_t}(\Delta K_t - \alpha\Delta C_t) \tag{3.34}$$

where: $\alpha = \frac{[1-\beta(1-\delta)]}{\sigma}$

To compute $\Delta\zeta_t$, we want to control for seasonality and the effects that interest rate and relative price changes may have on the movement of durables with respect to nondurables. Therefore, we actually measure $(\Delta K_t - \alpha\Delta C_t)$ as the residuals of a linear regression of durables expenditure on ΔC_t, as well as the difference in the relative price of durables with respect to nondurables, the real interest rate, seasonal dummies, and a dummy for price freezes. Then we generated $\Delta\zeta_t$ by plugging ϕ_t from the estimation of 3.33. The results are shown in figure 3.8[19].

The pattern of the changes in the shadow price is similar to the path followed by inflation and credit to individuals. It decreases during the beginning of both Cruzado and Real plans, but increases in between, which includes the credit crunch of the Collor Plan period. We also show in the figure a Hodrick-Prescott smoothed $\Delta\zeta_t$. The comparison with credit to individuals in figure 3.4 is suggestive: the supply of credit seems to be important in constraining consumption during high and volatile inflation times.

In the following section we summarize our findings and conclude.

[18] Consistently with the estimation results, it is assumed that $\Delta\phi_t \cong 0$.

[19] A word of caution is needed here. The residuals obtained from this regression incorporate adjustment costs, which may bias $\Delta\zeta$. We have two observations on this caveat.

First, the impact of adjustment costs is to dampen the response of durables, and so to smooth $\Delta\zeta$. But it does not affect the *direction* of the movement of durables with respect to nondurables.

Second, the theory without adjustment cost predicts that the first difference of durables expenditure should be a MA(1) with coefficient $-(1-\delta)$. This is strongly rejected for US, where it takes almost two years for the sum of the MA coefficients to add up to one (see Caballero, 1987 for details). In Brazil, however, the MA(1) coefficient with quarterly data is already close to -1. In other words, the evidence indicates quick adjustment.

3.5 Summary and Conclusion

The credibility explanation for the consumption booms that characterize ERB stabilization programs relies on consumption being cheaper while the plan lasts. Expecting inflation to resume its post-failure rate, consumers optimally choose to increase consumption during the stable period. In this chapter, we claim that credibility driven intertemporal reallocation has no empirical support in the case of Brazil; in addition, we identify credit as the dominating factor behind consumption booms. The reasons are the following.

First, nondurables prices and the user cost of durables were actually higher during low inflation times. This was the case even in the beginning of the Real plan; although durables prices fell, they did not drop as much to offset the increase in the user cost as real interest rates were kept as high as 45% a.a.

Second, the credibility story neglects uncertainty. We presented evidence of significant and strong precaution, so that, besides higher prices, there is an additional reason for consumers to save more during the stabilization.

Third, we also found strong evidence of liquidity constraints. More than that, our findings suggest that this constraint becomes looser during lower inflation periods and that this effect dominates intertemporal reallocation in explaining the non-smooth consumption path. On the one hand, income redistributions that accompany stabilization plans are skewed towards the constrained consumers, which then have more "cash" to consume as stabilization sets in. On the other hand, retail credit markets reopen, which facilitates the purchase of all goods, specially durables.

In summary, the evidence strongly suggests that movements in credit constraints dominate intertemporal reallocation as the underlying force driving consumption booms in Brazil.

Appendix 1

A1)Intermediary

The first order condition for the intermediary is:

$$E\left[u'\left(r_L L_t - r_B B_t - F(D_t)\right)\left(r_L - \frac{F'(D)}{1-q}\right)\right] = 0 \tag{.35}$$

The second order condition is:

$$E\left[u''\left(r_L L_t - r_B B_t - F(D_t)\right)\left(r_L - \frac{F'(D)}{1-q}\right)^2 - u'\left(r_L L_t - r_B B_t - F(D_t)\right)\frac{F''(D)}{(1-q)^2}\right] \prec 0 \tag{.36}$$

Differentiating totally with respect to L, and γ:

$$(SOC)dL = -E\left[u''(\cdot)\left(\tilde{r}^L - E\left[\tilde{r}^L\right]\right)\left(\tilde{r}^L - \frac{F'(D)}{1-q}\right)L + u'(\cdot)\left(\tilde{r}^L - E\left[\tilde{r}^L\right]\right)\right]d\gamma \tag{.37}$$

where: SOC is the LHS of .36.

Now, $u'(\cdot)\left(\tilde{r}^L - E\left[\tilde{r}^L\right]\right)$ is negative for concave $u(.)$. If the mean preserving spread is around the certainty equilibrium, we get $E\left[\tilde{r}^L\right] = \frac{F'(D)}{1-q}$, so that the RHS of .37 is positive. Since SOC is negative, $\frac{\partial L}{\partial \gamma} \prec 0$.

A2)Durables and nondurables with variable price and interest rate.

Here we extend the model of section 3.4 to allow for time-varying R and P . The consumer problem becomes:

$$\underset{C,K}{max}\, E_0\left\{\sum_{t=0}^{\infty}\beta^t\left[U(C_t) + V(K_t)\right]\right\}$$

s.t.:

$$K_t = d_t + (1-\delta)K_{t-1} \tag{.38}$$

$$L_t = L_{t-1} + l_t \tag{.39}$$

$$A_t = A_{t-1} + a_t \tag{.40}$$

$$W_t = A_t - L_t \tag{.41}$$

$$A_t - L_t = y_t + R^A_{t-1} A_{t-1} - R^L_{t-1} L_{t-1} - C_t - P_t d_t \tag{.42}$$

$$A_t + L_t \geq 0 \tag{.43}$$

$$L_t = L(A_t, K_t, \pi_t) \tag{.44}$$

where:

K: durables stock

C: nondurables

P: relative price of K with respect to C

L: liabilities

l: borrowing

A: liquid assets

a: savings

W: net worth

δ: depreciation rate

d_t: purchase of durables

π: inflation

$R = 1 + r$: real interest rate

To get the first order conditions, we substitute for C_t and maximize the following Lagrangian:

$$\mathcal{L}(A, L, K, \mu) =$$

$$= E_0 \left\{ \sum_{t=0}^{\infty} \left[\beta^t \left[\begin{array}{c} U\left(y_t - PK_t + P_t(1-\delta)K_{t-1} + R^A_{t-1}A_{t-1} - R^L_{t-1}L_{t-1} - A_t + L_t\right) \\ +V(K_t) \end{array} \right] + \begin{array}{c} \\ \\ +\mu_t (A_t + L_t) \end{array} \right] \right\}$$

FOC's are:

$$E_t\left[\beta R_t^L U_c(t+1)\right] = U_c(t) \tag{.45}$$

After envelope theorem on L_t:

$$E_t\left[\beta R_t^A U_c(t+1)\right] = U_c(t) - \mu_t(1 + L_{A_t}) \tag{.46}$$

$$U_K(t) = P_t\left\{U_c(t) - E_t\left[\beta(1-\delta)\pi_{t+1}^K U_c(t+1)\right]\right\} - \mu_t L_{K_t} \tag{.47}$$

where $\pi_{t+1}^K = \frac{P_{t+1}}{P_t}$

Complementary slackness:

$$\mu_t(A_t + L_t) = 0 \tag{.48}$$

We assume R_t and π_{t+1}^K known as of t to avoid assuming covariances with respect to $U_c(t+1)$.

From .46 and .47:

$$\frac{U_K(t)}{P_t} = U_c(t)\left(\frac{R_t^A - \pi_{t+1}^K(1-\delta)}{R_t^A}\right) - \mu_t(1 + L_{A_t})\left(\frac{R_t^A\varphi_t - \pi_{t+1}^K(1-\delta)}{R_t^A}\right) \tag{.49}$$

where:

$\varphi_t = \frac{L_{K_t}}{P_t(1+L_{A_t})}$ is a function of A_t, K_t, π_t as obtained from the intermediary's problem above.

Note , that, without liquidity constraint, we get the standard condition that the marginal rate of substitution equals the user cost of durables:

$$\frac{U_K(t)}{P_t} = U_c(t)\left(\frac{R_t^A - \pi_{t+1}^K(1-\delta)}{R_t^A}\right) \tag{.50}$$

Parameterization:

We assume CRRA utility functions, allowing for non-homotheticity ($\alpha \neq \gamma$):

$U(C) = \frac{C^{1-\rho}}{1-\rho}$, and $V(K) = \frac{K^{1-\gamma}}{1-\gamma}$

Rewriting equation .46:

$$E_t\left[\beta R_t^A \frac{C_{t+1}^{-\rho}}{C_t^{-\rho}}\right] = -\frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}} \tag{.51}$$

Hence, for ε_{t+1} orthogonal to information dated t, we can write .51 as:

$$\beta R_t^A \frac{C_{t+1}^{-\rho}}{C_t^{-\rho}} = 1 - \frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}} + \varepsilon_{t+1} \tag{.52}$$

From .45 and .46, we note that:

$$E_t\left[\beta\left(R_t^L - R_t^A\right)U_c(t+1)\right] = \mu_t(1+L_{A_t}) \tag{.53}$$

or:

$$E_t\left[\frac{\mu_t(1+L_{A_t})}{C_{t+1}^{-\rho}}\right] = \beta\left(R_t^L - R_t^A\right) \tag{.54}$$

Since, from .46, we expect $C_{t+1}^{-\rho} \prec C_t^{-\rho}$, $\frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}}$ should be small, so that we can take logs and approximate .52 as:

$$\rho\Delta \ln C_{t+1} = \left(r_t^A - \tau\right) + \frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}} - \varepsilon_{t+1} \tag{.55}$$

where τ is the intertemporal discount rate.

This is the basic formulation for Euler equation based tests of liquidity constraints.

Now, in parameterizing .49 we first rewrite it as:

$$\frac{R_t^A U_K(t)}{P_t U_c(t)\left(R_t^A - \pi_{t+1}^K(1-\delta)\right)} = 1 - \frac{\mu_t(1+L_{A_t})}{U_c(t)} \frac{\left(\varphi_t R_t^A - \pi_{t+1}^K(1-\delta)\right)}{\left(R_t^A - \pi_{t+1}^K(1-\delta)\right)} \tag{.56}$$

Call:

$R_t^K = P_t R_t^A - \pi_{t+1}^K(1-\delta)$, and

$R_t = \frac{R_t^K}{R_t^A}$.

Now, with the functional form substituted in .56:

$$\frac{K_t^{-\gamma}}{P_t C_t^{-\rho} R_t} = 1 - \frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}}\phi_t \tag{.57}$$

where:

$\phi_t = \left[\frac{\left(\varphi_t R_t^A - \pi_{t+1}^K(1-\delta)\right)}{\left(R_t^A - \pi_{t+1}^K(1-\delta)\right)}\right]$

Using the log approximation[20]:

$$-\gamma \ln K_t = \ln R_t - \rho \ln C_t - \frac{\mu_t(1 + L_{A_t})}{C_t^{-\rho}}\phi_t \qquad (.58)$$

Solving .55 and .58 for $\frac{\mu_t(1+L_{A_t})}{C_t^{-\rho}}$ and working with differences, we get:

$$\Delta \ln K_t = \phi_t \frac{\rho}{\gamma}\Delta \ln C_{t+1} + \frac{\rho}{\gamma}(1 - \phi_t)\Delta \ln C_t - \frac{1}{\gamma}\Delta \ln R_t - \frac{\phi_t}{\gamma}\Delta r_t^A - \eta_{t+1} \qquad (.59)$$

where:

$\eta_{t+1} = \frac{\phi_t}{\rho}\Delta\varepsilon_{t+1}$

This is similar to equation 3.33 in section 3.4, but now relative prices and the interest rate appear as regressors. This is a very complicated non-linear form to be estimated, though. Therefore, in the empirical work we just introduce relative prices and interest rates as linear regressors.

Data Appendix

Credit to individuals and commerce, overnight rates and nominal interest rates on 30 days CD's, and price indexes for durables and nondurables were obtained from the Central Bank Bulletin.

Expenditure on durables and nondurables, nominal and real, were provided by FCESP and cover the metropolitan area of São Paulo.

Unemployment comes from IBGE - Open Unemployment Index. Wages are total wages collected by FIESP, which are available from *Revista de Conjuntura Econômica*.

Finally, non-performing loans was obtained from SERASA. The wholesale price index from IFS was used as deflator for credit, non-performing loans, price indexes of durables and non-durables, and interest rates.

[20] Remember that the estimated ϕ_t from the Kalman filter is less than one in absolute value.

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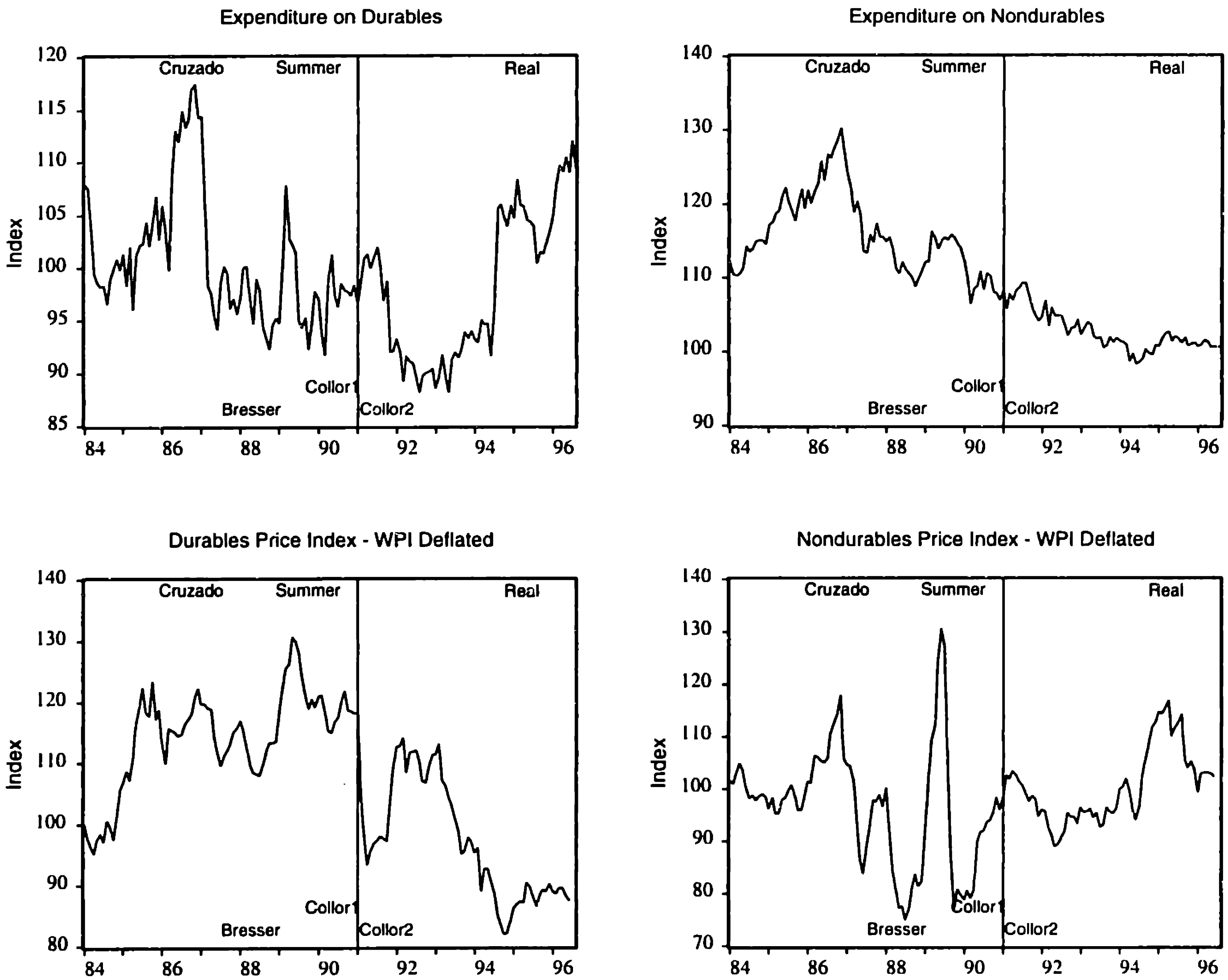

Figure 3.1: Expenditure and Prices

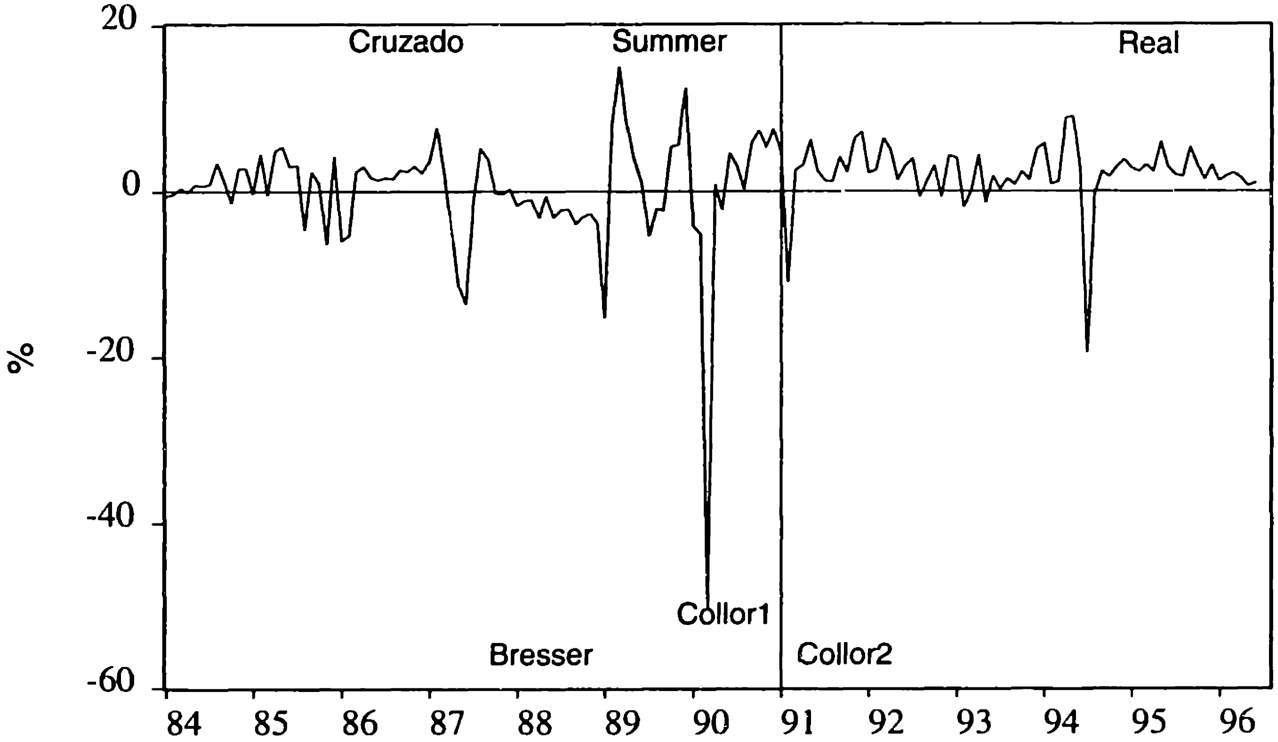

Figure 3.2: Monthly Real Interest Rate - WPI Deflated 30 Days CD's

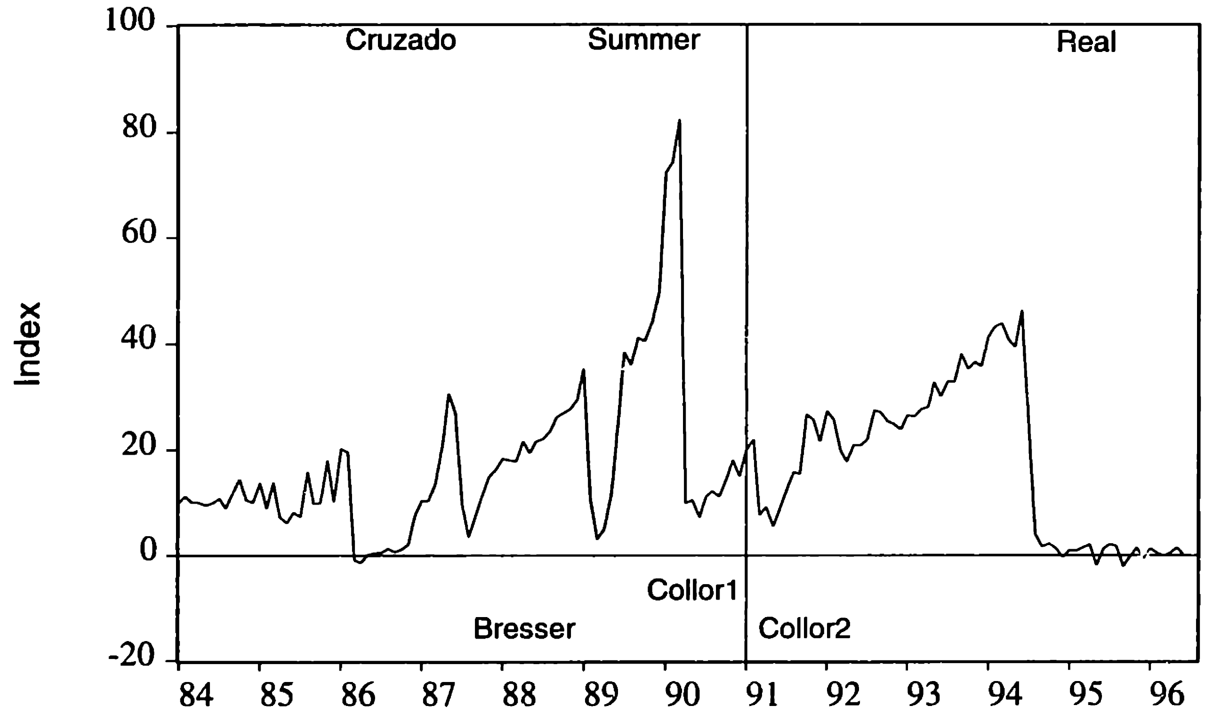

Figure 3.3: Monthly Inflation

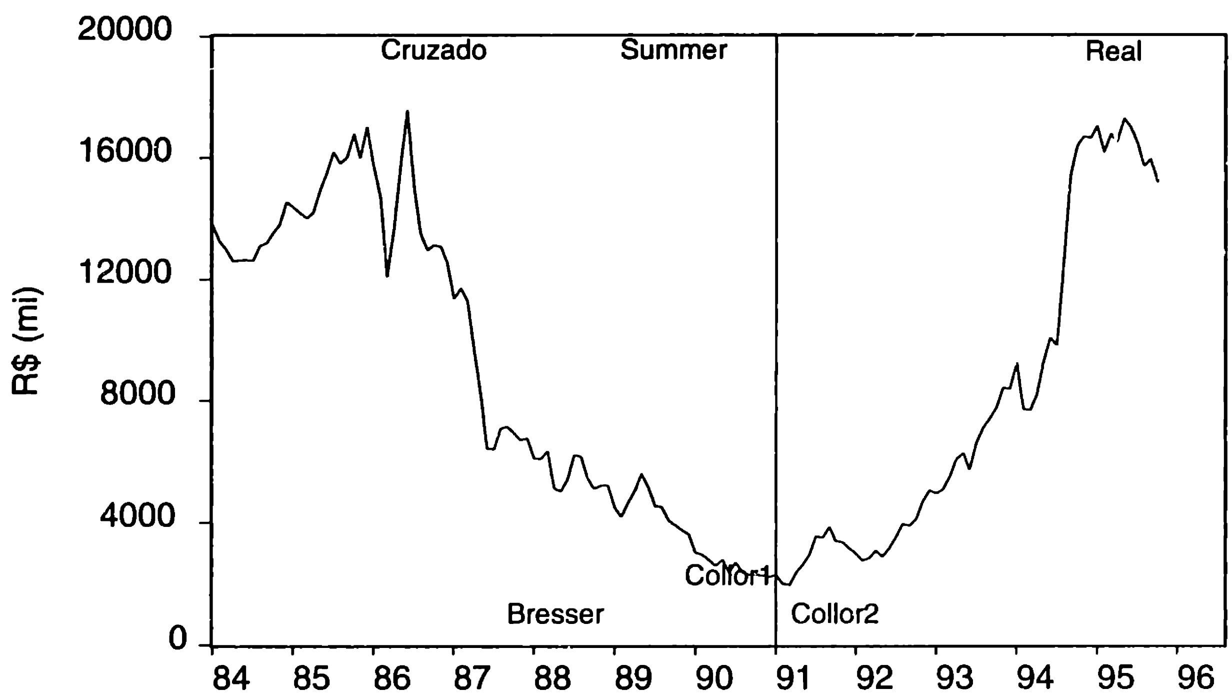

Figure 3.4:Credit to Individuals

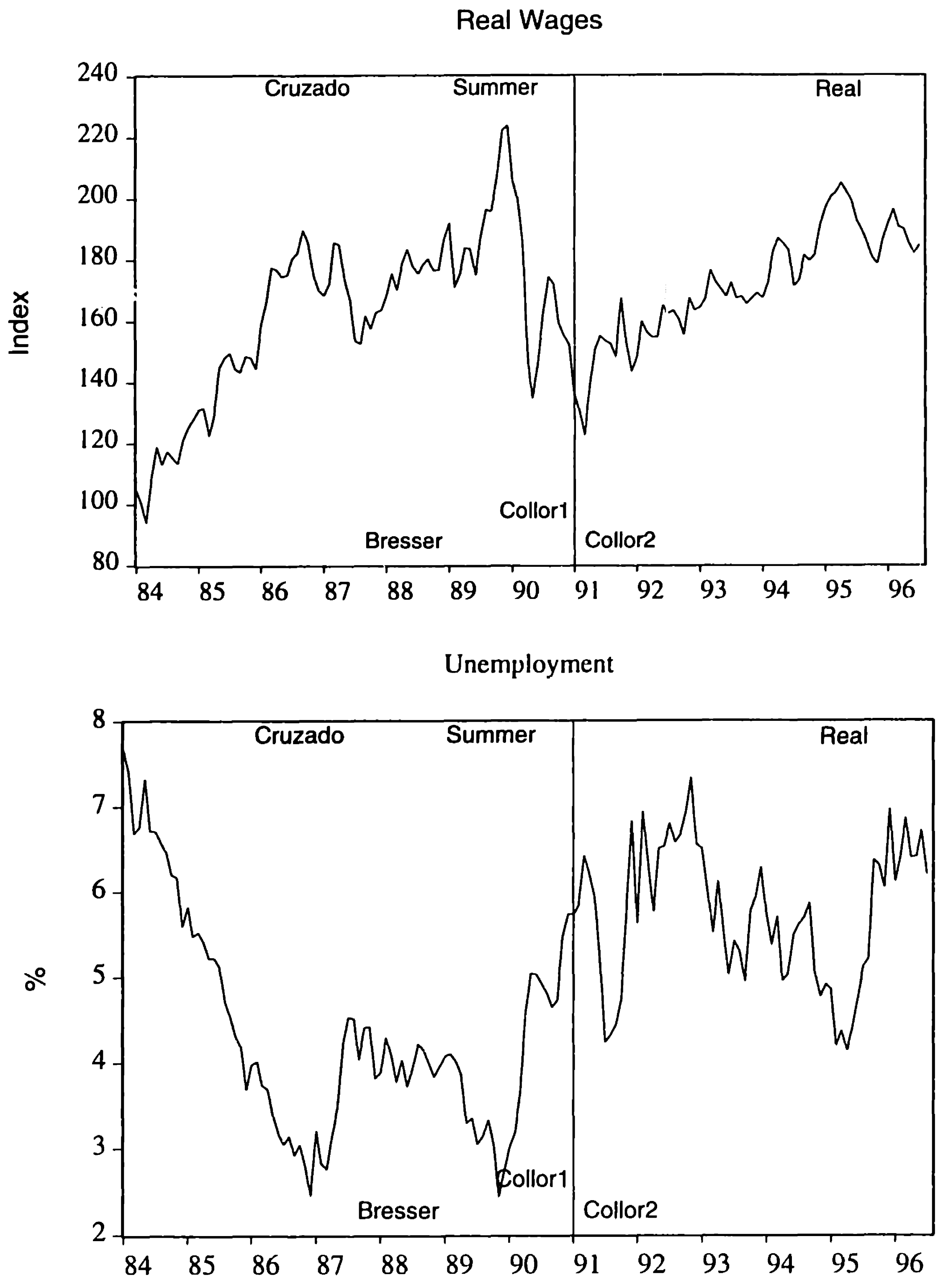

Figure 3.5: Real Wages and Unemployment - Seasonally Adjusted

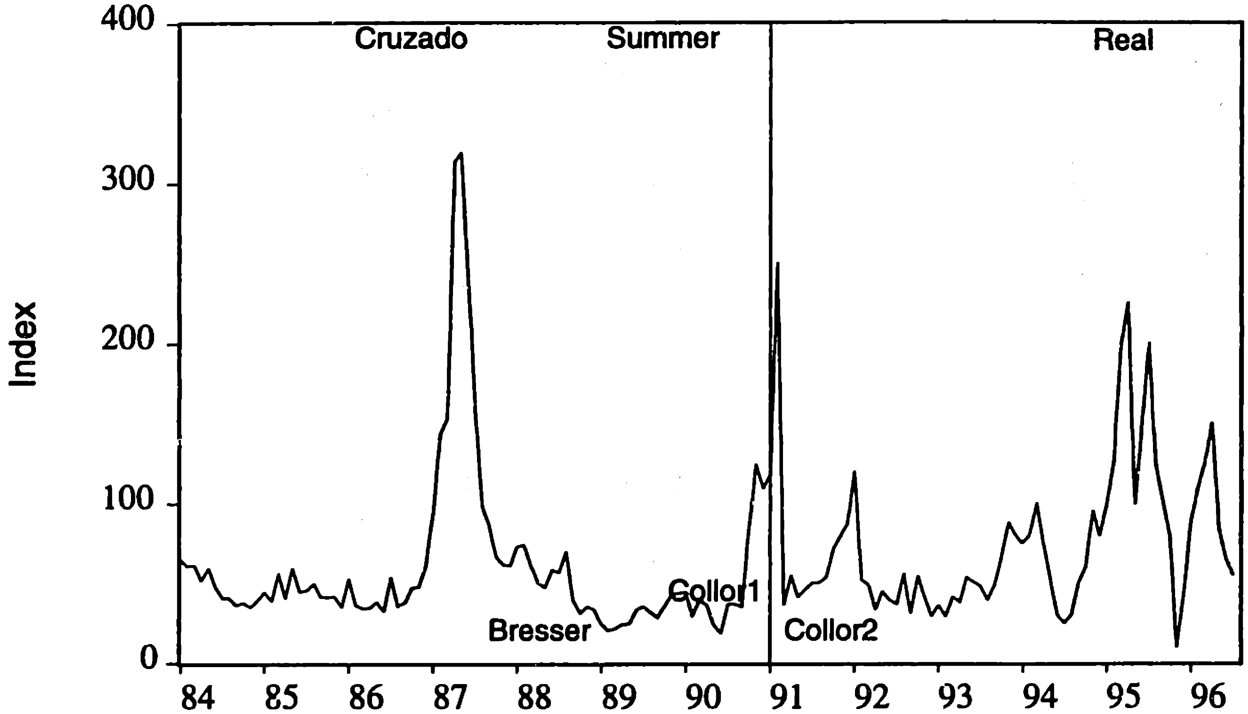

Figure 3.6: Non-Performing Loans

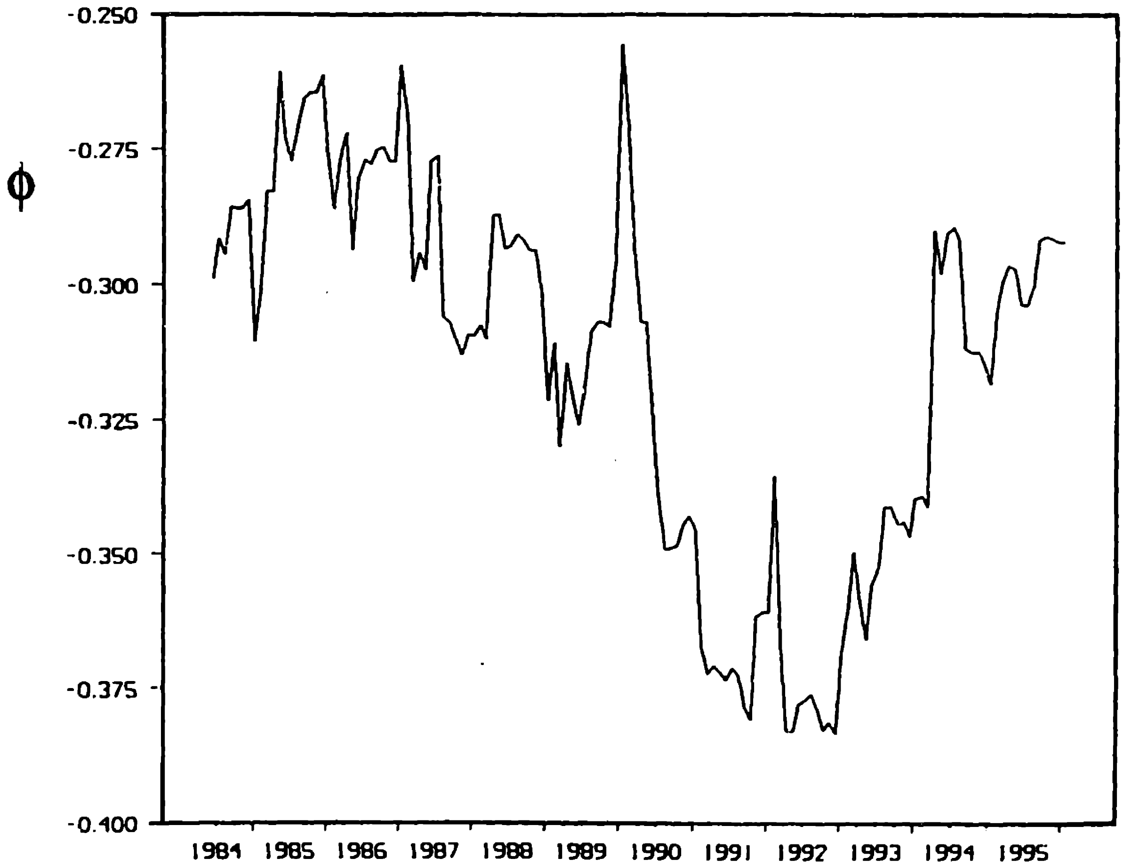

Figure 3.7: Time Variation of Euler Equation Coefficient ϕ

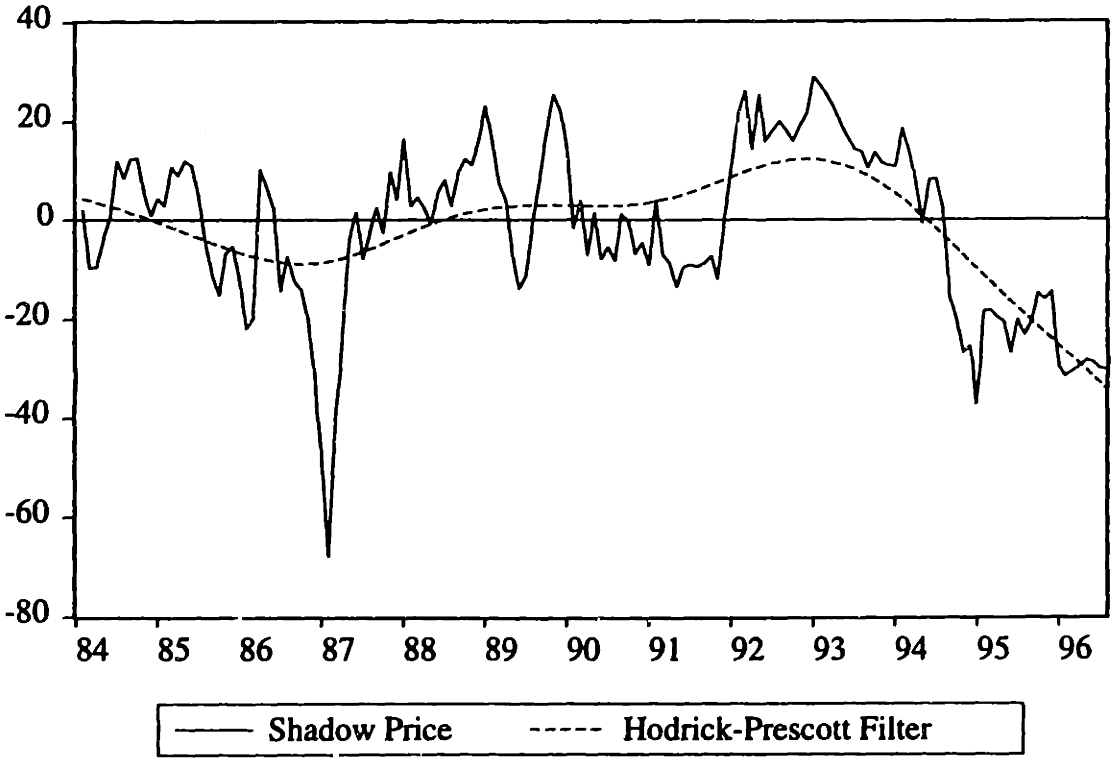

Figure 3.8: Changes in the Shadow Price of the Credit Constraint

Table 3.1
Equation 1.8 Estimation Results
Dependent variable is consumption growth of nondurables (GNDUR)
Estimation: GMM
Sample(adjusted): 1985:07 1996:02
Included observations: 128

Coefficient	Estimate	Std. Error	t-Statistic
C	-0.086	0.0869	-0.98
$\lambda/2$	4.461	1.2008	3.72
θ	0.373	0.1576	2.37
Inflation Acceleration	-0.0018	0.0004	-4.24
$\alpha 1$	0.0190	0.0041	4.64
$\alpha 2$	0.577	0.3129	1.84
Seasonal Dummies			
SEAS(1)	-0.634	0.0357	-17.8
SEAS(2)	0.1002	0.0867	1.16
SEAS(3)	0.0909	0.0653	1.39
SEAS(4)	-0.0127	0.0795	-0.16
SEAS(5)	0.0741	0.0873	0.85
SEAS(6)	0.0485	0.0777	0.62
SEAS(7)	0.1109	0.0846	1.31
SEAS(8)	0.1205	0.0811	1.49
SEAS(9)	0.0551	0.0817	0.67
SEAS(10)	0.0788	0.0843	0.93
SEAS(11)	0.0866	0.0878	0.99
Adjusted R-squared	0.64	**Mean GNDUR**	0.004
Durbin-Watson stat.	2.09	**S.D. GNDUR**	0.141
Hausman Test: χ^2_{17}	3.53		

Newey-West standard errors
Instrument list:
Except for $(GNDUR)^2$, the explanatory variables own lags (1 to 4) were used as instruments; for $(GNDUR)^2$, squared income growth lagged 1 to 4 were the instruments.

Table 3.2
Equation 1.33 Estimation Results
Dependent variable is durables expenditure; GNDUR is nondurables expenditure growth.
Estimation: 2SLS
Included observations: 145

Variable	Estimate	Std. Error	t-Statistic
C	198.702	14.134	14.06
Price Dur./Nondur.	-0.452	0.102	-4.42
GNDUR	0.220	0.160	1.37
GNDUR(+1)	-0.264	0.213	-1.24
Real Int. Rate (%p.y.)	0.152	0.122	1.24
Seasonal Dummies			
SEAS(1)	-47.377	13.325	-3.6
SEAS(2)	-62.143	9.896	-6.3
SEAS(3)	-55.407	7.970	-7.0
SEAS(4)	-56.081	9.339	-6.0
SEAS(5)	-44.145	8.592	-5.1
SEAS(6)	-54.287	9.452	-5.7
SEAS(7)	-45.269	9.492	-4.8
SEAS(8)	-45.167	8.319	-5.4
SEAS(9)	-43.780	9.328	-4.7
SEAS(10)	-42.690	8.877	-4.8
SEAS(11)	-31.086	13.181	-2.4
Dummies for Stabilization Plans			
DFREEZE	10.836	6.832	1.6
DCRUZADO	17.126	5.677	3.0
DBRESSER	-4.582	4.468	-1.0
DVERAO	-2.878	4.709	-0.6
DCOLLOR1	0.231	5.256	0.0
DCOLLOR2	-24.975	3.350	-7.5
DREAL	-2.660	4.576	-0.581
Adjusted R-squared	0.7638	**Mean GNDUR**	99.6
Hausman Test: χ^2_{23}	2.7	**S.D. GNDUR**	27.3

Newey-West standard-errors
Mean(Price Dur./Nondur.) = 1.1
Instruments list:
GNDUR, income growth, and real interest rate lags (1 to 4) were were used as instruments.
Obs: These are the starting values used in the Kalman filter

Chapter 4

The Duration of Real Exchange Rate Deviations

4.1 Introduction

Scarcity of empirical work on exchange rates is for sure not among the reasons why we still fail to closely track or predict their movements. The numerous papers on this issue have spanned the short and long-run of it, real and nominal rates, forward and spot markets, currency crises and contagion, so as to make of the exchange rate possibly the most empirically scrutinized topic in International Economics.

Yet, while the amplitude of exchange rate movements has received a lot of attention in the literature, the duration of appreciation and depreciation spells has been, to our knowledge, completely overlooked. We will show in this paper that duration analysis both provides a flexible regression approach and broadens the reach of empirical work on exchange rates.

We give a preview of our findings. First, contrary to what the previous literature might have suggested, fixed regimes look more prone to misalignments. Not only they concentrate the high and longer appreciation spells, but appreciation time is also relatively longer for fixed regimes. Looking at 15% or higher appreciation spells, while under fixed regimes 25% of the spells lasted 4 years or longer, 75% of them never surpassed the 6 months cutoff under flexible arrangements.

Second, duration regressions, besides being conceptually appropriate for the problem at hand, provide consistent results. Higher interest rates, government consumption and GDP growth are strongly associated with longer appreciations. For depreciations, higher government consumption and the cumulation of current account surpluses increase the hazard of such spells ending.

Third, the estimated baseline hazards suggest that, even after controlling for government consumption, interest rate differential, net foreign assets or GDP growth, the pressure for reversion rises along the path of exchange rate deviations.

In terms of empirical research, this study benefits from the recent encouraging results on long-run exchange rate estimation, which constitutes the reference around which our deviation spells are constructed. As a result of the development of econometrics and the introduction of new and longer data sets, today we have much more to say about the exchange rates in the long-run and the dynamics around it than just a decade ago, when the resilience of the random walk model was hard to beat. The so called fundamentals have recently drawn renewed attention from researchers, and the new evidence suggests that their importance increases the further away one stays from the very short run, when the effect of news indeed seem to dominate[1]. As shown in chapter 2, the usual suspects, namely terms of trade, commercial policy and international productivity differential across tradables and non-tradables, proved to be more than just suspects and provided a robust long-run referential for exchange rate assessment. Government expenditure, international interest rate differentials, and cumulated current accounts also played the usual role in explaining the dynamics around the long-run, but as can be seen there, the explanatory power of these variables was not startling, and neither was the dynamics natural to interpret.

This later remark constitutes a feature of empirical work on exchange rates that has not changed with the most recent research. While the long-run models have rendered encouraging results, studies that aim at explaining or forecasting higher frequency exchange rate movements have lagged behind. After so many different regressors have been considered and so many data sets explored, we believe it is unlikely that either some extra years of observations or that an important missing regressor, just waiting to be discovered, would do the trick. In fact, we believe that a trick here would even look suspicious, as we will argue shortly.

[1]See Rogoff (1996) for a recent survey.

What we propose is a change of focus. Instead of emphasizing the amplitude of the deviations, we explore their durations at different amplitude bands. By doing so, the focus of estimation also changes from conventional regressions to limited dependent variable models. While the first relies on comovements, the later allows for discrete movements of the dependent variables even if the explanatory variables remain constant.

This turns out to be very convenient for our analysis, since nominal exchange rates are often managed variables, which are subject to big discrete changes. More than that, the fact that expectation errors (noise) and price stickiness are pervasive, adds an extra burden to linear regression models, which rely on correlations. Needless to say that this problem becomes more severe the higher the frequency of analysis, when price stickiness and noise play a more important role. In addition, the duration approach can deal with non-linearity, which is particularly useful to relate real exchange rates and net foreign assets.

But, on top of providing a meaningful alternative to conventional regressions, duration analysis provides a richer statistical characterization of the data, which allows the researcher to ask a broader set of questions. For example, depreciations and appreciations can be compared across regimes so as to identify which regime concentrates the higher and longer misalignments. The probability that a 15% or higher appreciation lasts t years can be measured, and so on.

It is not hard to justify why the answers to those questions are relevant. They contain valuable information for those concerned with the effect of sunk costs on foreign direct investment, trade hysteresis, as well as currency crises.

This papers is organized as follows. In section 4.2, we introduce the techniques that will be used in the paper. In section 4.3, we briefly describe the theory underlying the empirical work and present the results. Section 4.4 concludes.

4.2 Duration Models

Duration models introduce both flexibility and new possibilities to the empirical analysis of exchange rates. By looking at the exchange rate deviations as spells, a whole new set of statistical description techniques and estimation strategies can be added to what traditional regressions already provide in tracing the amplitude of such deviations.

As far as estimation flexibility is concerned, what makes this class of models appropriate for the problem at hand is the fact that duration models, as other limited dependent variables models, are designed to deal with variables which, like the real exchange rate, are subject to discretionary and discrete changes. This is accomplished by modeling the probability distribution associated with the spells. Besides naturally allowing for non-linearities, this estimation strategy takes into account not only contemporaneous and some lagged values of the explanatory variables, but the functional of the covariates, i.e. their whole path during each spell.

This is specially convenient for three reasons. First, because it sidesteps explicitly assuming the dynamics linking covariates and the deviations. Second, as the limited dependent variable literature has made it clear, if the discrete nature of the exchange rate changes is pervasive, linear regression gives biased estimates. Last, but not least, by characterizing the duration and not the amplitude, this class of models provides interesting information regarding the spells, like the probability of a currency collapse and by how much each covariate contributes to it.

As a result, duration regressions can properly accommodate the variables driving exchange rate deviations, namely government consumption, real interest rates differential and net foreign assets. To start with the easiest case, the real interest rate, it suffices to say that the overshooting is actually a spell like process. The higher the increase in the interest rate, the higher the jump in the exchange rate, and, hence, the longer the spell.

Consider now a reduction in government consumption under a fixed regime. As prices are sticky, the decrease in government consumption is not readily followed by a real depreciation, but it actually creates a downward pressure on non-tradable prices that will eventually end an appreciation or help sustain a depreciation spell. By the same token, a fixed exchange rate regime may not resist the cumulation of current account deficits combined with high unemployment or a slowdown in growth. In both cases, the pressure on the real exchange rate should reflect in the probability distribution associated with the spells. However, this effect would be difficult to be captured by linear models, given that, for most of the time, the exchange rate does not move.

This last fact, i.e. that conventional regression analysis relies on comovements, is worth emphasizing, since it can be the reason why the evidence on the effect of trade on real exchange rates has been so weak[2]. As we will discuss further in section 4.3.2, if resources have to be transferred abroad, but tradables and non-tradables are imperfect substitutes, a change in their relative prices is necessary to achieve both internal and external equilibrium. While this story establishes a relationship between exchange rates and net foreign assets, it is silent about the path these variables follow in the adjustment. Reasonable explanations are consistent with the occurrence of both positive and negative correlations along the adjustment path[3].

Therefore, since the theory has little to say about exchange rate and net foreign assets comovements, linear regressions have little to test. Duration models, however, do not rely on correlations, but on the entire path of net foreign assets, so that a history of cumulated current account imbalances can be captured by the probability of a change in the real exchange rate. In this sense, duration regressions provide a method of detecting the effect of trade imbalances on real exchange rate deviations.

As mentioned in the beginning of this section, more than providing a flexible method of estimation for the problem at hand, duration analysis introduces a new set of statistics to describe the deviation spells. The sheer accounting it provides can answer interesting questions like: 1)What is the probability that a 15% or higher appreciation lasts more than 3 years, and what is the probability that it collapses, conditional on it having lasted these 3 years? 2)What is the time share that exchange rates stays away from the long-run under fixed and flexible arrangements? 3)Do appreciations and depreciations differ? 4)Which regime gets the higher and longer appreciations?

In the next subsection we introduce the statistics to answer these questions as well as the regression approach to duration analysis.

4.2.1 Survival and Hazard Functions

It is not hard to think of problems where it would be helpful to know the probability distribution associated with exchange rate deviations. Krugman, for instance, has forcefully argued that sunk cost in investment is an important determinant of international trade and foreign

[2]See Campa and Wolf (1998) for recent evidence on this topic.

[3]In fact, if intertemporal considerations are added, any correlation can emerge, depending on whether shocks are antecipated or not, common or specific. See Razin (1995) for a discussion.

direct investment patterns[4]. More recently, currency crisis episodes have spurt a search for the underlying indicators of such crisis in an attempt to assess how long an appreciation can last. Yet, we are not aware of any study exploring the information conveyed in the duration of exchange rate deviations[5].

In particular, in order to assess either the trade and investment issues involved or the risk of currency collapses, it would be interesting to measure the likelihood of the deviation spell surviving at least t years or the probability that it will end at t, but conditional on the fact that it has survived as long as t. For these purposes, survival and hazard functions, respectively, provide the statistical measure.

The survival function is defined as follows. Calling T the random variable whose probability distribution we want to estimate, the survival at t is:

$$S(t) = \Pr(T \succeq t) \tag{4.1}$$

which is the probability of a spell surviving at least t.

The hazard function, being the probability of a spell ending, given that it has lasted up to t, is obviously related to the survival function. Assuming a continuous distribution, it can be shown that the hazard $h(t)$ is:

$$h(t) = -\frac{d \ln S(t)}{dt} \tag{4.2}$$

Since specification tests are not as easily available for duration analysis as for linear models, a non-parametric approach is a step worth taking in estimating the survival functions (and, consequently, the associated hazard). The Kaplan-Meier non-parametric maximum-likelihood estimator of the survival function is defined as[6]:

$$\hat{S}(t) = \prod_{s|s \preceq t} \left(\frac{n_s - f_s}{n_s} \right) \tag{4.3}$$

[4]See Krugman (1989) for a discussion.

[5]The studies using limited dependent variable models, as probit and logit, have only focused on measuring the probability of crises.

[6]See Kalbfleish and Prentice (1980) for a thorough presentation of duration models and estimation.

where s measures duration, n_s is the number of spells that have survived up to s, and f_s is the number of failures at s.

A shortcoming of this estimator is that it ignores explanatory variables and, therefore, it cannot control for the heterogeneity that is likely to be present when a cross section of countries is estimated. For example, expansionary fiscal policies can sustain longer appreciation durations and distort the non-parametric estimates. The natural alternative is then to follow a regression approach and parameterize the hazard function.

4.2.2 The Proportional Hazard Model

Besides incorporating censoring, duration models are specially useful when time and cross-sectional variation in the covariates are present. Needless to say that both are potentially harmful to our results if neglected, since censoring can be as high as 20% and a sudden hike in foreign interest rates, for example, can be key in ending an appreciation spell.

Exponential, Weibull and a variety of other distributions have been used to parameterize the hazard function, each of them imposing some restriction on the shape of the hazard. The exponential distribution constrains the hazard to be constant, the Weibull allows for a non-zero slope to be estimated, and so on and so forth. Unfortunately, the available specification tests are not so powerful as to provide a safe guide for model choice. Unless one has a clear prior about the shape of the hazard function, the chances of incorrectly constraining its shape are not trivial. This raises an important issue, since simulation results suggest that a wrong restriction can significantly bias the covariates' estimates.

In this sense, the proportional hazard model (Cox, 1972) adds a lot of flexibility to estimation. The hazard function is assumed to be of the form:

$$h(t) = h_o(t) \exp(x_t \beta) \tag{4.4}$$

where h_0 is an arbitrary non-negative function, called baseline hazard, and x_t is a vector of time-varying covariates.

This formulation has several advantages. Besides incorporating time-variation, as well as the Weibull and exponential distributions, $\exp(x\beta)$ can be easily read as the relative risk associated with x with respect to its 0 value. More than that, the baseline hazard can be non-parametrically estimated, as in the discrete-time versions of this model, or it can be conditioned out of the estimation, as in Cox (1972). In the later, a partial likelihood estimator provides a way of estimating β without imposing any restriction at all on $h_o(t)$[7]. This becomes important when the baseline hazard misspecification is an additional source of inconsistency for estimation.

Finally, the estimated baseline is a useful diagnostics instrument, since its shape or outliers are indicators of possible omitted variables. As it will be shown in the empirical section that follows, we will use such estimates to suggest that the covariates considered provide an incomplete characterization of the exchange rate deviations around the long-run.

4.3 Results

The results are presented in two steps. In the first subsection, the duration spells distribution is characterized and special attention is devoted to the differences that emerge across fixed and flexible regimes. We assess regime non-neutrality by contrasting our findings with those presented by Mussa (1986). It will be shown that fixed regimes concentrate the high and lasting appreciations: although the share of observations under fixed regimes is only 30%, the share of appreciation spells that are no lower than 15% amounts to almost 50%. Moreover, after integrating these appreciation spells, the proportion of time that the real exchange rate stays

[7] Cox's model is implemeted by maximizing the following partial log-likelihood with respect to β :

$$\ln L = \sum_{i=1}^{n} \left\{ \sum_{k \in D_i} x_k \beta - f_i \ln \left[\sum_{j \in R_i} \exp\left(x_j \beta\right) \right] \right\}$$

where i indicates one of the n distinct failure times; D_i is the set spells ending at i; f_i is the number of failures at time i; and R_i is the set of observations that have survived at least i. The spells start at time 0, and x_j is the vector of covariates at time interval $j \in (1, ..., T)$. See Kalbfleish and Prentice (1980) for more details.

The discrete-time version is given by:

$$\ln L = \sum_{l=1}^{M} \left\{ c_l \ln \left\{ h_j\left(x_{lj}\right) \prod_{s=1}^{j-1} \left[1 - h_s\left(x_{ls}\right)\right] \right\} + \left(1 - c_l\right) \ln \left\{ \prod_{s=1}^{j} \left[1 - h_s\left(x_{ls}\right)\right] \right\} \right\}$$

where: $c_l = 1$ if spell ends during interval j; l and j indexes individual and time intervals, respectively, and:

$$h_j\left(x_{lj}\right) = 1 - \exp\left[- \exp\left(x_{lj}\beta + \gamma_j\right)\right]$$

with:

$$\gamma_j = \ln \int_j h_o\left(\tau\right) d\tau$$

away from the long-run trend is two times higher under fixed regimes. Finally, depreciation spells show no clear sign of non-neutrality across regimes.

In the second subsection, after briefly discussing the underlying theoretical framework, we take one step further in characterizing the real exchange rates deviation spells by introducing explanatory variables.

For appreciations, possibly because consumption and investment driven current account deficits are mixed in the sample, net foreign assets were often insignificant and even more so when GDP growth was introduced in the model. Higher GDP growth, however, was significantly and consistently associated with sustaining appreciations. The same followed for real interest rate differentials and government consumption; in addition, the estimates do not differ much across bands and regimes. To illustrate the magnitudes involved, a 5% decrease in growth or in the real interest rate differential, or a 2% lower than average share of government consumption in GDP are associated with approximately 30% higher probability of an appreciation spell ending, conditional on it having survived up to that point.

The regression results for depreciation spells confirm the importance of government expenditure and net foreign assets in the duration of such spells. Higher government consumption and net foreign assets are significantly associated with shortening depreciation spells, as expected. Interestingly, the baseline hazard functions obtained from these duration regressions suggest that the covariates are short of telling the whole story.

4.3.1 Regime Neutrality and the Duration of Real Exchange Rate Deviations Post-Bretton Woods

The natural starting point for this discussion is Mussa (1986). Using a sample of 16 industrial countries from 1957 to 1984, he forcefully shows how the sluggishness of prices leads to the non-neutrality of the exchange rate regime: bilateral quarterly real exchange rates are much more volatile under flexible arrangements than under fixed regimes. Indeed, as shown in Dornbusch and Giovannini (1990), wpi deflated German real exchange rates with respect to the US dollar are as much as 15 times more volatile after the collapse of Bretton Woods than in the 1960's.

Although Mussa is very careful in not drawing straightforward welfare conclusions on his findings, the notion that the volatility of flexible exchange rate regimes makes them more prone to misalignments, which, in turn, harm trade and investment allocation, has permeated the literature. Proponents of less flexible arrangements are eager to draw on these findings in making their case.

We do not want to dispute these results at all; in fact, they are pretty sturdy evidence. What we argue instead is that: 1)these volatility measures are poor indicators for regime choice, and 2)when duration analysis is used, the picture revealed shows that, in fact, fixed regimes look more prone to misalignments.

Regarding the first point, it is important to keep in mind that Mussa compares fixed and flexible regimes using bilateral rates. What is a very good strategy to detect price sluggishness, however, does not necessarily provide a good reference if one is concerned about the possible effects that exchange rate misalignments may have on foreign investment and trade. In this case, effective rates would be a better measure.

When multilateral exchange rates are used and regimes are compared within the float era, however, floating exchange rate regimes are not considerably more volatile than fixed ones. Instead of 15 times, the average standard deviation for a flexible regime is just 1.35 times higher than the same measure for fixed arrangements[8].

Of course, this result comes from the use of effective exchange rates instead of bilateral ones, combined with the fact that most currencies start to float after 1973. But, that is exactly the point we are trying to make: one cannot simply associate more volatility of flexible regimes as shown by Mussa with a higher tendency to misalignment. One thing is to choose a fixed regime when all other currencies are pegged to each other, as happened during the Bretton Woods period. In this case, even effective rates would look stable. A different story follows if all other currencies start to float. Now, even if bilateral rates are stable, multilateral rates can obviously move a lot.

Putting it differently, the post-Bretton Woods experience has shown that, unless a representative currency basket is used and real shocks as terms of trade, trade opening and international productivity trend differentials are controlled for, the choice of a fixed exchange rate arrange-

[8]To compute volatility, we use a one year rolling window and averaged the quarterly results for each regime. This tends to decrease the volatility for fixed regimes, since they have more persistent movements. In fact, stardard deviations computed for the whole period and averaged across countries yield even lower differences among regimes. See Kent and Naja (1998) for similar evidence. See appendixes for data description and country list.

ment will not necessarily render currency stability.

But, as argued early in this section, volatility comparisons are at most a partial characterization for the assessment of regime neutrality. What we will show next is that, by looking at the deviation spells instead, an interesting pattern emerges. First, fixed regimes concentrate the higher and longer appreciations, even after controlling for real shocks as well as for monetary and fiscal policies. Second, real exchange rates stay away from the long-run trend relatively longer under fixed regimes. Altogether, this says that, as a matter of fact, it is fixed regimes that are more prone to exchange rate misalignment, and not the flexible ones, as Mussa's findings might have suggested.

Spell Distribution, Non-Parametric Survival Estimates, and Time at Risk

As described in more detail in the data appendix, our deviation spells are constructed as follows. First, for a sample of 14 OECD and 24 developing countries listed in Appendix 1, the deviations from the long-run trend are computed, where the long-run cointegration equation has terms of trade, international productivity differentials across tradables and non-tradables, and trade policy. Second, bands around the long-run trend are used to characterize either an appreciation or a depreciation. A $x\%$ spell is then defined as the period of time in quarters where the real exchange rate remained outside the $x\%$ band. Four bands are used: 0, 5, 10 and 15, which then gives four spell sets for each depreciations and appreciations.

Table 4.1A shows the frequency distribution of spells, time at risk[9] and the non-parametric estimates of survival functions at 25%, 50% and 75% percentiles. Each of them is presented by band size, deviation type and regime. The first interesting result comes from the frequency distribution of spells across regimes. Although 31% of all quarterly observations used in this study come from fixed regimes, the share of appreciation spells under fixed exchange rates amounts to 46% of the 15% band sample. This is not the case for depreciations, where the share of spells for each regime and band size more closely matches the one found in the original sample: 31%, 46%, and 23% for fixed, intermediary and flexible regimes, respectively[10]. This picture gets sharper if we look at time at risk. Now, fixed regimes are responsible for 60% of

[9]Time at risk is the integral over all deviation spells. For a 10% appreciation band, it will be the total length of time the real exchange rate remained at least 10 % appreciated with respect to the long-run trend.

[10]The regime named intermediary can be considered as a dirty float.

the 15% band appreciation time, i.e. twice as much its share in the original sample.

The survival estimates confirm this pattern. While appreciations and depreciations show similar shapes for the more flexible exchange rate arrangements, the fixed regime results are quite distinctive: appreciation spells tend to last longer than depreciation ones[11]. Note that, while 25% of the 15% or higher appreciation spells last more than 4 years under fixed regimes, the cutoff for the flexible regime is only half a year.

The Log-Rank tests presented in table 4.1B provide the statistical confirmation for these findings. First, while we cannot reject regime neutrality for depreciation spells, survival functions across regimes are significantly different for appreciations. Second, if all regimes are pooled, only for higher bands do appreciation spells look different than depreciations, which is consistent with the fixed regimes getting more of the longer and higher appreciation spells[12].

To summarize, while regime neutrality holds for depreciations at all bands, fixed regimes concentrate the higher amplitude and longer appreciations[13]. Moreover, if one takes the time the real exchange rates trip away from the long-run trend as an indicator of misalignment, again fixed regimes get more overvaluations.

As a final check, one can still argue that these results may be biased by differences in the conduct of monetary or fiscal policy. Although we do not believe this to be the case, since, in the lines of the Mundell-Fleming model, it is the fixed system which restricts the leeway for policy, we also control for this possibility. In figure 4.1, the survival functions for fixed and flexible regimes are graphed for 5% and 15% appreciation bands after adjusting the estimates for government consumption, domestic credit and interest rate differentials[14]. Confirming the results

[11] The table gives a rough idea of the shape of the suvival fu..ctions across regimes. We actually graphed the survivals with their respective confidence intervals, before drawing any conclusion. The log-rank tests are meant to summarize this information.

[12] Note at the bottom of table 4.1B that these results are not driven by an unbalanced panel, where non-OECD or inflationary countries dominate the sample. In fact, the results are uniform across these subgroups.

[13] See the data appendix for further information on the distribution. There the sample is further split according to OECD membership, the occurrence of high inflation and for the period not including 1980-85.

[14] These graphs are obtained from the non-parametric survival functions after estimating a Cox proportional hazard model (equation 4.4), i.e. the survival is obtained from h_0.

We do not show the unadjusted graphs, but the distiction across regimes is even sharper after controlling for government consumption, credit and interest rates. Different combinations of covariates for both appreciation and depreciation spells, as well as different bands, countries and excluding the 1980-85 period did not qualitatively change the results either.

We do not have the estimator for confidence intervals. We can say, though, that, when all regimes were pooled and a Cox model was run with the fiscal and monetary variables mentioned above, a regime dummy entered very significantly the estimation.

in table 4.1, the survival functions are clearly flatter for the fixed regime, meaning that the distribution is relatively more dense towards longer appreciation spells. Regime non-neutrality for appreciations is ratified. However, contrary to what the higher volatility associated with a flexible arrangement might have suggested, now it is the fixed regime that raises more suspicion of misalignment.

To conclude this subsection, we would like to draw regime choice recommendations on these findings. But this becomes tricky without a microeconomic founded model, since inflation and output trade-offs are likely to show up. In fact, a recent paper by Ghosh, Gulde, Ostry and Wolf (1997) confirms this to be the case for a sample of 136 countries, during 1960 to 1990. As expected, pegged regimes are associated with lower inflation. However, output is less volatile for flexible regimes, which also have on average a 1% higher income growth. Not surprisingly, given our results, trade growth is 4.6% lower under fixed exchange rate arrangements.

Although we avoid policy recommendations, the message is clear. First, fixed regimes do not render real exchange rates as stable as previous evidence suggested. Second, non-neutrality fails, and unfavorably so, for fixed regimes: they more likely concentrate exchange rate misalignments.

How these spells relate to other economic variables is the object of the next section.

4.3.2 Duration Regressions

Theory

Although there is not an undisputable consensus on how and by how much government consumption, net foreign assets and real interest rates affect the real exchange rate, both the empirical and the theoretical literature seem to agree that those are the three main factors associated with its deviations. In this subsection, we outline these links and show how duration models can appropriately handle the empirical analysis.

The basic setup is a small economy where traded and non-traded goods are imperfect substitutes, prices are sluggish and capital cannot be moved across sectors or installed at no cost. However, capital is mobile across borders, and the small economy takes both tradable prices as well as the interest rate abroad as given. Also, government expenditure is assumed to fall more heavily on non-traded goods[15].

Under these conditions, the supply of non-tradables is *not* perfectly elastic, so that an increase in government consumption causes the relative price of non-tradables with respect to tradables to rise. Therefore, an increase in the path of government consumption is expected to lower the hazard of an appreciation ending.

As to international interest rate differentials, with capital mobility and sluggish prices, a domestic interest rate hike should produce the expected overshooting path. Ceteris paribus, the higher the hike, the longer the spell, i.e. the lower the hazard of an appreciation ending[16].

The relationship between net foreign assets and real exchange rates is more involved, and, to keep it short, we will organize the discussion around the identity that links current accounts, savings, and investment: $CA \equiv S - I$.

Keeping investment constant for now, imagine that this economy starts with a history of cumulated current account imbalances, say deficits, that it desires to revert in order to move back to its desirable net foreign assets path. To revert the deficits, clearly the country has to save more so as to satisfy the identity. But, unless the relative price of tradables rises with respect to the price of non-tradables, the lower level of consumption will cause an excess supply of non-tradables due to the imperfect substitutability between these goods. As a result, the desired transfer abroad will not be effected in a way compatible with internal equilibrium without a change in the real exchange rate[17].

Note that this explanation does not say anything about how real exchange rates and net foreign assets commove during the adjustment; it just associates *cumulated* trade imbalances today with a different real exchange rate level in the future. The empirical implementation of this sort of prediction is tricky using linear models, but it fits nicely in duration regressions. Since they take into account the whole path of the covariate, a history of cumulated current accounts can be directly used as a regressor. Moreover, the pressure that net foreign assets exert on the exchange rate can be captured through the associated probability distribution, which does not require these variables to commove. In summary, as deficits (surpluses) cumulate and

[15]See chapter 4 of Obstfeld and Rogoff (1996) for a more formal introduction to the main themes considered in this section.

[16]In the original model, the speed of decay is constant. See Dornbusch, 1976.

[17]In the tradition of small economy models, the real exchange rate is the relative price of tradables with respect to non-tradables.

net foreign assets decrease (increase), the hazard of an appreciation (depreciation) ending rises.

However, this clear association becomes moot when investment is not held constant. In this case, current account deficits can build up as a result of a boom in investment. Now, a change in relative prices is not necessary to transfer resources abroad anymore. It may well be the case that the higher level of investment itself will provide a future surplus in the tradable sector that will allow the transfer to be effected. As a result, the effect of net foreign assets on the real exchange rate will depend on whether its changes originate in consumption or investment.

Since higher investment is associated with higher GDP growth, while consumption driven current account deficits are more likely to face financing constraints that end up slowing growth, we also try GDP growth as a regressor. We do so as an identification attempt to circumvent the ambiguity in the relationship between real exchange rate appreciations and net foreign assets movements.

Finally, in addition to the variables mentioned above, the path of exchange rate deviations is included in the regressions. There are no special theoretical reasons to include this variable beyond two simple considerations. First, as bigger deviations take longer to build, wide trips away from trend should be associated with longer spells. Second, it is more likely that big deviations bring with them unsustainable current account disequilibria, government expenditure, or interest rate levels, which soon will have to be reverted. In this case, it is not unreasonable to expect that higher deviations may also be associated with higher pressure for reversion, i.e. shorter spells. Whichever dominates will be left as an empirical question.

Regression Results

Hazard Ratio Estimates Since prices are stickier downwards, appreciations and depreciations are asymmetrically affected by price rigidity and are considered separately in tables 4.2 and 4.3, respectively. Part A of each table shows the Cox model results for fixed regimes, while part *B* has the estimates for more flexible arrangements. GDP growth, real interest rate differentials (R), government consumption (GCONS), net foreign assets (NFA), and real exchange rate deviations (RERDEV) are all expressed as differences from country means, but GCONS and NFA are first scaled by GDP. As shown in the tables, the regressions are also run separately for different amplitude bands and, whenever sample size allowed, shorter durations (DUR) are dropped.

The estimates are expressed as $exp(\beta)$, so that the entries in the table can be read as hazard ratios, i.e. the contribution to the hazard of a one unit increase in the covariate with respect to its zero level (see equation 4.4). Hence, say, a negative β (or a hazard ratio less than 1) means that a unit increase in the covariate with respect to zero reduces the hazard by a factor of $exp(\beta)$. Since variables are demeaned, this makes the hazard ratios the marginal contribution of a unit change in the covariate with respect to the mean.

The first point worth making is that the results are more sensible if the shorter spells are dropped, which is what one should expect if noise is concentrated in shorter durations. Although one has to be careful, given the sample sizes involved, this is apparent for government consumption and net foreign assets, which become more significant and of the expected sign[18].

From table 4.3, it can be seen that GCONS and NFA can have a big impact on the duration of a depreciation. For example, taking a 5% band, a 1% increase in GCONS for depreciation spells longer than 1 year, i.e. a 1% higher government consumption share in GDP with respect to the mean, is associated with a 26.6% higher hazard. These values are lower for flexible regimes, but they still can add 16% to the hazard if spells lasting at least two years are considered. The magnitudes are similar for NFA, and there is strong support for the association of cumulated current account surpluses and future real appreciations.

RERDEV captures the simple fact that longer trips survive a longer time: the higher the amplitude of the deviation, the longer it lasts[19]. Reserves, inflation as well as current accounts were insignificant when included, while R tended to slowdown the end of depreciation spells, which is inconsistent with its expected effect[20].

Moving to appreciations, NFA estimates varied a lot in sign and significance. In particular, they tended to be insignificant when GDP growth was included in the regressions. As discussed in the theory subsection, current account deficits that are consumed have a different implication for the equilibrium real exchange rate than those deficits generated by higher investment. A

[18] Some regressors were omitted if insignificant in order to save degrees of freedom.

[19] We did not quantify the duration of the ups and downs, but visual checks suggest that the ending of the spell tend to be quicker, although not much quicker.

[20] For both appreciations and depreciations, government surplus tended to give equivalent results as GCONS, although its use was limited by data availability. Domestic credit, however, was always insignificant. This series had a clear upward trend, though, even after scaling by GDP. This certaily rendered the demeaning meaningless.

higher consumption of tradables per se cannot be sustained and will need a future change in relative prices of tradables with respect to non-tradables to effect the transfer; higher investment that increases the supply of tradables need not.

As discussed before, GDP growth is introduced, because investment and consumption driven deficits are likely to have asymmetric effects on growth. The results in table 4.2 confirm that higher than average growth is associated with longer life to appreciation spells, and consequently, lower growth rates increase the conditional probability of a change in relative prices. The hazard ratios are concentrated in the .85-.95 range; taking a 0.95 estimate - the lower bound, a 5% slowdown in growth, which is not rare in developing economies pre-crisis, increases the hazard of an appreciation ending by 25%.

The effect of GCONS is also important. Taking 0.85 as an average hazard estimate, a 2% cut in the share of government consumption in GDP with respect to its mean is associated with a 30% increase in the hazard. As to the real interest rate differential, for an average estimate of 0.95, a 6% decrease in R has the same impact on the conditional probability of an appreciation spell ending. Finally, RERDEV has the same interpretation as before: higher spells take longer trips. But, note that the coefficients are now closer to one, so that the higher pressure for reversion associated with larger appreciations partially offsets the longer trip effect.

Overall, the results shown in table 4.2 are consistent and sensible, which reassures the usefulness of the approach we introduced in this paper. We were limited in data availability to try other variables than those already discussed. However, we did estimate the discrete version of the Cox model, allowing the baseline hazard to be non-parametrically estimated, as in Meyer (1990), or approximating it by quadratic and cubic functions so as to save degrees of freedom. Whenever sample size allowed comparisons, the estimates turned out to be very close to those obtained from the original Cox model.

In addition to that, we checked for omitted variable bias using the baseline hazard functions retrieved for the regressions presented in tables 4.2 and 4.3. The findings are discussed below.

Baseline Hazard Figures 4.2 and 4.3 show the baseline hazard estimates for 0% band appreciation and depreciation spells, respectively. Fixed and flexible exchange rate regimes are graphed separately. For the other bands (not shown) the overall distribution of the estimates was similar, except that, the higher the band, the steeper the hazard tended to be. It is worth clarifying two things about these pictures. First, the scattered dots are not representative of the total number of observations. In fact, over 200 observations are available for each picture[21]. Second, and more important, the positive slopes shown by the hazard functions are not implied by the real exchange rate reversion to the long-run trend. Mean reversion implies that the survival function tends to zero as duration increases; the hazard is a conditional distribution, and as such it can be upward or downward sloping regardless of whether the deviations are mean reverting or not.

Figures 4.2 and 4.3 show the less steep hazards estimated, i.e. band 0 results. Even in these pictures, however, it can be seen that, although the more flexible regimes show flatter baseline hazards, all shapes are upward sloped. As mentioned above, this feature becomes much clearer as higher bands are considered. The fact that the hazards are increasing means that, even after controlling for the covariates, the longer one country advances in a spell, the higher the probability of reversion to the long-run trend.

What an increasing hazard suggests is that the pressure for reversion increases along a deviation path. Using a 10% band, for example, after 3 years of appreciation under fixed regimes, the probability of a reversion to the long-run trend approaches one. For depreciation spells (figure 4.3), the same happens even when band 0 is considered, which is possibly due to the higher upward flexibility of prices.

4.4 Conclusion

By analyzing the duration of real exchange rate deviations instead of the amplitude of their movements, this paper brings new information to the empirical literature on exchange rates.

First, it sheds new light on Mussa's non-neutrality of exchange rate regime. Contrary to what his findings might have suggested, fixed regimes are actually more prone to appreciation misalignments. Not only they concentrate the higher and longer appreciation spells, but appreciation time is also relatively longer for fixed regimes. Not surprisingly, average trade growth for a large number of countries was 4.6% lower under fixed regimes during the 1960-90 period.

[21] If for some particular duration the baseline hazard has no estimate, this means that no spell ended at that particular time.

Second, it shows that duration regressions, besides being conceptually appropriate for the problem at hand, provide consistent results. Interest rates, government consumption and GDP growth are associated with longer appreciations. For depreciations, on the other hand, government consumption and the cumulation of current account surpluses increase the hazard of such spells ending.

Third, the estimated baseline hazards suggest that those covariates do no tell the whole story. In fact, even after controlling for government consumption, interest rate differential, net foreign assets or GDP growth, the pressure for reversion rises along an exchange rate deviation path.

The effect of net foreign assets on appreciations needs to be studied further. Special attention should be devote to identifying the source of imbalances, so as to establish more clearly how trade and exchange rates are related.

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Data Appendix

Data Description and Sources

1. Deviation Spells

The real exchange rate deviation spells used in this paper are measured with respect to the long-run trend as defined in Giacomelli (1997), where effective international labor productivity differentials in tradables with respect to non-tradables, terms of trade, and the Sachs and Warner dummy for openness are shown to provide a robust model to determine the effective real exchange rate in the long-run.

Using the long-run estimation results for each country, appreciation and depreciation deviations are computed as the difference from the predicted values. The actual values are the quarterly effective real exchange rates (cpi deflated). According to the amplitude of these deviations, four groups of spells are constructed, namely bands 0, 5, 10 and 15%. Each group contains those spells where the deviations remained outside a 0, 5, 10 or 15% band around the real exchange rate level. The distribution of the obtained spells is presented in table A1 below.

2. Covariates

The observations used in the duration regressions consist of the spell duration itself (in quarters), as well as the path of each explanatory variable (the covariate) spanning the spell. Below are listed the covariates used, together with a brief description and source. All the variables listed are quarterly, and they are expressed as deviations from the respective country period average.

- RERDEV is the path in absolute value of the real exchange deviation around the long-run trend. It is obtained from the country estimates presented in Giacomelli (1997) after dropping the 1980-85 dummy. As described above, the dependent variable is the quarterly effective real exchange rate (cpi deflated), while the regressors are the Sachs and Warner dummy and the spline fitted values of the annual terms of trade and international effective labor productivity differentials. The sources are: 1)World Bank for the terms of trade; 2)International Financial Statistics (IFS) for prices and exchange rates; and 3)International Labor Organization and United Nations Industrial Statistics Yearbook for labor productivity calculations;

- GCONS is government consumption or expenditure as a share of GDP. Source: IFS;
- R is the discount rate (line 60) differential with respect to the US, where both are first deflated by the respective contemporaneous CPI inflation rates. Whenever this series is missing for a country, the deposit rate is used instead (line 60b). It is worth mentioning that, when we could compare their behavior, the deviations from the mean for the deposit and the discount rate tended to commove closely. Source: IFS;
- NFA is the net foreign assets position in constant dollars of 1990 as a share of GDP (also in constant dollars of 1990). Source: IFS.
- RES is total reserves (including gold) in 1990 dollars as a share of GDP (also in 1990 dollars). Source: IFS;
- Exports-Growth is dollar denominated exports annualized growth rate. Source: IFS;
- CRED is domestic credit outstanding as a share of GDP. Source: IFS;
- SUR is the government surplus as a share of GDP. Source: IFS;
- INFL is the CPI annualized inflation rate. Source: IFS;
- GDP is expressed in 1990 national currency units. Spline fitted values were used to scale the variables above after those variables were also expressed in 1990 national currency units. Source: The World Bank;
- GDP-GROWTH is obtained by fitting a spline on annual growth rates of GDP. Source: The World Bank.
- Regime is obtained from Kent and Naja (1997).

Table 1A

Deviation Spells Description:

Frequency Distribution, Non-Parametric Survival Estimates by Percentile, and Time at Risk

	Freq.	Risk	Survival			Freq.	Risk	Survival			Freq.	Risk	Survival			Freq.	Risk	Survival		
	%	per.	25%	50%	75%	%	per.	25%	50%	75%	%	per.	25%	50%	75%	%	per.	25%	50%	75%
Band	Band 0					Band 5					Band 10					Band 15				
Appreciation	49.1	1703	1	4	10	51.1	1009	1	3	6	48.9	640	1	3	6	56.7	485	1	3	10
Fixed	24.6	35%	2	7	20	28.4	42%	1	5	15	34.4	53%	2	5	19	45.8	60%	3	5	15
Interm.	46.4	47%	1	3	10	44.4	40%	1	3	6	44.4	34%	1	2	5	33.3	30%	1	2	5
Flexible	29.0	18%	1	3	6	27.2	17%	1	2	5	21.2	14%	1	2	4	20.8	10%	1	1	2
Depreciation	50.9	1579	1	4	9	48.9	915	1	3	7	51.1	461	1	2	6	43.3	206	1	2	4
Fixed	24.8	26%	2	4	9	26.7	28%	2	3	7	25.8	28%	1	3	6	23.4	15%	1	1	4
Interm.	44.8	46%	1	4	8	40.7	42%	1	2	7	41.2	43%	1	2	5	47.1	57%	1	3	5
Flexible	30.4	28%	1	3	9	32.6	29%	1	2	5	33.0	29%	1	2	5	29.5	27%	1	2	3
Total	477	3282	1	4	9	356	1924	1	3	7	219	1101	1	2	6	134	691	1	3	5

Each percentile is the probability of a spell lasting no longer than the entry value indicated in the table.

Risk is time at risk, i.e. the integral of the deviation spells in quarters.

Table 1B

Non-Parametric Survial Functions Log-Rank Tests

		χ^2	Prob.	χ^2	Prob.	χ^2	Prob.	χ^2	Prob.
		Band 0		Band 5		Band 10		Band 15	
Apprec. vs Deprec.		0.18	67	0.00	99	1.70	20	4.72	3
Appreciation									
By:	**Regime**	14.86	0.06	11.28	0.04	9.44	0.9	7.75	2.1
	Inflation	0.02	89	0.88	35	0.23	63	0.07	79
	OECD	3.03	8	1.33	25	1.95	16	0.00	99
Depreciation									
By:	**Regime**	0.37	83	1.75	42	0.72	70	2.23	33
	Inflation	0.13	72	0.60	44	0.52	47	5.27	2
	OECD	0.31	58	6.93	1	0.44	51	3.69	6

Under the null survivals are the same. As indicated, survivals are compared in terms of appreciation or depreciation spells, exchange rate regime, high inflation experience, and OECD membership.
Prob. indicates probability of not rejecting the null.

Table 2

Duration Model Estimates for Appreciation Spells

Fixed Regime

	Band 0		Band 5		Band 10	Band 15
	Dur>0	Dur>1 year	Dur>0	Dur>1 year	Dur>0	Dur>0
	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)
GCONS	0.844	0.742	0.930	0.883	0.907	0.815
	-1.46	-1.59	-1.10	-0.94	-1.49	-1.82
R	0.950	0.798	0.990	0.961	0.988	0.959
	-1.92	-1.36	-1.60	-2.60	-1.62	-2.24
GDP GROWTH	0.875	0.837	0.919	0.960	0.97	0.978 [1]
	-1.66	-1.85	-1.30	-1.92	-2.17	-2.13
RERDEV	0.945	0.954				
	-2.35	1.88				
Obs.	38	24	34	24	28	27
χ^2	9.54	29.60	5.42	18.8	7.46	9.00
$Pr>\chi^2$	0.05	0.000	0.14	0.000	0.06	0.03

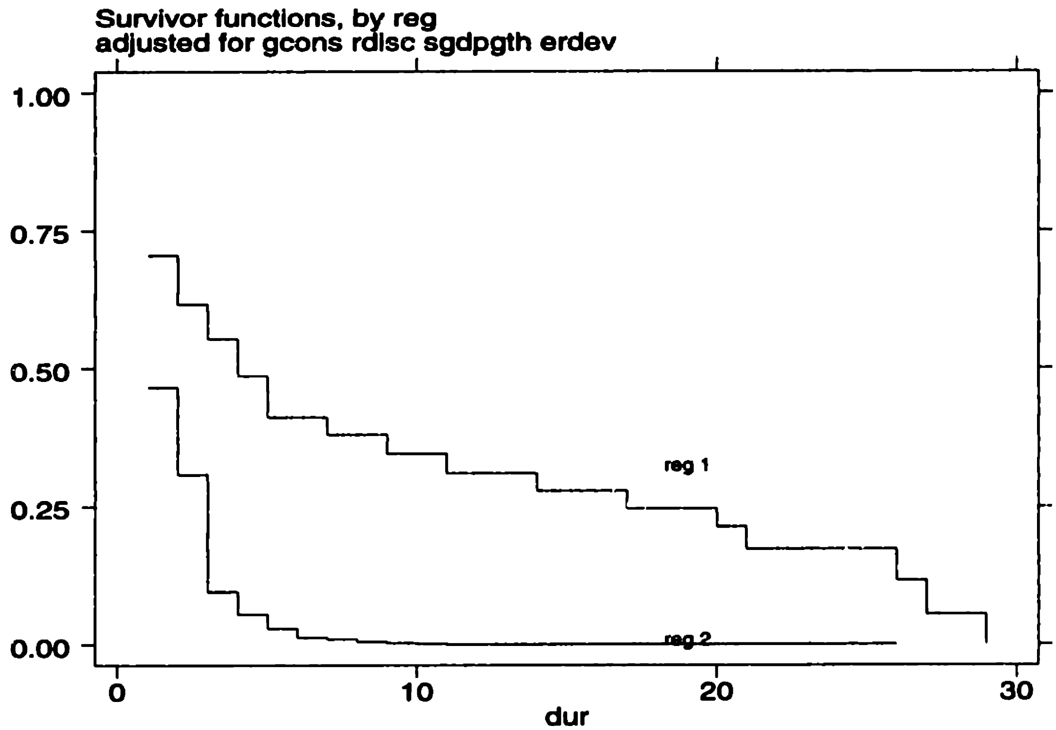
Flexible Regime

	Band 0		Band 5		Band 10	Band 15
	Dur>0	Dur>2 years	Dur>0	Dur>1 year	Dur>1 year	Dur>0
	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)
GCONS	0.958	0.736	0.921	0.907	0.969	1.166
	-0.60	-1.59	-1.04	-1.05	-0.17	3.80
R	0.981	0.948	0.962	0.901	0.804	0.777
	-2.54	-0.78	-1.06	-2.12	-2.48	-4.05
GDP GROWTH	0.952	0.919	0.969	0.948	0.825	0.911
	-1.51	-1.33	-1.47	-1.75	-2.52	-2.11
RERDEV	0.917	0.939	0.919	0.930	0.966	0.950
	-2.53	-1.86	-1.34	-1.21	-3.23	-4.68
Obs.	87	41	85	59	30	22
χ^2	32.10	9.35	7.09	14.82	20.27	25.46
$Pr>\chi^2$	0.000	0.05	0.130	0.005	0.000	0.000

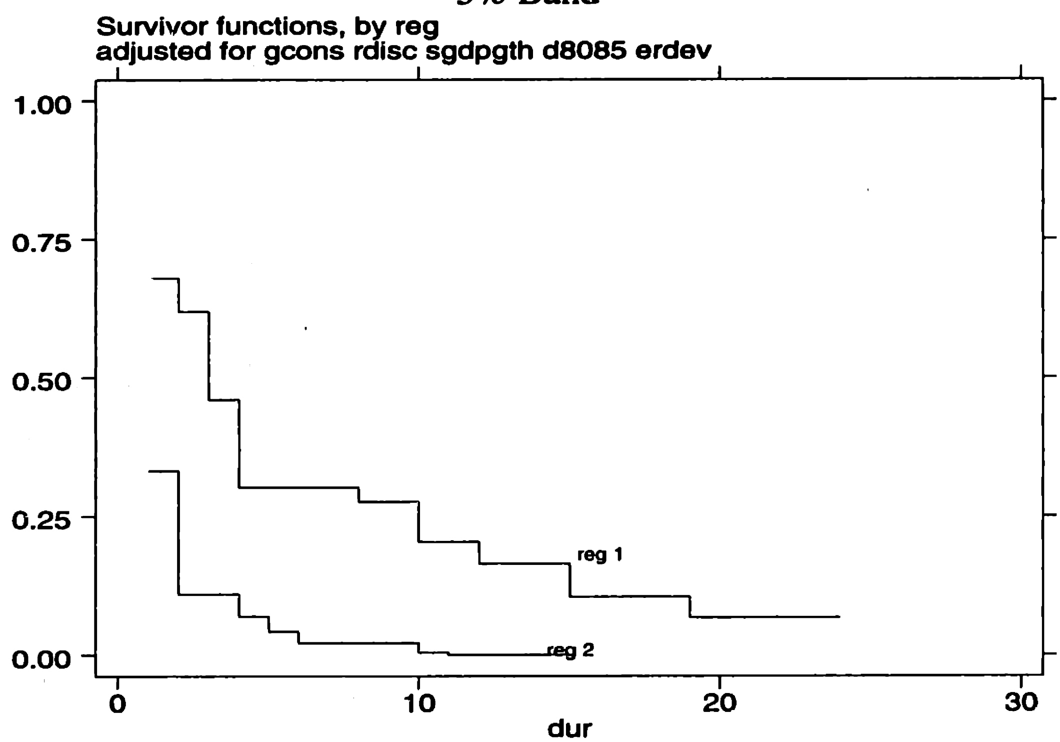
Table 3
Duration Model Estimates for Depreciation Spells

Fixed Regime					
	Band 0		Band 5	Band 10	Band 15
	Dur>0	Dur>1 year	Dur>0	Dur>0	Dur>0
	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)
GCONS	0.935	1.330	1.266	1.583	
	-0.47	1.50	1.82	1.20	
R	0.797	0.729	0.933	1.198	
	-2.38	-1.89	-0.81	1.55	
NFA	0.954	1.216	1.343	1.217	1.272
	-1.41	1.18	1.82	1.89	1.73
RERDEV	0.795	0.781			0.794
	-2.92	-1.79			-1.54
Obs.	42	23	27	21	12
χ^2	16.18	10.77	17.32	8.79	4.94
$Pr>\chi^2$	0.003	0.03	0.002	0.03	0.085

Flexible Regime						
	Band 0		Band 5		Band 10	Band 15
	Dur>0	Dur>2 years	Dur>0	Dur>1 year	Dur>0	Dur>0
	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)	Haz. Ratio (z-stat.)
GCONS	1.053	1.158	0.992	0.955	1.061	1.024
	0.70	1.08	-0.83	-3.11	1.64	0.97
R	0.945	0.832	0.967	0.947	0.956	0.933
	-1.34	-1.59	-1.82	-0.90	-1.79	-3.79
NFA	0.994	1.019	1.007	1.056	0.968	1.159
	-0.76	1.54	0.43	2.78	-0.86	1.33
RERDEV	0.813	0.787	0.842	0.772	0.869	0.875
	-3.94	-3.02	-4.18	-2.91	-2.52	-3.2
Obs.	117	29	93	30	42	33
χ^2	18.15	13.91	19.60	17.57	19.84	15.45
$Pr>\chi^2$	0.001	0.01	0.001	0.002	0.001	0.004



5% Band



15% Band

Figure 4.1: Baseline Survival across Regimes for 5% and 15% Appreciation Bands - reg 1 is fixed and reg 2 includes flexible and intermediary (dirty float) regimes.

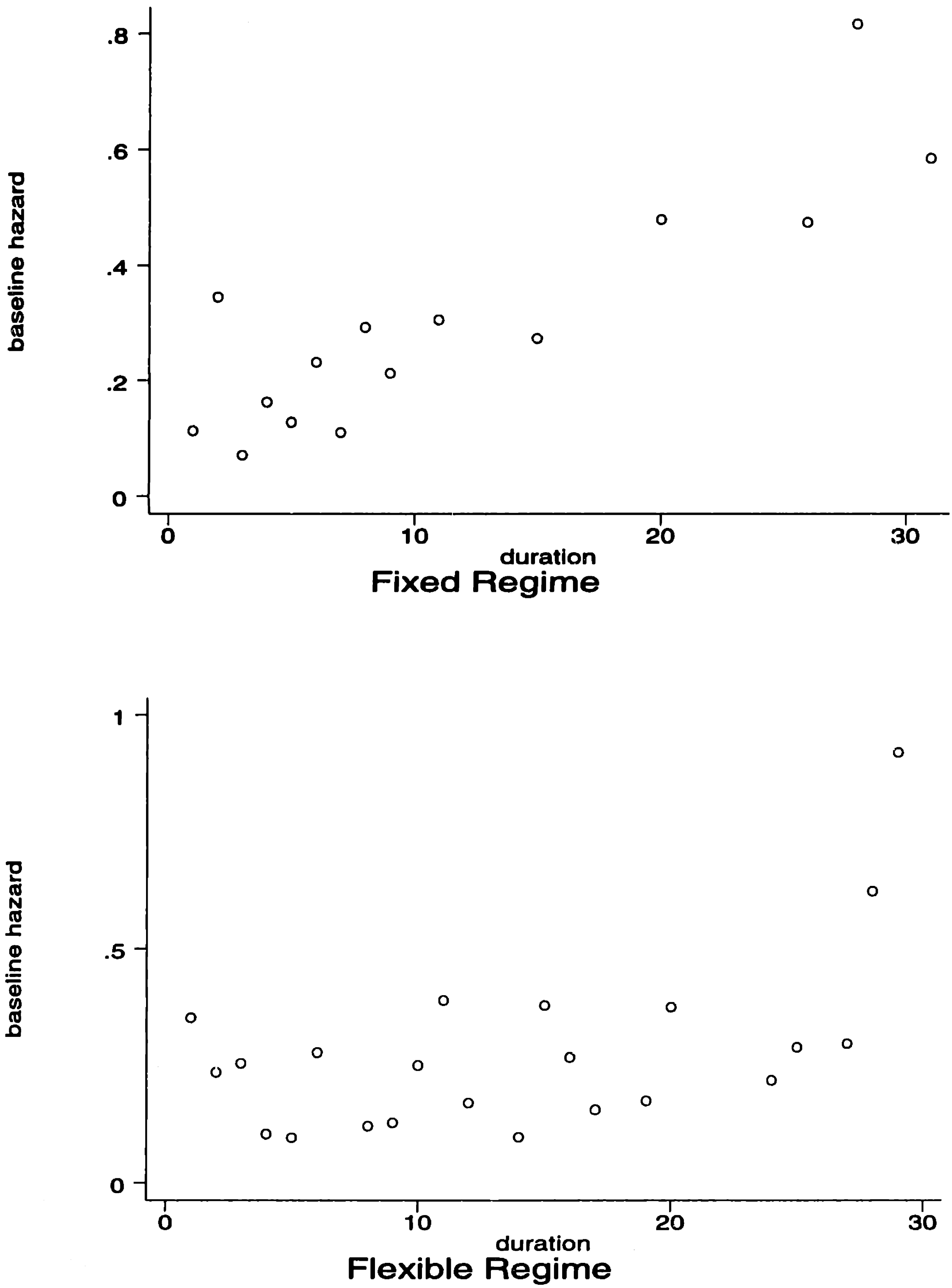


Figure 4.2: Baseline Hazards across Regimes for 0% Band Appreciation Spells

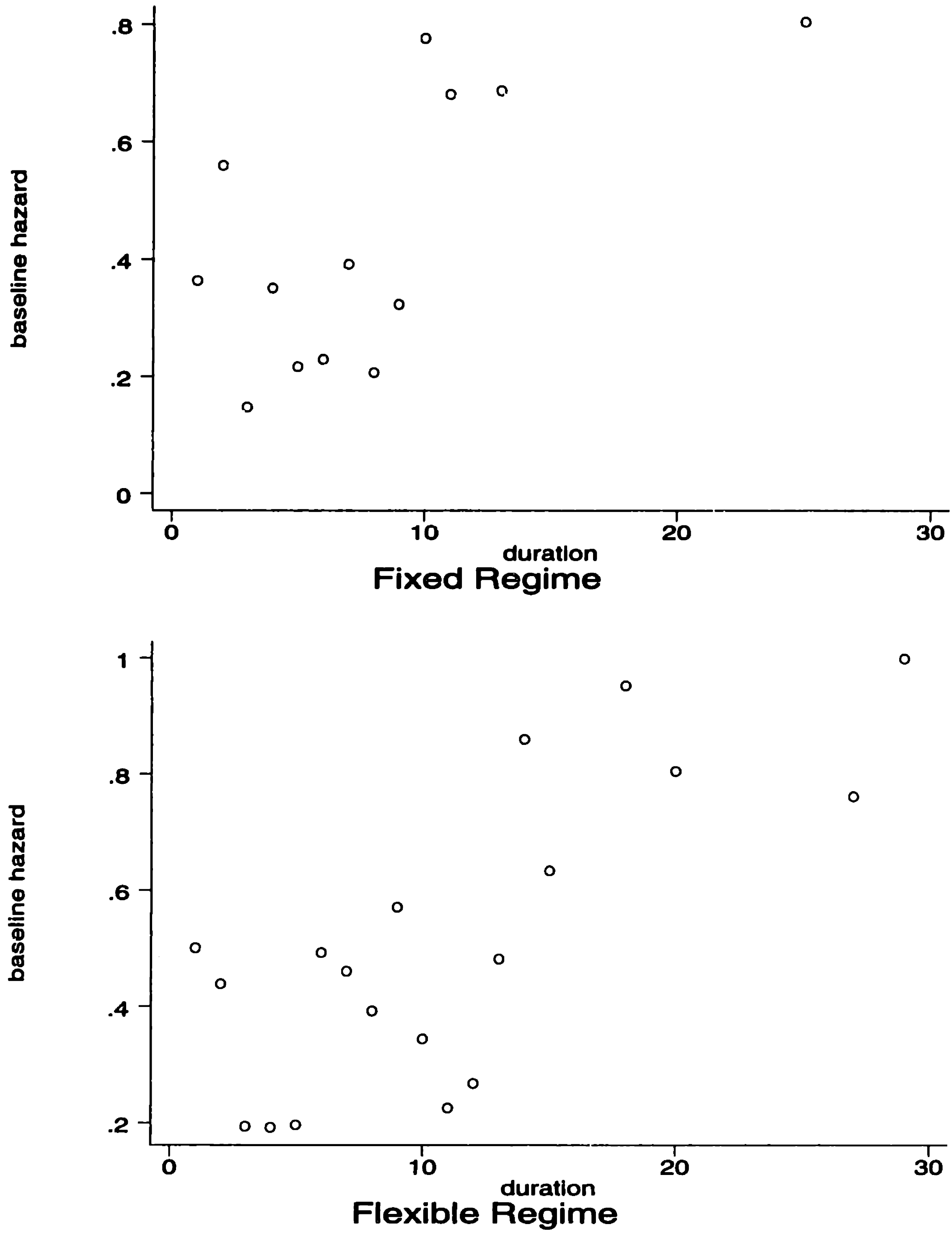


Figure 4.3: Baseline Hazards across Regimes for 0% Band Depreciation Spells

Table 4.A1
Real Exchange Rate Deviation Spells Frequency Distribution

Band	0	5	10	15
Appreciation (total)	243.0	182.0	107.0	76.0
Fixed	24.6	25.3	31.8	45.8
In Between	46.4	39.6	41.1	33.3
Flexible	29.0	24.2	19.6	20.8
OECD	44.9	34.1	20.6	13.2
1980-85	2.6	7.1	20.6	35.5
Depreciation (total)	234.0	174.0	112.0	58.0
Fixed	24.8	23.0	22.3	23.5
In Between	44.8	35.1	35.7	47.1
Flexible	30.5	28.2	28.6	29.4
OECD	45.7	42.0	29.5	24.1
1980-85	3.7	6.3	17.9	21.4

Appreciation and depreciation rows show total observations.
Regime classification, bands and spell construction are described in the data appendix.

Table 4.A2
Country List

OECD	UN	
AUS	BOL	NZL
BEL	BWA	PAK
CAN	CHL	PHL
DEU	CRI	PRY
DNK	ESP	SGP
FIN	GTM	SLV
FRA	HKG	THA
GBR	IDN	TUR
ITA	IND	URY
JPN	ISR	VEN
NDL	JAM	
NOR	KEN	
SWE	KOR	
USA	LKA	