Exchange Rate Misalignment and Realignment

by

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Abstract

The first chapter is titled, *Real Exchange Rate Misalignment and Economic Growth: New Evidence*. I investigate the effect of Real Exchange Rate (RER) misalignment on economic growth. Nonparametric kernel regressions clearly establish that the larger the magnitude of RER disequilibrium the lower the growth. I then make the leap to parametric modelling and estimate, using panel regression techniques, numerous variations of Barro's standard growth framework augmented by my measures of RER misalignment. The findings confirm the nonparametric results and are robust to a wide variety of growth theories. Finally, I highlight the basic elements of two alternative theoretical models that capture the empirical results. The main finding that undervaluations are as serious a problem as overvaluations has important theoretical and policy implications.

The second chapter is titled, *Undoing Real Exchange Rate Misalignments: Do Transitions Have Real Costs?* I assess the real output costs of *undoing* RER undervaluations and RER overvaluations. I start by presenting several distinguishing features of undervaluation episodes. I then focus on the costs of undoing *large* RER misalignments. Using panel estimation techniques and allowing for multiple adjustment times and for potential nonlinearities, I find that correcting large undervaluations is *costly* while correcting large overvaluations is *beneficial*. My focus then shifts to realignment costs of *smaller* RER misalignments. The investigation reveals that the initial results are sensitive to extreme outliers. The refinements introduced clearly establish that smaller corrections of undervaluations are *less costly* than larger corrections, and that smaller corrections of overvaluations are *less beneficial* than larger corrections.

The third chapter is titled, *Effective Real Exchange Rates and Irrelevant Exchange Rate Regimes*; it is joint work with Christopher Kent. There is strong evidence that the short-term variance of the bilateral RER is significantly higher under floating nominal exchange rate regimes than under fixed regimes. However, we show that the short-term variance of

the effective RER displays no systematic difference across nominal exchange rate regimes. This result is based on 27 low inflation and stable growth rate countries from 1978 to 1992. Our study benefits from variation in the timing of regime switches across different countries. In part the result is due to the fact that effective RER's are averages of bilateral RER's.

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Dedication

I dedicate my thesis to:

The memory of my paternal grandfather, ***Rafic***, whose name I proudly share. I was blessed to have known him so well, to have loved him so much, and to have his blood flowing in my veins.

The memory of my maternal grandmother, ***Najwa***, whose wise advice made me the real man I am today, and whose loving heart I miss every second of every living hour.

The memory of my cousin, ***Ghina***, whose friendship I treasured. I feel and I know that she is with Jeddo now and that, one sweet day, we will all be together, one happy family, again.

My mother, ***Nada***, whose incredibly great genes keep propelling me to new hights in every aspect of my life. By far, she is my most important source of inspiration and support. The mother of all mothers, her unfailing care is the one thing I cannot do without in this life, and the one thing I thank Allah to have privileged me with.

My father, ***Walid***, whose name I will proudly pass on to my son. Never in the history of mankind has a son owed so much to a father. Since Day One, he has been my best friend and my most serious fan. He is the single most important person in my life. Without any reservation, and with high pride and distinct appreciation, I give him all the credit for all my accomplishments.

Acknowledgments

Over the years I have spent at the MIT Department of Economics, I incurred large debts and built great friendships. First, I would like to thank my advisors, Rudi Dornbusch and Jaume Ventura. Rudi taught me how to think logically, how to communicate concisely, and how to analyze carefully, in addition to teaching me most of the economics that I now know, while Jaume's helping hand and technical support have been truly invaluable. Moreover, this thesis would not have been completed had it not been to Roberto Rigobon's contributions. I thank him for spending countless prime-time hours helping me understand key concepts and interpret main results: it was an honor benefiting from Roberto's time and enthusiasm.

Four great men, great in every sense of the word, enriched my MIT journey, strengthened my self-confidence and heightened my ambitions. Franco Modigliani was my mentor and my good friend. Robert Solow, one of the greatest economists of all times, taught me how to shatter assumptions and challenge conventional wisdom. Richard Eckaus was always there, ready to provide me with his fatherly advice: I honestly would not have made it through the program had it not been to his unfailing support and good judgement. Avinash Dixit taught the class I enjoyed most at MIT (International Trade) and taught me to "think like" an economist.

It was a pleasure pooling brainpower with a genius like Christopher Kent, the co-author of chapter 3 of this thesis. I enjoyed every phase of our joint work and developed with Chris an exceptional friendship. Haralabos Gakidis kept the enthusiasm going anytime the future looked uncertain and the present felt painful; I am very grateful to "Brother Harry" for being a great brother and a genuine friend.

Contents

Chapter 1

Real Exchange Rate Misalignment and Economic Growth: New Evidence

1.1 Motivation

In open-economy macroeconomics literature as well as in policy discussions, Real Exchange Rate (RER) overvaluation has often been singled out as the most important factor responsible for weak economic growth performance. Dornbusch and Werner (1994, p.255), for example, take the position that "...just as in Chile in the late 1970s positive, sustainable growth [in Mexico] will come only after the overvaluation is corrected," adding that "overvaluation is one of the gravest policy errors" (1994, p.280). Recently, Dornbusch unequivocally stated that "...overvaluation cuts into growth and already in this fashion signals its unsustainability" (1997, p.13). Theoretical and policy discussions of the growth effects of another form of RER misalignment, namely RER undervaluation, have been, however, much more uncommon. As Goldfajn and Valdes (1996, p.5) explained:

> We ignore undervalued episodes. The emphasis on overvaluations in the literatrure and policy discussions is probably because prices and wages are flexible upwards. Presumably, undervaluations are less costly to reverse.

This chapter investigates the effect of RER misalignment on economic growth. Our main question is: does *any* departure from RER equilibrium significantly harm growth performance? In section 1.2, we specify the sources of our data, explain our methodology, and provide some descriptive statistics. In sections 1.3 and 1.4, we present our empirical evidence. For a sample of 88 countries over the time period 1960 - 1992, using nonparametric kernel regressions, we empirically show in section 1.3 that the larger the magnitude of RER overvaluation or RER undervaluation the lower the growth. In section 1.4, we make the leap to parametric modelling and analyze the effect of RER misalignment on economic growth in the context of Barro's standard growth framework. We extend Barro's framework to include our measures of RER misalignment, and use panel regression techniques to estimate numerous variations of the basic model. We find that our results are robust to a wide variety of growth theories. A 25% RER overvaluation or a 25% RER undervaluation result in about 4 percentage points reduction in economic growth. In section 1.5, we highlight the basic elements of two alternative theoretical models that capture our empirical findings. Finally, section 1.6 has the concluding remarks.

1.2 Data, Methodology, and Descriptive Statistics

1.2.1 Data

We use monthly data on *effective* RER's for 88 countries over the time period 1960-1992 from the Goldfajn-Valdes data set. Data on annual growth rates in real per capita GDP are from the Penn World Tables. Data on annual gross domestic investment per capita (in constant 1987 U.S. dollars) are from the World Bank's STARS retrieval system (version 3.0). The data used to estimate our variants of Barro's growth model are from the Barro-Lee data sets (1996 and 1997). Data on inequality are from Deininger and Squire (1996). All other data are from the IFS.

1.2.2 Methodology

1.2.2.1 A Measure of RER Disequilibrium

In order to identify overvaluation and undervaluation episodes, we need to define an RER equilibrium concept and the dynamics out of steady state. We adopt the Goldfajn-Valdes approach (1996). We compute,

$$RER^{*} = \alpha + T'\beta + X'\gamma \qquad [1.1]$$

where RER^{*} is the predicted value, T includes two time trends (linear and square) and X is the set of fundamentals (including terms of trade, the ratio of government expenditures to GDP, and openness). Then, for each country and for each month i, we compute the percentage deviation of the actual RER from its equilibrium, and denote it d_i. We then build the following annual or quinquennial measure of the magnitude of RER disequilibrium which we call the *absolute value* and denote by *a*:

$$a = \sum_{i=1}^{n} |d_i| \qquad [1.2]$$

where n=12 (1 year) or 60 (5 years).

1.2.2.2 Two Alternative Ways to Answer the Main Question

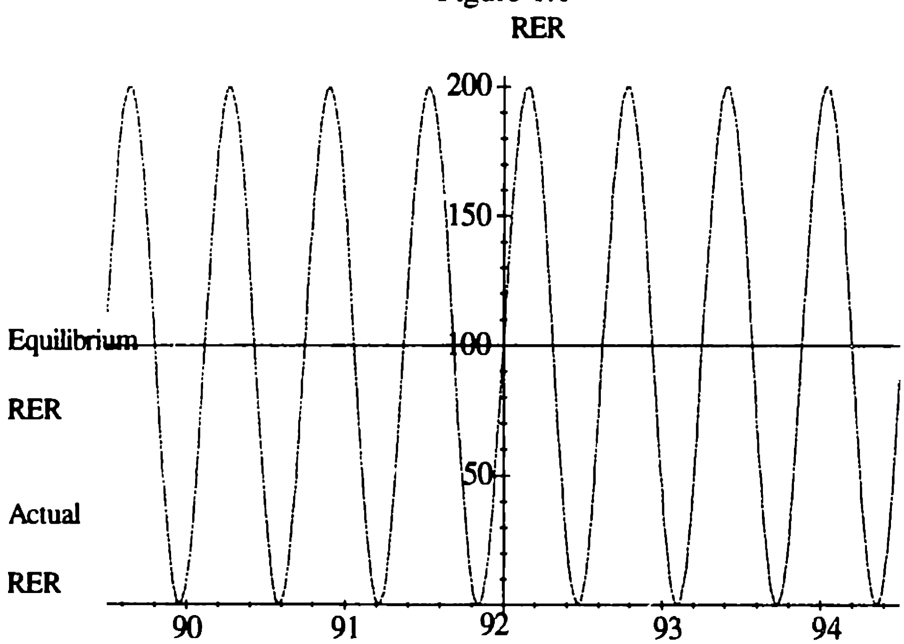
This chapter will answer our main question (*does any departure from RER equilibrium adversely affect growth performance?*) by considering the effect on economic growth of the magnitude of RER disequilibrium (using the *absolute value* measure defined in section 1.2.2.1). An alternative way to show that *any* deviation from RER equilibrium harms growth is also considered but deferred to appendix A.2 to minimize redundancy and ensure proper focus. We call this the mean-and-standard-deviation approach. To implement this approach we need to build the *standard deviation* measure (denoted *sd*) and the *average misalignment* measure (denoted *m*):

$$sd = \sqrt{\frac{\sum_{i=1}^{n}(d_i - \bar{d})^2}{n-1}} \qquad [1.3]$$

$$m = \sum_{i=1}^{n} d_i \qquad [1.4]$$

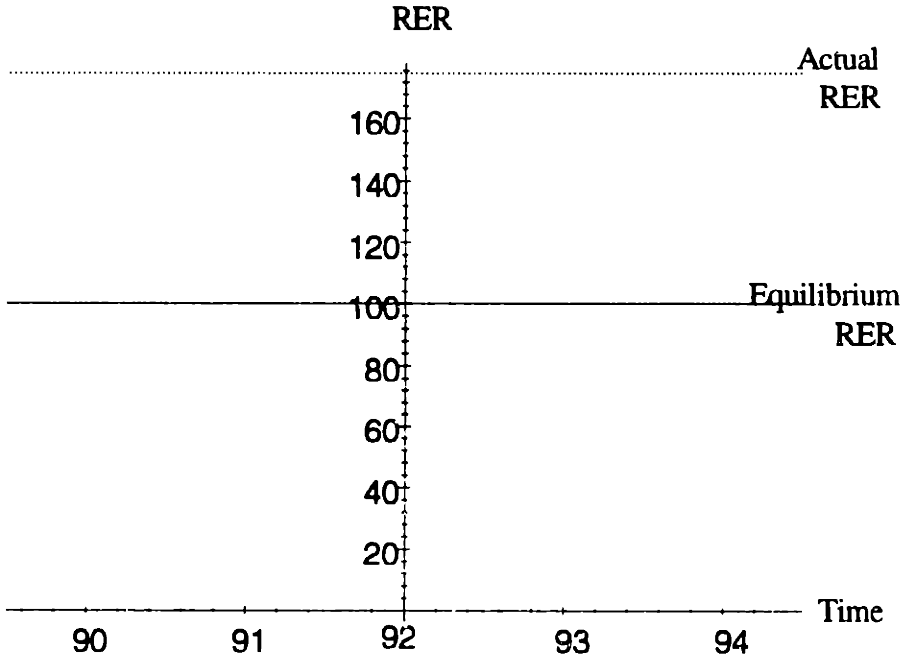
The measure *sd* is the usual standard deviation (i.e. it is a measure of how widely values are dispersed from the (period's) mean (of the monthly percentage deviations)), while the measure *m* provides information about whether "on average" the RER was over-appreciated or over-depreciated. To answer our main question we need to consider the effect on economic growth of *both* the standard deviation and the mean of the percentage deviations of actual RER from its equilibrium level. In fact, to only show that "the higher the variability of the percentage deviations from RER equilibrium the lower the growth" does not fully answer our main question; similarly to only show that "the more (on average) the RER is over-appreciated or the more (on average) it is over-depreciated, the lower the growth" does not fully answer our main question either. Figures 1.1 and 1.2 below illustrate this point.

Figure 1.1



Note: In figure 1.1, the standard deviation is very large but average misalignment is zero.

Figure 1.2



Note: In figure 1.2, the standard deviation is zero but average misalignment is very large.

Only by showing that *both* results hold would we have established that any departure from RER equilibrium has a harmful effect on economic growth. As discussed earlier, we implement the mean-and-standard-deviation approach in appendix A.2 and show that it essentially yields the same results as the absolute-value approach.

1.2.2.3 Nonparametric Estimation: Letting the Data Speak for Themselves

We perform nonparametric kernel regressions (the Nadaraya-Watson estimators) to recover the underlying relationships between the *absolute value* of the percentage deviations of actual RER from its equilibrium level and economic growth. The purpose of nonparametric regressions is to avoid placing a structure on the functional form being estimated. Hence, the estimates that result from this procedure are robust to erroneous assumptions that might have been made had the estimation problem been parametrized in the usual way. Interest centers on the relationship:

$$y = \Psi(x) + \varepsilon \qquad [1.5]$$

where y is the growth rate in real per capita GDP and x is the *absolute value* (or, in appendix A.2, one of our two measures discussed in section 1.2.2.2).

The nonparametric approach to regression is related to the nonparametric approach to density estimation. Let f(x) be the univariate kernel estimator (Rosenblatt-Parzen kernel density estimator), then

$$f(x) = (1/hn)\sum_{i=1}^{n} K[(x_i - x)/h] \qquad [1.6]$$

where K is the kernel function such that

$$\int_{-\infty}^{+\infty} K(x)dx = 1 \qquad [1.7]$$

We have,

$$\Psi(x) = E(y \mid x) = \int y.f(y \mid x)dy = \frac{\int y.f(x,y)dy}{f(x)} \qquad [1.8]$$

where the multivariate density function's estimation is a straightforward generalization of the univariate kernel estimator f(x). The kernel estimator is changed in only two regards: the kernel function $K^*(y,x)$ must be a bivariate density function, and the h in 1/hn now becomes h^2. After some algebra, we arrive at the Nadaraya-Watson estimator:

$$\Psi(x) = \frac{\sum_{i=1}^{n} y_i.K[(x_i - x)/h]}{\sum_{i=1}^{n} K[(x_i - x)/h]} \qquad [1.9]$$

This is calculated for several values of x, producing an empirical representation of the unknown functional form Ψ.

1.2.3 Descriptive Statistics

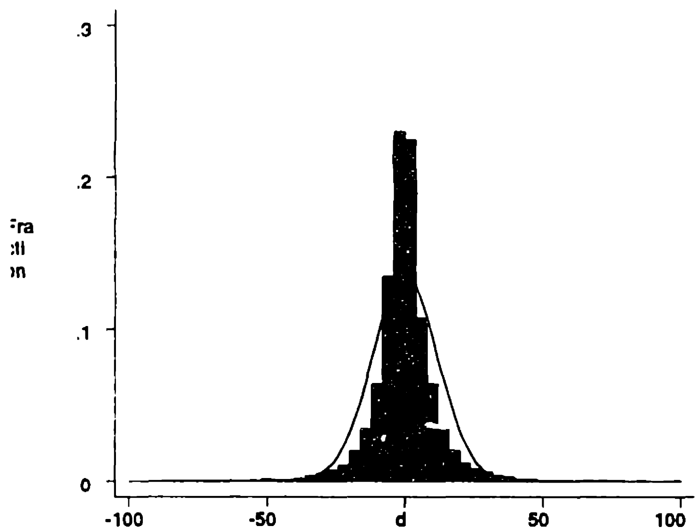
We now provide some descriptive statistics on the measures we have built. Table 1.1 below summarizes the statistics on the (monthly) percentage deviation from RER equilibrium (d), the (annual) absolute value measure (a), the (annual) average misalignment measure[1] (m), and the (annual) standard deviation measure (sd).

Table 1.1

	# of Observations	Mean	Standard Deviation	Min	Max
d	31,404	.059477	12.15239	-89.03723	157.5933
a	2484	89.08696	97.74309	2.635231	1017.564
m	2484	-.3136566	124.293	-1017.564	776.2211
sd	2484	3.650417	4.663303	.1597082	60.88128

Figure 1.3 below has the histogram of the monthly percentage deviation from RER*.

Figure 1.3



Finally, to get a better feel of extreme misalignments, we report in appendix A.1 (table A.1), by country, maximum undervaluations and maximum overvaluations.

1.3 Empirical Evidence

1.3.1 Nonparametric Estimation: First Results

Throughout this chapter, we use either the Gaussian kernel function (K_G) or the Cosine kernel function (K_C), where

$$K_G(z) = \frac{1}{\sqrt{2\pi}} e^{-z^2/2} \forall z \qquad [1.10]$$

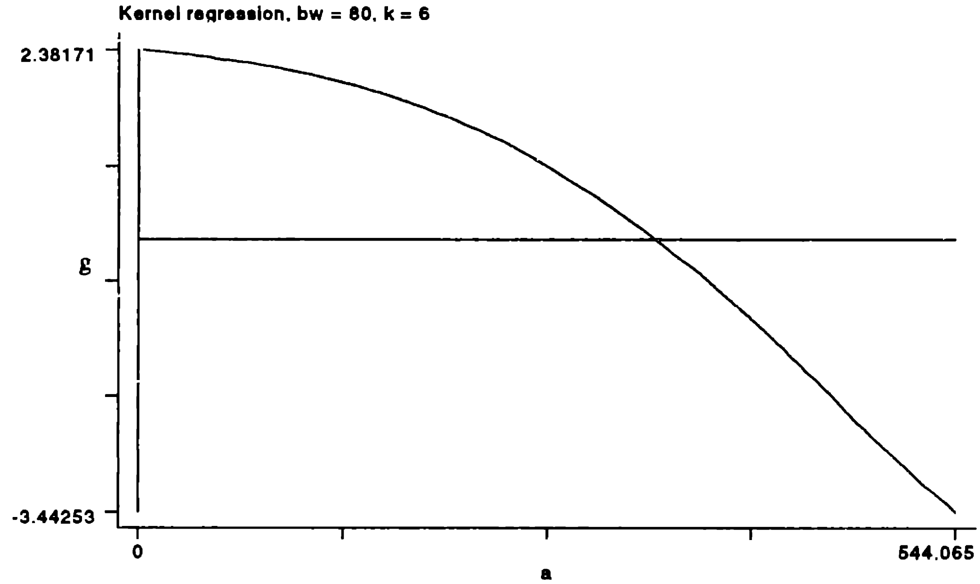
and,

$$K_C(z) = \begin{cases} 1 + \cos(2\pi z) if |z| < 1/2 \\ 0 \; otherwise \end{cases} \qquad [1.11]$$

The first pass is to take yearly values of our absolute value measure *a* and consider its relationship with annual growth. Figure 1.4 (Gaussian kernel, N=2433 observations) shows the kernel fit exploring the bivariate relationship between the annual absolute value measure and annual economic growth.

[1] Note that this is the *sum* and not the average (which can be retrieved by dividing by 12).

Figure 1.4

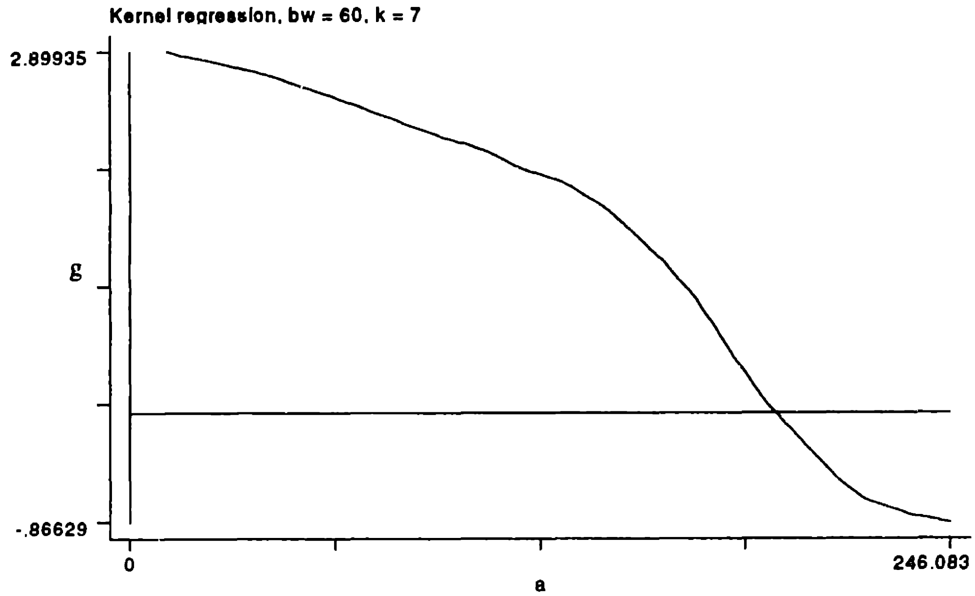


Clearly, the larger the magnitude of RER disequilibrium the lower the growth. Appendix A.2 contains additional kernel regressions between the yearly values of our standard deviation and average measures and annual growth.

1.3.2 Dealing with Some Concerns: Long-Run vs. Short-Run

The effects of RER misalignment on growth could exhibit dynamics which may be obscured by temporal effects emanating, for example, from the business cycle. This is a traditional concern in the growth literature, which we address by considering 5-years based values of our absolute value measure and exploring its relationship with 5-years average growth. Figure 1.5 (Cosine kernel, N=405 observations) shows the result.

Figure 1.5

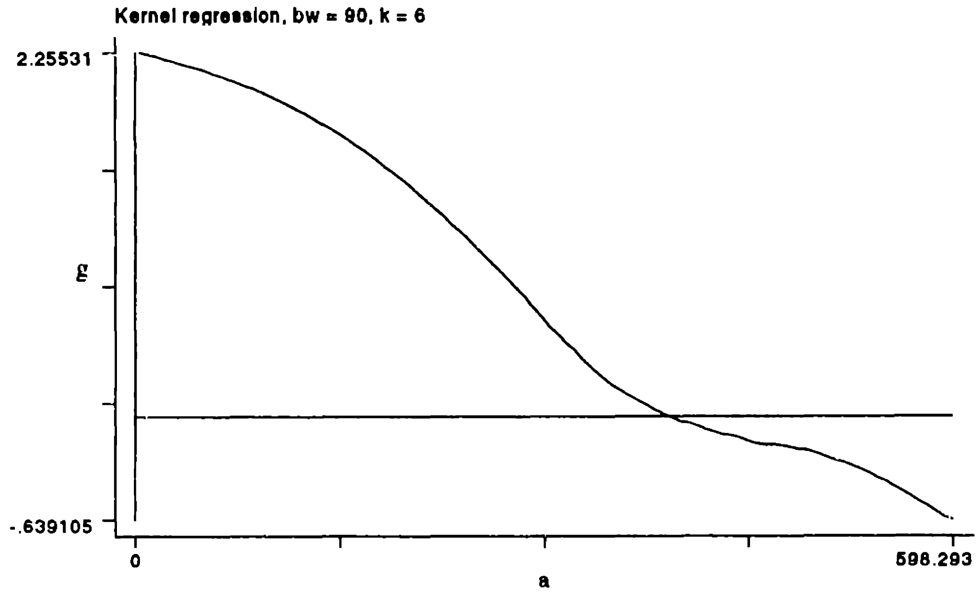


This kernel fit, based on 5-years intervals, did *not* alter the qualitative message of our initial results. Appendix A.2 contains additional kernel regressions between the 5-years based values of our standard deviation and average measures and 5-years based values of growth.

1.3.3 Dealing with Some Concerns: Joint-Determinancy

Another concern is that our variables could be jointly determined. We address this concern by considering the effects of lagged values of our absolute value measure on growth. Figure 1.6 (Gaussian kernel, N=2342 observations) shows the kernel fit:

Figure 1.6



Clearly, the qualitative messages of our initial results are not altered as well. Again, appendix A.2 contains additional kernel regressions between the lagged values of our standard deviation and average measures and growth.

In brief, then, nonparametric estimation has clearly shown that *any* deviation from RER equilibrium adversely affects economic growth performance.[2]

[2] To enhance our understanding of the findings in sections 1.3.1-1.3.3, we consider the effect of RER misalignment on per capita investment growth in appendix A.3.

1.4 A leap to Parametric Modelling: Barro's Standard Growth Framework

One serious limitation of the nonparametric regression method that we have considered is that it does not extend well to more than two variables – this is the well-known *curse of dimentionality*. As we extend beyond two dimensions, estimation, interpretation and display of the results become more difficult (Johnston and DiNardo, p.383).

In the previous sections, we were unwilling to specify any parametric form for $\Psi(x)$ in

$$y = \Psi(x) + \varepsilon \qquad [1.12]$$

We now make the leap to parametric modelling and analyze the effect of RER misalignment on economic growth in the context of Barro's standard growth framework. We extend Barro's framework to include our measures of RER misalignment. We model growth as:[3]

$$GR_{it} = \alpha_i + \beta_1 MIS_{it} + \beta_2 INC_{it} + \beta_3 INEQ_{it} + X'\phi_k + \varepsilon_{it} \qquad [1.13]$$

Where, i represents each country and t represents each time period, GR_{it} is average annual growth for country i over time period t, MIS_{it}, INC_{it}, and $INEQ_{it}$ are respectively RER misalignment (one of our three measures), income and inequality. Also, X is a $z \times 1$ vector of variables specific to the different model specifications considered and ϕ is a $z \times 1$ corresponding vector of coefficients (see appendix A.4 for exact variable definitions).

We estimate numerous variations of the basic Barro framework, focusing on the specifications most frequently cited in the growth literature: Levine & Renelt (1992), Caselli et. al. (1996), Barro, Alesina & Perotti (1994), Deininger & Squire (1996), and Perotti (1996). Note the following:

[3] For a brief explanation of the theory behind each of the explanatory variables included in our different specifications see Forbes (1997).

1. We augment these models by adding one of our three measures of RER misalignment: a (results reported in this section), m and m^2 (results reported in tables A.2 and A.3 of appendix A.5), and sd (results reported in tables A.4 and A.5 of appendix A.6).

2. We added inequality (INEQ) to each of the original specifications following the contribution of Forbes (1997).[4]

Using panel estimation techniques and controlling for country and time fixed effects, we estimate our various models and report the results in tables 1.2 and 1.3 below (see appendix A.4 for exact variable definitions).

Table 1.2

	Levine & Renelt (1992)			Caselli et. Al. (1996)		Barro
a	-0.000138	-0.000159	-0.0001135	-0.0001374	-0.0001411	-0.0001538
	-3.128	-3.5	-2.401	-3.119	-3.274	-4.047
INEQ	0.0018647	0.0018503	0.0013898	0.0017041	0.0020147	0.0020316
	2.606	2.502	1.87	2.467	2.941	3.894
INC	-0.0585068	-0.0575064	-0.0663465	-0.0563731	-0.0544104	-0.0395823
	-4.274	-4.075	-3.641	-4.19	-4.109	-3.849
MALED					0.018253	0.0236636
					1.493	2.252
FEMED					-0.0081001	-0.0162243
					-0.629	-1.507
PPPI						-0.0022416
						-0.165
BMP			-0.0223479			
			-1.436			
EXP/GDP			0.1039998			
			2.002			
GCONS/GDP		0.0165338	0.0367978			
		0.126	0.268			
INV/GDP	0.0987001	0.1456195	0.1923268	0.1070683	0.1033571	
	1.681	2.33	2.394	1.85	1.783	
PRIM		-0.0784506	-0.061692			
		-2.019	-1.485			
REVCP		0.0184839	0.0179994			
		1.912	1.832			
SEC	0.0243719	-0.0037589	-0.0082993			
	0.878	-0.128	-0.293			
POP GR	1.175017	1.201911	1.054123	1.085303	0.8264982	
	1.53	1.533	1.367	1.428	1.096	
# OBS.	145	140	133	145	141	180

Notes: T-statistics are below the coefficients. The dependent variable is GR. See appendix A.4 for exact variable definitions.

[4] We follow Forbes (1997) in the choice of variables used to replicate each of these studies.

Table 1.3

	Alesina & Perotti (1994)			Deininger & Squire (1996)	Perotti (1996)	
a	-0.0001537	-0.0001438	-0.0001447	-0.0001421	-0.000149	-0.0001415
	-4.28	-3.249	-3.292	-3.939	-3.888	-3.063
INEQ	0.0016693	0.0017064	0.0016476	0.0016765	0.0020062	0.0020267
	3.199	2.428	2.352	3.236	3.841	2.757
INC	-0.0415854	-0.0567938	-0.0578854	-0.0450111	-0.0416629	-0.0518701
	-4.068	-4.25	-4.342	-4.373	-3.971	-3.766
MALED					0.0256406	0.0231839
					2.398	1.814
FEMED					-0.0200673	-0.0134413
					-1.755	-0.958
PPPI					-0.0065463	-0.0006845
					-0.46	-0.042
INV/GDP				0.1112403		
				2.297		
LIFE EXP						0.0006464
						0.334
POP>65					0.2639344	
					0.998	
PRIM	-0.0298187	-0.0517616	-0.0552048			
	-1.018	-1.441	-1.54			
PSTAB		0.0334709				
		1.661				
PSTAB*INEQ			0.0009357			
			1.944			
# OBS.	184	145	145	186	180	141

Notes: T-statistics are below the coefficients. The dependent variable is GR. See appendix A.4 for exact variable definitions.

We find that the coefficient of a is negative and statistically significant across our model specifications. Hence our finding that "the larger the magnitude of RER disequilibrium the lower the economic growth" is indeed robust to a wide variety of growth theories. A 25% RER overvaluation or a 25% RER undervaluation (see table 1.4 for coefficient means across our specifications and for 95% confidence intervals) result in about 4 percentage points reduction in economic growth.

Table 1.4

	Mean	95% Confidence Interval
a	-.0001431	[-.0001505,-.0001358]
m	-.000013	[-.0000183,-7.59e-06]
m^2	-5.26e-07	[-5.83e-07,-4.69e-07]
sd	-.0016753	[-.0017958,-.0015548]

In addition, most of our coefficient estimates support traditional findings. Indeed, the coefficient on initial income is negative and statistically significant supporting the convergence hypothesis (developing countries grow faster than developed ones). Also, we find that the effect of inequality on growth is positive and statistically significant confirming Forbes' findings (Forbes, 1997) and the "Kaldor effect" (inequality has a positive effect on growth through increased savings and investment). As is typically reported in the literature, market distortions as proxied by the PPP of the investment deflator have a negative but insignificant effect on growth.

1.5 Future Research: Theoretical Frameworks

This section highlights the basic elements of two alternative theoretical models that capture our empirical findings, the full development of which is reserved for a separate paper.

1.5.1 RER Misalignment, Uncertainty, Irreversible Investment and Growth

We explore the effect of RER misalignment on economic growth in the context of an irreversible investment framework characterized by RER uncertainty. Given a certain degree of undervaluation, there is a probability α of oncoming RER appreciation. Indeed, in the context of overvaluation, Dornbusch and Werner (1994, p.280) noted that

> Overvaluation stops growth and, more often than not, ends in a speculative siege on the exchange rate and ultimately currency realignment.

As the degree of undervaluation increases, so does α. The more undervalued the RER is, the higher the expectation of oncoming RER appreciation. Since investment is *irreversible*, there is a value to *waiting* to see whether there is real appreciation before taking an action (i.e. investing in the nontradables sector). The higher the expectation of oncoming RER appreciation, the more the firms that halt investment in the tradables sector and wait (delay investment in the nontradables sector), the less aggregate investment there is and the lower the growth. Similarly, the more overvalued the RER, the higher the expectation of oncoming RER depreciation, the more the firms that halt investment in the nontradables sector and wait (delay investment in the tradables sector), lowering aggregate investment and slowing growth. Hence, the more undervalued the RER, or the more overvalued the RER, the lower the growth.

1.5.2 RER Misalignment, Resource Misallocation and Growth

In undervaluation episodes, the production of tradables is more profitable relative to nontradables. As a result, more resources are devoted to the production of tradables and less to the production of nontradables, relative to what would have been devoted had the RER been in equilibrium. Similarly, in overvaluation episodes, more resources are devoted to the production of nontradables and less to the production of tradables, relative to what would have been devoted had the RER been in equilibrium. Thus, whether the RER is overvalued or undervalued, the economy's resources are misallocated and as a result the economy would be growing at a rate that is lower than that which would have prevailed had there been no RER misalignment. The more overvalued the RER is, or the more undervalued the RER is, the more misallocated the economy's resources are and the lower the economic growth.

1.6 Concluding Remarks

We have presented empirical evidence showing that the larger the magnitude of RER disequilibrium the lower the economic growth. Our findings have important theoretical and policy implications. From a theoretical standpoint, models that assign a negative growth effect to RER overvaluation "linearly" (with the logical implication that undervaluations have a positive growth effect) are liable to yielding misleading results. From a policy standpoint, one of the implications of our findings is that an "excessive" devaluation, leading to a severe undervaluation, can be even more harmful to growth performance than no devaluation at all. In other words, a devaluation should aim at "getting it right" and avoid over-correcting the overvaluation: undervaluations are as serious a problem as overvaluations.

Chapter 2

Undoing Real Exchange Rate Misalignments: Do Transitions Have Real Costs?

2.1 Introduction

Corrections of Real Exchange Rate (RER) overvaluations have often engaged politicians and policy makers in heated debates about the potential economic costs that such corrections may inflict. As recently as September 1997, Malaysian Prime Minister Mahathir Mohamad vehemently attacked the undoing of the Ringgit's overvaluation; as he explained:

> When a currency is devalued ... the per capita income and purchasing power parity of the countries under attack ... decline. Those who think that manipulated currency devaluations are normal have obviously never ... understood the meaning of poverty, never appreciated the desire of poor countries and poor people to rise above their miserable conditions.[5]

The undoings of RER undervaluations, on the other hand, have almost always invoked no reactions. According to Goldfajn and Valdes (1996, p.5), "Presumably, undervaluations are less costly to reverse [than overvaluations]." For a sample of 51 countries over the time period 1960-1994, using panel estimation techniques, this chapter assesses the real costs of *undoing* RER undervaluations and RER overvaluations.

In section 2.2, we present definitions, provide some descriptive statistics, and highlight France's *Franc Poincaré* interwar undervaluation episode. In section 2.3, we explain our methodology and specify the sources of our data. In section 2.4, we present our empirical evidence. We first focus on the costs of undoing *large* RER misalignments. We find that correcting large[6] undervaluations is *costly* while correcting large overvaluations is *beneficial*. Our focus shifts to realignment costs of *smaller* RER misalignments in section 2.5. We find that smaller corrections of undervaluations are *less costly* than larger corrections, and that smaller corrections of overvaluations are *less beneficial* than larger corrections. Finally, section 2.6 has the concluding remarks and suggestions for future research.

2.2 Correction Episode Definition, Descriptive Statistics and the *Franc Poincaré*

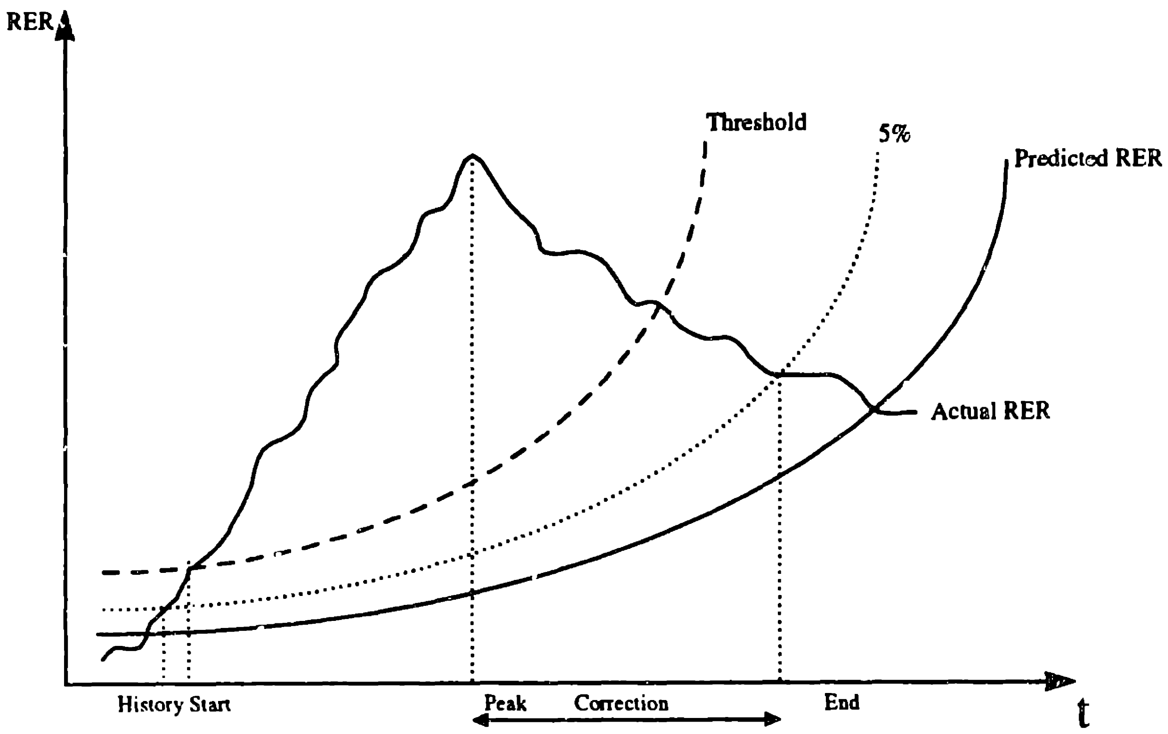
2.2.1 Correction Episode Definition

In the spirit of Goldfajn and Valdes (1996), we define the *start* of a misalignment episode (whether it is an overvaluation or an undervaluation) as the time when the absolute value of the difference between the actual RER and our estimate of equilibrium RER is greater than a certain threshold. We consider 3 thresholds: 10%, 15%, and 25%. The *end* of a misalignment episode is defined as the time when this difference hits a second threshold (5%) associated with the existence of no misalignment. Also, *history* is defined as the time when the misalignment first reaches 5%. We define *peak* as the time when the RER *appreciation* is highest in an overvaluation episode, and *trough* as the time when the RER *depreciation* is highest in an undervaluation episode. A *misalignment episode* is defined as the start-end period; we only consider misalignment episodes that are sustained for 2 or

[5] The Wall Street Journal. September 23 1997, p.A22, "Highwaymen of the Global Economy."
[6] The exact definition of "large" misalignments is specified in section 2.2.

more consecutive quarters so as to control for data blips. Finally, a *correction episode* is then defined as either a *peak-end* period or a *trough-end* period (see figure 2.1).

Figure 2.1: Correction Episode Definition



2.2.2 Some Descriptive Statistics

For a sample of 88 countries over the time period 1960-1994, we now present several features of undervaluation episodes to complement Goldfajn and Valdes's (1996) findings on overvaluation episodes. Our first finding concerns the number of undervaluation episodes that exist under our different thresholds: as shown in table 2.1 below, as expected, that number declines as the threshold increases.

Table 2.1: Number of Undervaluation Episodes

Threshold	#
10%	219
15%	156
25%	70

We find that undervaluation episodes have features that are quite *different* from those of overvaluation episodes. Table 2.2 presents the statistics on average durations in quarters. Indeed, the average duration of an entire undervaluation episode (1½-2 years) is *larger* than that of an overvaluation episode.[7] Also, the difference between the average duration of the history-trough phase (representing the buildup problem) and that of the correction phase is *not* statistically significant.[8] This result hints at inflation (as opposed to sudden nominal revaluation) as the common undervaluation correction mechanism. Moreover, across our thresholds, the differences between average durations of undervaluation correction episodes are *not* statistically significant, implying that the correction mechanism (inflation) for large undervaluations seems to be no different than that for smaller undervaluations.[9]

[7] Goldfajn and Valdes found that the average duration of an overvaluation episode is about 1 year.

[8] Goldfajn and Valdes found that the average duration of the peak-end phase is about one half that of the history-peak period, and attributed that finding to the sudden return to equilibrium produced by nominal devaluations.

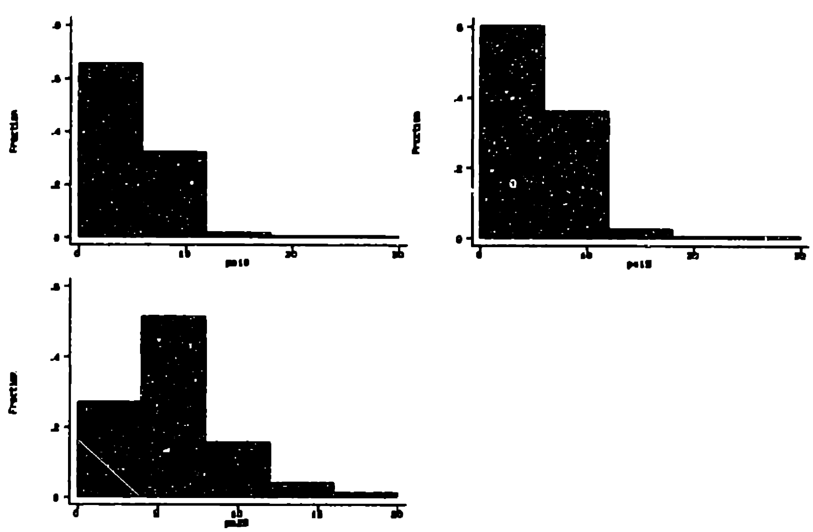
Table 2.2: Average Durations (Quarters)

Threshold	Entire Undervaluation Episode	History-Trough	Trough-End
10%	6.95 [5.93-7.99]	4.34 [3.58-5.11]	4.81 [4.04-5.59]
15%	7.00 [6.02-7.98]	4.76 [3.88-5.63]	5.33 [4.54-6.12]
25%	7.23 [6.35-8.11]	5.00 [4.02-5.98]	5.93 [5.27-6.58]

Note: confidence intervals are in brackets.

We now present, for each threshold, the frequency histograms of the duration of our undervaluation *correction* episodes (figure 2.2) and undervaluation history-trough episodes (figure 2.3).[10]

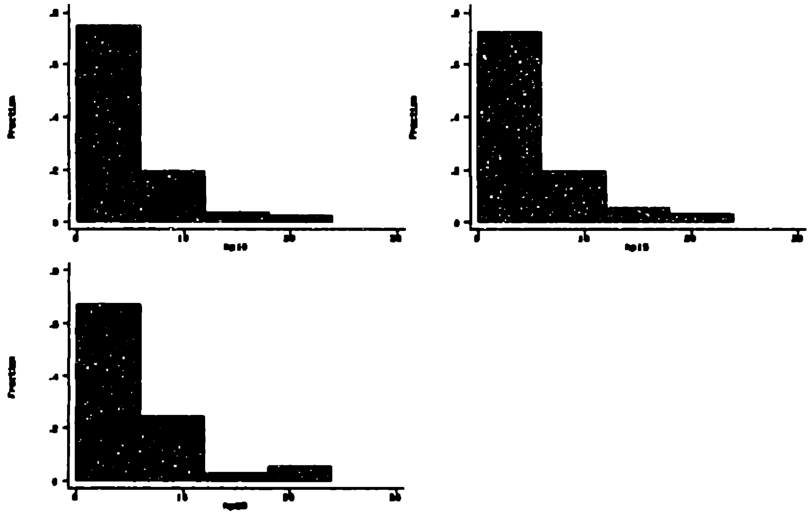
Figure 2.2: Histogram of Undervaluation Correction Episodes' Durations



[9] Goldfajn and Valdes found that the higher the threshold, the lower the duration of overvaluation correction episodes.

[10] Goldfajn and Valdes found that duration is highly asymmetric between the build-up and the correction phases. The higher duration of history-peak spreads over all categories of duration lasting more than 4 months.

Figure 2.3: Histogram of Undervaluation History-Trough Episodes' Durations



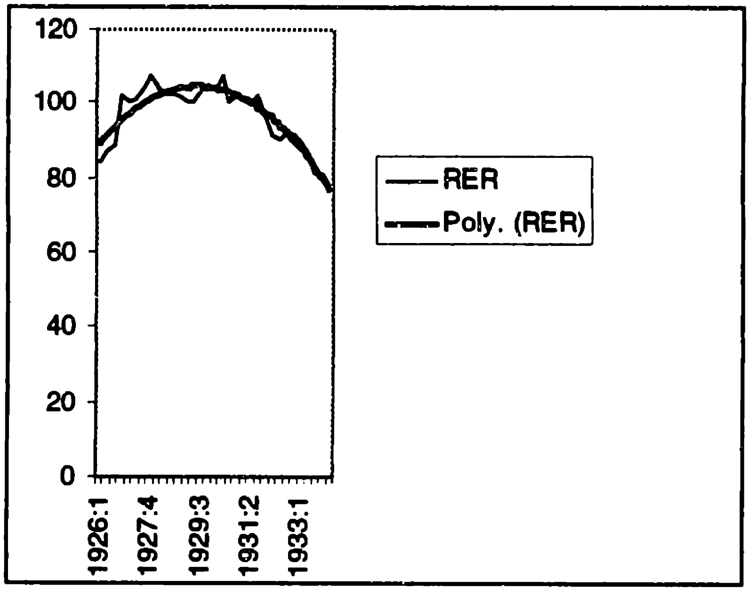
Finally, to get a better sense of extreme cases, we report in appendix A, by country, maximum undervaluations and maximum overvaluations as well as the dates on which they materialized (table A.1).

2.2.3 The *Franc Poincaré*: A Famous Undervaluation Episode

One of history's most famous undervaluation episodes materialized over the period 1926-1930 in France. This interwar episode, known as that of the *Franc Poincaré*, was characterized by an exchange rate stabilization at an undervalued parity which considerably enhanced the competitiveness of France's economy. Starting in 1931, however, successive nominal devaluations of some of France's main trading partners caused a real appreciation of the French Franc that rendered it overvalued (Eichengreen and Wyplosz, 1988). Figure 2.4 below plots France's *effective* RER over the time period (as well as a fitted polynomial).[11]

[11] Quarterly *effective* RER data are from Eichengreen and Wyplosz (1988).

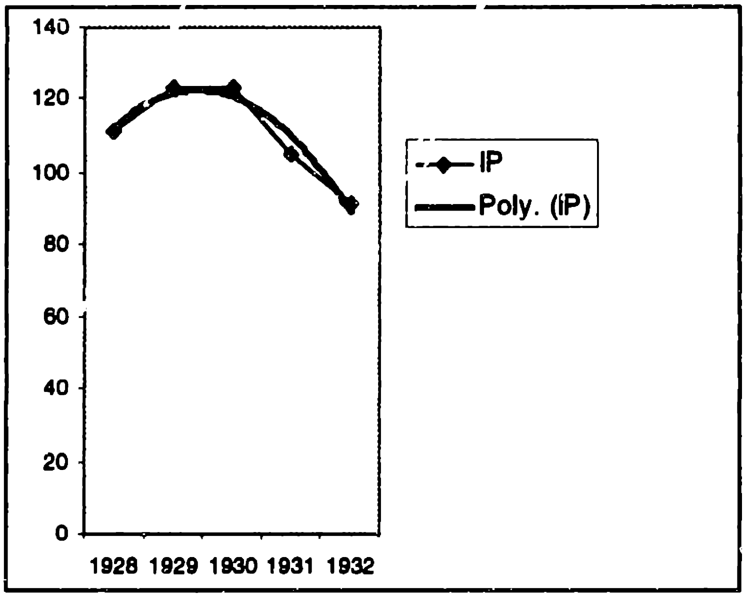
Figure 2.4



In conventional accounts, the *Franc Poincaré* period is credited for bringing about an export-led boom and growth through the end of 1930 and for allowing France to resist the onset of the Depression until 1931. In figure 2.5 below, we plot an index of France's Industrial Production (IP) as well as a fitted polynomial.[12]

[12] Data from B.R. Mitchell's International Historical Statistics: Europe 1750-1988.

Figure 2.5



The overvaluation of the French Franc which started in 1931 led to a 14.6% decline in IP in 1931 and 13.3% in 1932. According to Eichengreen and Wyplosz (1988, p.258), that overvaluation "greatly exacerbated the impact of the slump on French industry and trade, largely accounting for the singular depth and long duration of the French Depression."

2.3 Methodology and Data

2.3.1 Preliminary Remarks on Methodology

Before proceeding to explain our methodology, two clarifications must first be stressed:

1. Throughout this paper, the term "real cost" refers to real *output* cost. Indeed, alternatives exist as in Krugman (1996) where he assumed that there are real costs in terms of *reputation* when authorities decide to devalue.

2. As will become clearer when we specify in section 2.3.2 the model we estimate, the "costs" of correcting a misalignment refer to the real output growth effects of a

realignment "on top of" the direct effects of RER changes on real output growth in a correction episode.

2.3.2 Methodology

In its most elementary form, the specification of the model we estimate is such that output depends on *both* the level of the RER (the price effect) and its distance from equilibrium (the disequilibrium effect), hence,

$$IP = \alpha + \beta RER + \delta \left| RER - RER^{eq} \right| + \varepsilon \qquad [2.1]$$

where,

IP is industrial production, RER is the actual real exchange rate, and RER^{eq} is the equilibrium real exchange rate.

Our goal is to assess the real costs of *undoing* RER misalignments (both undervaluations and overvaluations). To that end, for *each* threshold, we take first differences and use panel regression techniques to estimate:

$$\begin{aligned} \Delta IP &= \beta \Delta RER + \delta \Delta \left| RER - RER^{eq} \right| \\ &+ \beta_1 \{\Delta RER * D_u\} + \delta_1 \{\Delta \left| RER - RER^{eq} \right| * D_u\} \\ &+ \beta_2 \{\Delta RER * D_o\} + \delta_2 \{\Delta \left| RER - RER^{eq} \right| * D_o\} + \varepsilon \qquad [2.2] \end{aligned}$$

Our 2 dummy variables D_u and D_o are built as follows. D_u is a dummy variable for undervaluation *correction episodes* with 1's for the quarters between "trough" and "end" and 0's otherwise, while D_o is a dummy variable for overvaluation *correction episodes* with 1's for the quarters between "peak" and "end" and 0's otherwise.

We also introduce *lags* to factor in the fact that the adjustment time may take several quarters, hence we have,

$$\Delta IP = \sum_{k=0}^{n}[\beta_{0k}\Delta RER_{t-k} + \delta_{0k}\Delta\left|RER_{t-k} - RER^{eq}{}_{t-k}\right|$$
$$+ \beta_{1k}\{\Delta RER_{t-k} * D_u\} + \delta_{1k}\{\Delta\left|RER_{t-k} - RER^{eq}{}_{t-k}\right| * D_u\}$$
$$+ \beta_{2k}\{\Delta RER_{t-k} * D_o\} + \delta_{2k}\{\Delta\left|RER_{t-k} - RER^{eq}{}_{t-k}\right| * D_o\}] + \varepsilon \qquad [2.3]$$

We consider the cases where the adjustment may take 1, 2, 3, or 4 quarters (n=0,...,4).

2.3.3 Preliminary Remarks on Data

Before proceeding to specify the sources of our data, two remarks must first be highlighted:

1. Our analysis requires high frequency output data. Even though IP is only about 20% of GNP, we use it in our analysis instead of quarterly GNP as it produces a larger (includes 51 countries while GNP-based includes only 27 countries), longer (most series start in 1960 while most GNP series start in the mid 1970's) and more balanced (includes a mixture of OECD and developing countries while GNP-based consists mostly of OECD countries) final sample.

2. If IP is a good proxy for GNP, then our results are capturing the costs of correcting a misalignment in *both* the tradables and nontradables sectors, and thus the whole economy. Otherwise, our results would be capturing the realignment costs in the tradables sector alone. However, since the realignment costs in the tradables sector have to be positively correlated with the realignment costs in the nontradables sector (can be easily shown using a Ricardian general equilibrium framework), then our results regarding the tradables sector generalize to the whole economy.

2.3.4 Data

Our RER equilibrium paths are built following the Goldfajn-Valdes approach (1996). We compute,

$$RER^{*} = \xi + T'\phi + X'\psi \qquad [2.4]$$

where RER^{*} is the predicted value, T includes two time trends (linear and square) and X is the set of fundamentals (including terms of trade, the ratio of government expenditures to GDP, and openness). Our initial sample consists of 88 countries over the time period 1960-1994. However, due to the limited number of countries that have IP data, our final sample now consists of 51 countries over the time period 1960-1994. The data on *effective* RER's are from the Goldfajn-Valdes data set. All other data are from the IFS.

2.4 Empirical Evidence -- Costs of Undoing Large RER Misalignments

2.4.1 Panel Regressions

We first focus on the costs of undoing *large* RER misalignments. To that end, we start with the 25% threshold, and assume that the adjustment time takes 2 quarters. For a sample of 51 countries over the time period 1960-1994, using panel estimation techniques and controlling for country and time fixed effects, we estimate equation 2.3. The estimation results of this "preferred" regression are reported in appendix B (table B.1).

In table 2.3, we report the "aggregate effect" (the sum of the coefficients over the lags) as well as the significance level of the test that the sum of the coefficients equals zero (using a Wald test to test our linear restriction).

Table 2.3: Costs of Large Realignments

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	0.03346	-0.00003	-0.26975	0.05035	-0.22517	-0.06037
Prob>F	0.2744	0.5271	0.0200	0.0055	0.1930	0.0466

We find that correcting large overvaluations is *beneficial*: $\sum\delta_{2k}$ is negative and is statistically significant at the 5% level. This result is robust across lags (at the 5% level)[13] as can be seen from table B.7 in appendix B.3. To see why a negative aggregate effect implies that correcting overvaluations is beneficial, note that, in realignment times $|RER - RER^{eq}|$ is decreasing, hence $\Delta|RER - RER^{eq}|$ is always negative.

We also find that correcting large undervaluations is *costly*. Indeed, $\sum\delta_{1k}$ is positive and statistically significant at the 1% significance level. This result is very robust across lags (see table B.7 in appendix B.3).

2.4.2 Outlier Sensitivity Assessment

We now assess the sensitivity of our initial results to outliers. We do that by comparing our initial results to those obtained after "trimming" extreme outliers in section 2.4.2.1 and to those obtained through "robust estimation" in section 2.4.2.2.

2.4.2.1 Trimming Extreme Outliers

"Trimming" is the most straightforward method of assessing the sensitivity of our results to outliers. We completely drop independent variables' observations that are more than 4 standard deviations away from the corresponding variables' means. The number of observations that are dropped is about 1% of the total number of observations. The results of our new regression assuming that the adjustment time takes 2 quarters and controlling for country and time fixed effects are summarized in table 2.4 below.

Table 2.4: Costs of RER Realignments – Trimming Outliers

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	0.102103	0.0006049	-0.39253	0.068851	-0.29561	-0.06154
Prob>F	0.0087	0.1342	0.0138	0.0007	0.1698	0.0555

We find that $\sum\delta_{2k}$ is negative and statistically significant, while $\sum\delta_{1k}$ is positive and statistically significant. These results confirm those of section 2.4.1. Hence, the fact that the initial messages were not altered indicates that our initial findings were not driven by outliers dynamics.

2.4.2.2 Biweight and Huber Robust Panel Regressions

An alternative method to assess the sensitivity of our initial results to outliers is that of "robust estimation." A "robust regression" is implemented as follows. A regression is performed, case weights are calculated based on absolute residuals, and a new regression is performed based on those weights. Iterations stop when the maximum change in weights drops below "tolerance." The weights derive from one of two weight functions: Huber weights and biweights. Huber weights (Huber 1964) are used until convergence and then, based on that result, biweights are used until convergence.[14] Both weighting functions are used because Huber weights have problems dealing with severe outliers while biweights sometimes fail to converge or have multiple solutions. The initial Huber weighting should improve the behavior of the biweight estimator. The Huber weighting

[13] Except for the 4th lag.

[14] The biweight was proposed by A. E. Beaton and J. W. Tukey (1974, 151-152).

function is such that cases with "small" residuals receive weights of 1 and cases with "larger" residuals receive gradually smaller weights. It is defined as:

$$w_i = \begin{cases} 1 & \text{if } |u_i| \le c_h \\ c_h / |u_i| & \text{otherwise} \end{cases} \qquad [2.5]$$

Let $\Theta = \text{med}(|e_j - \text{med}(e_j)|)$ be the median absolute deviation from the median residual. Then, u_i , the ith scaled residual, is such that $u_i = e_i/s$, where e_i is the ith case residual and $s = \Theta/.6745$ is the residual scale estimator. We have the tuning constant[15] $c_h = 1.345$, so downweighting begins with case whose absolute residual exceeds $(1.345/.6745)\Theta \approx 2\Theta$.

The biweight function is such that all cases with nonzero residuals receive some downweighting, according to the smoothly decreasing biweight function:

$$w_i = \begin{cases} [1 - (u_i/c_b)^2]^2 & \text{if } |u_i| \le c_b \\ 0 & \text{otherwise} \end{cases} \qquad [2.6]$$

where the tuning constant $c_b = 4.685$. Thus, cases with absolute residuals of about 7Θ or more are assigned 0 weight and thus are effectively dropped.

The results of our robust regressions[16] assuming that the adjustment time takes 2 quarters and controlling for country and time fixed effects are summarized in table 2.5 below.

[15] The tuning constants c_h and c_b give the "robust regression" estimation 95% of the efficiency of OLS when applied to data with normally distributed errors (Hamilton 1991). Lower tuning constants downweight outliers more drastically (but give up Gaussian efficiency); higher tuning constants make the estimator more like OLS.

[16] Standard errors are calculated using the pseudo-values approach described in Street, Carroll, and Ruppert (1988).

Table 2.5: Costs of RER Realignments – Robust Regressions

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	0.00862	-0.00005	-0.30808	0.01837	-0.29201	-0.05266
Prob>F	0.57500	0.02220	0.00000	0.04360	0.00080	0.00060

Again, $\sum\delta_{2k}$ is negative and statistically significant, while $\sum\delta_{1k}$ is positive and statistically significant. These results confirm those of sections 2.4.1 and 2.4.2.1. Once more, the fact that the initial messages were not altered indicates that our initial findings were not driven by outliers dynamics.

2.4.3 Understanding the Short-Run Effects of RER Movements on IP

Since IP consists largely of manufacturing goods (tradables), it should theoretically be positively affected by an increase in the RER (real depreciation). We find, however, that while the *aggregate* effect of RER on IP is positive (statistically insignificant), the coefficient of RER_t is negative.

Our interpretation[17] for this result is that our model could be suffering from an *endogeneity problem*. As we show below, this would bias our coefficient of RER_t downwards. Indeed, consider the following set of equations:

$$RER_t = -\alpha_0\Omega_t + \cdots + \varepsilon_t \qquad [2.7]$$

where Ω_t is a tradables sector productivity shock, and

[17] A second interpretation of our initial result is that we have failed to put enough structure on the lags of ΔIP. Indeed, we re-estimate our model by including l=1,...,4 lags of ΔIP as independent variables. The results are reported in appendix B.2 (table B.3). This exercise however did not alter *any* of our initial results.

$$IP_t = \alpha + \lambda RER_t + \cdots + \alpha_1 \Omega_t + \varepsilon_t \qquad [2.8]$$

Solving, we get,

$$\begin{aligned} IP_t &= \alpha + \left(\lambda - \frac{\alpha_1}{\alpha_0}\right) RER_t + \cdots + \varepsilon_t \\ &= \alpha + \beta RER_t + \cdots + \varepsilon_t \qquad [2.9] \end{aligned}$$

Hence, if $\alpha_1/\alpha_0 > \lambda$ (positive), then β would be negative.

There are 2 *extreme* identifying assumptions that can be invoked. We show that they both yield the *same* results with respect to realignment costs. The first is to assume that "productivity shocks do *not* affect IP today (but they do affect the RER)." This amounts to setting α_1=0, and gives us our initial results presented in table 2.6 below. The second is to assume that "productivity shocks do *not* affect RER today (but they affect IP)" and that "today's RER does *not* affect IP." This amounts to setting α_0=0 and λ=0. We thus drop the ΔRER's from our estimation, and present the summary of the new results in table 2.6 below.

Table 2.6: Regressions Excluding ΔRER's

	α_1=0	α_0=0 and λ=0
ΔRER_t	-.033747 (.0179824)	--
ΔRER_{t-1}	.0512449 (.0181058)	.0467863 (.0179745)
$\sum\beta_{0k}$ – Sum	0.033461	0.064879
$\sum\beta_{0k}$ – Prob>F	0.2744	0.0110
$\sum\delta_{1k}$ – Prob>F	0.0055	0.0279
$\sum\delta_{2k}$ – Prob>F	0.0466	0.1129

Note: standard errors are in parentheses.

As can be seen from table 2.7, the differences between the coefficients given $\alpha_1=0$ and the coefficients given $\alpha_0=0$ and $\lambda=0$ are *not* statistically significant.

Table 2.7: Regressions Excluding ΔRER's: Associated Costs of Realignments

	$\alpha_1=0$		$\alpha_0=0$ and $\lambda=0$	
	Coefficient	s.e	Coefficient	s.e
$\Delta\|RER_t-RER_t^{eq}\|*d_u$	0.037735	0.019348	0.011014	0.01181
$\Delta\|RER_{t-1}-RER_{t-1}^{eq}\|*d_u$	0.013147	0.007457	0.016689	0.007185
$\Delta\|RER_{t-2}-RER_{t-2}^{eq}\|*d_u$	-0.00053	0.002511	8.23E-06	0.002494
$\Delta\|RER_t-RER_t^{eq}\|*d_o$	0.00611	0.029056	0.034307	0.021206
$\Delta\|RER_{t-1}-RER_{t-1}^{eq}\|*d_o$	-0.12568	0.031098	-0.14093	0.029224
$\Delta\|RER_{t-2}-RER_{t-2}^{eq}\|*d_o$	0.059197	0.021768	0.061767	0.021707

We can then confidently conclude that the endogeneity problem is not driving our main results one way or the other.

2.4.4 Augmented Model

We now modify the specification of our original model (equation 2.3) to factor in our analysis the effects of potential nonlinearities in the disequilibrium effect on realignment costs. Indeed, we augment our original model to include quadratic disequilibrium terms. Our augmented model is specified as follows:

$$\Delta IP = \sum_{k=0}^{n} [\beta_{0k} \Delta RER_{t-k} + \delta_{0k} \Delta |RER_{t-k} - RER^{eq}{}_{t-k}| + \gamma_{0k} [\Delta |RER_{t-k} - RER^{eq}{}_{t-k}|]^2$$
$$+ \beta_{1k} \{\Delta RER_{t-k} * D_u\} + \delta_{1k} \{\Delta |RER_{t-k} - RER^{eq}{}_{t-k}| * D_u\} + \gamma_{1k} \{[\Delta |RER_{t-k} - RER^{eq}{}_{t-k}|]^2 * D_u\}$$
$$+ \beta_{2k} \{\Delta RER_{t-k} * D_o\} + \delta_{2k} \{\Delta |RER_{t-k} - RER^{eq}{}_{t-k}| * D_o\} + \gamma_{2k} \{[\Delta |RER_{t-k} - RER^{eq}{}_{t-k}|]^2 * D_o\}] + \varepsilon \quad [2.10]$$

where, positive γ_{ik}'s imply a *convex* cost function, and negative γ_{ik}'s imply a *concave* cost function.

The inclusion of quadratic disequilibrium terms introduces 2 modifications to our framework. Indeed, when we introduce *lags* to factor in the adjustment time, the cross-terms now need to be included in the estimation.[18] Also, our disequilibrium variable and quadratic disequilibrium variable may be highly collinear. We orthogonalize them using Chebyshev polynomials.[19] Again, for the 25% threshold and assuming that the adjustment time takes 2 quarters, the results of our panel estimation (controlling for country and time fixed effects and using Chebyshev polynomials) are reported in appendix B.1.

We summarize our results by reporting the t-statistics on the γ's (table 2.8), the sum of the coefficients over lags (the aggregate effects) and the significance level of the Wald test that the sum of the coefficients equals zero (table 2.9).

Table 2.8: Quadratic Disequilibrium Terms (Chebyshev)

	t-statistics					
i	γ_i	γ_i^{-1}	γ_i^{-2}	γ_i^{cross}	$\gamma_i^{cross'}$	$\gamma_i^{cross''}$
0	-1.754	0.707	0.739	-0.360	-1.295	-0.054
1	-0.654	0.257	0.185	-1.178	-1.191	-0.308
2	1.702	1.903	0.898	-2.881	-1.179	-1.826

i=1 is for undervaluation, i=2 is for overvaluation.

Table 2.9: Costs of RER Realignments (Chebyshev)

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	0.03154	-0.00006	-0.59603	0.15428	-0.27372	-0.09116
Prob>F	0.3025	0.6319	0.0001	0.0001	0.1217	0.0616

The summary of the results of our panel estimation when our disequilibrium and quadratic disequilibrium variables are *not* orthogonalized are reported in tables 2.10 and 2.11 below.

Table 2.10: Quadratic Disequilibrium Terms (Uncorrected Model)

	t-statistics					
i	γ_i	γ_i^{-1}	γ_i^{-2}	γ_i^{cross}	$\gamma_i^{cross'}$	$\gamma_i^{cross''}$
0	-1.702	0.698	0.766	-0.376	-1.015	-0.086
1	-0.499	0.320	0.180	-1.570	-1.055	-0.320
2	0.448	1.496	0.876	-1.933	-1.757	-1.274

i=1 is for undervaluation, i=2 is for overvaluation.

Table 2.11: Costs of RER Realignments (Uncorrected Model)

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	0.03159	-0.00001	-0.56917	0.14584	-0.24007	-0.08168
Prob>F	0.3018	0.9131	0.0001	0.0001	0.1793	0.0922

[18] When considering one lag, we now need to include the terms x_t^2, x_{t-1}^2, and $x_t.x_{t-1}$; and when considering two lags, we now need to include the terms x_t^2, x_{t-1}^2, x_{t-2}^2, $x_t.x_{t-1}$, $x_t.x_{t-2}$, and $x_{t-1}.x_{t-2}$.

[19] We do that by substituting $(2x^2-1)$ for x^2.

We find that $\sum\delta_{2k}$ is negative and statistically significant at the 5% (or 10%) level across lags[20] when quadratic terms are included (see tables B.16 and B.19 in appendix B.5). Also, $\sum\delta_{1k}$ is positive and statistically significant (at the 1% level) when quadratic terms are included. This result is very robust across lags at the 1% level of significance (see tables B.15 and B.18 in appendix B.5).

2.5 Empirical Evidence -- Costs of Undoing Smaller RER Misalignments

2.5.1 Panel Regressions

Our focus now shifts to the realignment costs of *smaller* RER misalignments. Thus we lower the threshold from 25% to 10%.[21] Our preferred regression continues to assume that the adjustment time takes 2 quarters. The results of this regression are reported in appendix B.1 after filtering out country and time fixed effects.

In table 2.12 below, we summarize the relevant pieces of information from this regression. We report the sum of the coefficients over the lags (the aggregate effect) as well as the significance level of the test that this sum equals zero (using a Wald test).

Table 2.12: Costs of RER Realignments

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	0.00085	-0.00003	-0.03469	0.01234	0.07075	-0.04987
Prob>F	0.97860	0.47110	0.73300	0.29930	0.59110	0.00110

[20] When no lags are introduced, it is not statistically significant.

[21] The results associated with the 15% (table B.5) and 20% (table B.6) thresholds are reported in appendix B.3 to show the evolution of our results.

We find that correcting overvaluations is *beneficial*: $\sum\delta_{2k}$ is negative and statistically significant at the 1% level. These results are robust across lags (see table B.4 in appendix B.3). Our initial results regarding the costs of correcting undervaluations are not unambiguous. We show in sections 2.5.2 and 2.5.3 that they are to some extent somehow obscured by some outliers' dynamics. As shown in table 2.12, they only *point* in the direction of *costly* corrections of undervaluations: $\sum\delta_{1k}$ is positive but is statistically insignificant. These results are robust across lags (see table B.4 in appendix B.3).

2.5.2 Trimming Extreme Outliers

As we did in section 2.4.2.1, we assess the sensitivity of our initial results to outliers by completely dropping independent variables' observations that are more than 4 standard deviations away from the corresponding variables' means. The number of observations that we dropped is about 1% of the total number of observations. The results of our new regression, assuming that the adjustment time takes 2 quarters and controlling for country and time fixed effects are summarized in table 2.13 below.

Table 2.13: Costs of RER Realignments – Trimming Outliers

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	0.054373	0.0006351	-0.1026	0.033281	0.027588	-0.04693
Prob>F	0.1822	0.1164	0.4493	0.0250	0.8742	0.0105

We find that $\sum\delta_{2k}$ remains negative and statistically significant at the 1% level. The noticeable change, however, is that $\sum\delta_{1k}$ (positive) is now also statistically significant at the 2% level, confirming that correcting undervaluations is *costly*. We conclude that our initial findings on the costs of correcting undervaluations were to some extent somehow obscured by some outliers' dynamics.

2.5.3 Robust Panel Regressions

As in section 2.4.2.2, we assess the sensitivity of our initial results to outliers by comparing our initial results to those obtained through "robust regressions." The results of these robust regressions assuming that the adjustment time takes 2 quarters and controlling for country and time fixed effects are summarized in table 2.14 below.

Table 2.14: Costs of RER Realignments – Robust Regressions

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	0.00099	-0.00005	-0.31688	0.01845	0.16773	-0.02385
Prob>F	0.95070	0.02100	0.00000	0.00210	0.02200	0.00970

We find that $\sum\delta_{2k}$ remains negative and statistically significant at the 1% level. The noticeable change, again, is that $\sum\delta_{1k}$ (positive) is now also statistically significant at the 1% level, confirming that correcting undervaluations is *costly*.

Clearly, the results from our robust regressions indicate, as did the results from our "trimming" exercise in section 2.5.2, that our initial findings on the costs of correcting undervaluations were to some extent somehow obscured by some outliers' dynamics.

Hence, when the 10% threshold is considered, we can confidently conclude that correcting overvaluations is beneficial, while correcting undervaluations is costly.

2.5.4 The Short-Run Effects of RER Movements on IP

Again, we invoke our 2 extreme identifying assumptions specified in section 2.4.3.[22] We present the summary of our results in table 2.15 below.

Table 2.15: Regressions Excluding ΔRER's

	α_1=0	α_0=0 and λ=0
ΔRER_t	-.0388754 (.0184932)	--
ΔRER_{t-1}	.0479389 (.018674)	.0429443 (.0185449)
$\sum\beta_{0k}$ – Sum	0.00085	0.037376
$\sum\beta_{0k}$ – Prob>F	0.9786	0.1631
$\sum\delta_{1k}$ – Prob>F	0.2993	0.2284
$\sum\delta_{2k}$ – Prob>F	0.0011	0.0813

As can be seen from table 2.16, the differences between the coefficients given α_1=0 and the coefficients given α_0=0 and λ=0 are *not* statistically significant.

[22] We try putting more structure on the lags of ΔIP as we explained in note #17. The results are reported in appendix B.2 (table B.2). This exercise however did not alter *any* of our initial results.

Table 2.16: Regressions Excluding ΔRER's: Associated Costs of Realignments

	$\alpha_1=0$		$\alpha_0=0$ and $\lambda=0$	
	Coefficient	s.e	Coefficient	s.e
$\Delta\lvert RER_t-RER_t^{eq}\rvert * d_u$	.0052019	.0118461	.0018218	.007074
$\Delta\lvert RER_{t-1}-RER_{t-1}^{eq}\rvert * d_u$	.0031406	.0024324	.0032843	.002424
$\Delta\lvert RER_{t-2}-RER_{t-2}^{eq}\rvert * d_u$	.0040023	.0013326	.0040874	.0013255
$\Delta\lvert RER_t-RER_t^{eq}\rvert * d_o$	-.0503703	.0154794	-.0202862	.0119235
$\Delta\lvert RER_{t-1}-RER_{t-1}^{eq}\rvert * d_o$	.0001648	.0026202	-.0006541	.0026087
$\Delta\lvert RER_{t-2}-RER_{t-2}^{eq}\rvert * d_o$	.0003382	.0011489	.0003139	.0011502

We can then confidently conclude that the endogeneity problem is *not* driving our main results one way or the other.

2.5.5 Augmented Model

Again, we modify the specification of our original model to assess the sensitivity of our initial results on realignment costs to potential nonlinearities in the disequilibrium effect. For the 10% threshold and assuming that the adjustment time takes 2 quarters, the results of our panel estimation (controlling for country and time fixed effects and using Chebyshev polynomials) are reported in appendix B.1. We summarize our results in tables 2.17 and 2.18 below.

Table 2.17: Quadratic Disequilibrium Terms (Chebyshev)

	t-statistics					
i	γ_i	γ_i^{-1}	γ_i^{-2}	γ_i^{cross}	$\gamma_i^{cross'}$	$\gamma_i^{cross''}$
0	-1.717	0.698	0.936	-0.357	-1.293	-0.017
1	-1.572	-1.331	-1.898	0.516	-1.611	-1.200
2	1.225	2.764	0.130	-2.333	-1.936	-0.917

i=1 is for undervaluation, i=2 is for overvaluation.

Table 2.18: Costs of RER Realignments (Chebyshev)

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	0.00013	-0.00007	-0.10460	0.04206	-0.07723	-0.05463
Prob>F	0.99680	0.52940	0.33890	0.01670	0.60170	0.01850

The summary of the results of our panel estimation when our disequilibrium and quadratic disequilibrium variables are not orthogonalized are reported in tables 2.19 and 2.20 below.

Table 2.19: Quadratic Disequilibrium Terms (Uncorrected Model)

	t-statistics					
I	γ_i	γ_i^{-1}	γ_i^{-2}	γ_i^{cross}	$\gamma_i^{cross'}$	$\gamma_i^{cross''}$
0	-1.689	0.694	0.967	-0.373	-1.031	-0.049
1	-1.933	-1.224	-1.898	0.876	-1.324	-1.360
2	0.526	2.439	0.218	-1.847	-2.080	-0.854

i=1 is for undervaluation, i=2 is for overvaluation.

Table 2.20: Costs of RER Realignments (Uncorrected Model)

	β_{0k}	δ_{0k}	β_{1k}	δ_{1k}	β_{2k}	δ_{2k}
Sum	-0.00029	-0.00003	-0.09828	0.04356	-0.07876	-0.05371
Prob>F	0.9928	0.8062	0.3638	0.0111	0.5999	0.0254

We find that $\sum\delta_{2k}$ is negative and statistically significant at the 5% level (and in few instances at the 10% level) across lags when quadratic terms are included (see tables B.10 and B.13 in appendix B.4). Also, $\sum\delta_{1k}$ is positive (statistically insignificant) across lags when quadratic terms are included; when 2 lags are introduced, however, correcting undervaluations becomes unambiguously costly at the 1% significance level (see tables B.9 and B.12 in appendix B.4).

2.6 Concluding Remarks and Suggestions for Future Research

This chapter assessed the real costs of *undoing* RER undervaluations and RER overvaluations. First, we presented several features of undervaluation episodes. We then focused on the costs of undoing *large* RER misalignments. We found that correcting large undervaluations is *costly* while correcting large overvaluations is *beneficial.* Our focus then shifted to realignment costs of *smaller* RER misalignments. We found that smaller corrections of undervaluations are *less costly* than larger corrections, and that smaller corrections of overvaluations are *less beneficial* than larger corrections (table 2.21).

Table 2.21: Summary

	Overvaluation Correction	Undervaluation Correction
10% Threshold	Beneficial	Costly
25% Threshold	Very Beneficial	Very Costly

In table 2.22 below, we averaged the aggregate effects over the different specifications considered in this chapter to get a feel of "how costly" correcting an undervaluation is and of "how beneficial" correcting an overvaluation is.

Table 2.22: Summary – Average Aggregate Effects

	Overvaluation Correction Average $\Sigma\delta_{2k}$	Undervaluation Correction Average $\Sigma\delta_{1k}$
10% Threshold	-.04	.02
25% Threshold	-.06	.05

For example, correcting a 25% overvaluation augments IP growth by 6.14 percentage points (annualized), whereas correcting a 25% undervaluation costs 5.09 percentage points (annualized) of IP growth.

An interesting follow-up to this research would be to assess the real costs of RER realignments *conditional* on the correction instruments used, thus determining whether or not nominal devaluations are more beneficial than cumulative deflation differentials as overvaluation correction mechanisms, and whether or not nominal revaluations are costlier than cumulative inflation differentials as undervaluation correction mechanisms.

Chapter 3

Effective Real Exchange Rates and Irrelevant Exchange Rate Regimes

3.1 Introduction

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

The fact that RER's exhibit substantially higher variance under floating nominal exchange rate regimes than under fixed exchange rate regimes has been well documented in the literature.[23] However, to the best of our knowledge, all of these studies[24] are based on the analysis of bilateral RER's, whereas, as Black (1986) suggested, a meaningful comparison

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

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

would be based on effective RER's. The effective RER is more relevant than the bilateral RER for questions that relate to the effect of the nominal exchange rate regime on other real macroeconomic variables. We re-examine the evidence using effective RER's across a large sample of countries.

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

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

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

The chapter proceeds as follows. In Section 3.2 we use Mussa's sample of 16 industrialized countries and his definitions of exchange rate regimes to examine the volatility of the RER under fixed and floating regimes. We show how the use of effective RER's in place of bilateral RER's has an important impact on the results.

We provide a brief description of our data in Section 3.3 which also provides a discussion of the problematic task of classifying countries' exchange rate regimes.

We present results for the effective RER across a much broader sample of countries in Section 3.4. In contrast to existing studies that rely heavily on the breakup of the Bretton Woods system to delineate between exchange regimes, our data set contains regime experiences which are less correlated across time, in part because our monthly data starts after 1978 and in part because of the larger number of countries included in the sample.[25]

To make a valid determination of the effect of the nominal exchange rate regime, it is necessary to compare the behavior of the RER across countries which have similar characteristics. In other words, we do not want a comparison across extreme types of economies for which we would naturally expect very different RER behavior irrespective of the nominal exchange rate regime. In Section 3.4 we choose to select a subset of countries based on their inflation experience and on the variability of their growth rates. Both of these criteria are likely to influence the underlying behavior of the RER. Countries with high and variable inflation or variable rates of growth also tend to exhibit a very wide range of RER volatility across all nominal exchange rate regimes. Therefore, we choose to concentrate our efforts on countries with both low inflation and stable growth rates.

Section 3.5 concludes with some remarks concerning the interpretation of our results.

3.2 Re-Examining Existing Evidence

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

Mussa analyses the behavior of bilateral RER's (versus the US dollar) of 15 industrialized countries. His main result is that the variance of the quarterly changes in the bilateral

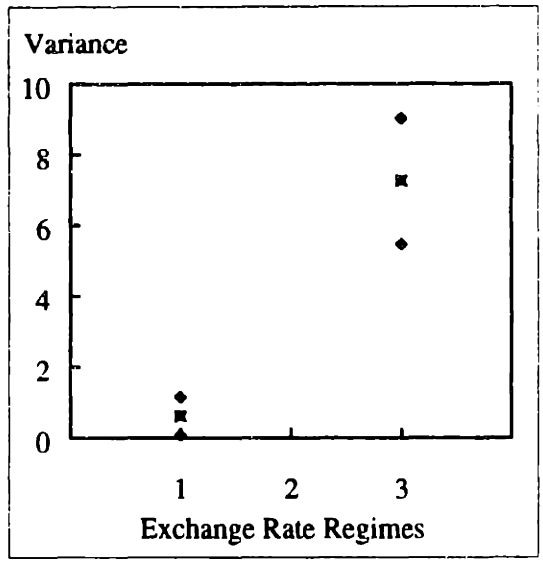
25 The existing findings could be due to very different behavior of the US RER pre- and post-Bretton Woods, but with no substantial change in the behavior of other countries' RER's. O'Connell (1986) makes this point when talking about the time series properties of bilateral RER's versus effective RER's.

RER's was on average almost 14 times higher under floating exchange rate regimes than under fixed exchange rate regimes. We replicate Mussa's methodology using monthly bilateral RER's (see Appendix C.2 for details of the data and regimes).[26] Figure 3.1 below shows the results for the bilateral RER's over the period January 1960 to December 1990; we label the fixed exchange rate regime as regime 1 and the floating exchange rate regime as regime 3.[27]

Figure 3.1: Average Variance of Monthly Bilateral RER Changes

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

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



Confidence intervals for the average variance across countries within each regime are constructed as follows. We assume independence across countries and use estimates of the standard error of each country's variance to obtain a standard error for the average variance across countries. Figure 3.1 clearly shows that the variance of bilateral RER

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

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

changes is significantly lower under regime 1 than regime 3; the ratio of the average variance is 1 to 12 respectively.[28]

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

We now replicate the above methodology using effective RER's. The results are shown in Figure C.1 in Appendix C, which uses the same set of countries and the same nominal exchange rate regime classifications as in Figure 3.1 (a description of the data is provided in Section 3.3 and in Appendix C.2). The effective RER changes show greater variance under regime 3 than regime 1, but this difference is not significant at the 5 per cent level. The ratio of the average standard deviation is now 1 to 1.9 which is a lot lower than for the case of bilateral RER's.

The issue of the classification of the nominal exchange rate regimes is more difficult in the case of effective RER's than in the case of bilateral RER's. To illustrate, consider the case of Austria. The Austrian shilling was fixed against the US dollar under Bretton Woods and then flexible against the US dollar post-Bretton Woods. This would be a natural way of classifying the nominal exchange rate regime for the purposes of examining the behavior of the Austrian bilateral RER (relative to the US). However, for the purposes of analyzing the effective RER, it is natural to classify the nominal exchange rate regime as fixed both during and after Bretton Woods – that is, fixed first against the US dollar and

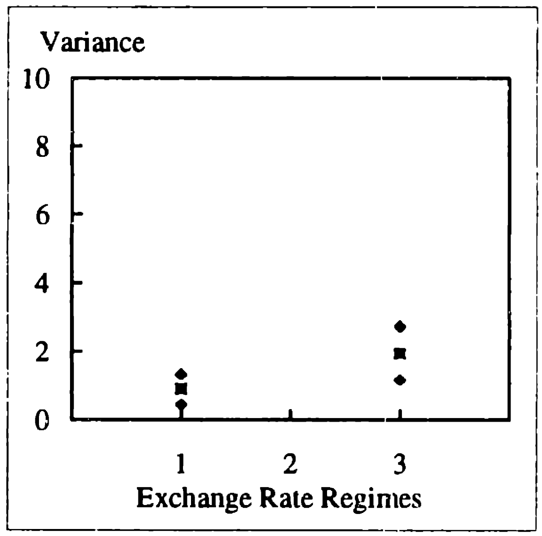
28 The ratio of the average variance is lower than Mussa's result due to slightly different sample periods, the use of monthly instead of quarterly data, the inclusion of Ireland's experience under regime 3 and the exclusion of Canada's experience with regime 3 prior to 1962.

later fixed against the German Deutsche mark.[29] Mussa attempted to account for this by considering more than one bilateral RER for a given country. When we look at effective RER's, we reclassified countries' exchange rate regimes according to whether or not the country was fixing its exchange rate against any major currency and not just against the US dollar. Also, we added the US to the sample of countries. The results of these refinements are shown in Figure 3.2 below. As before, the average variance of the monthly RER changes is higher under regime 3 than regime 1, but this difference is not significant at the 5 per cent level.

Figure 3.2: Average Variance of Monthly Effective RER Changes

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

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



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

The results of this section have shown that existing evidence that the variance of the changes in the RER is dramatically higher under a flexible exchange rate regime is no longer convincing when we consider effective RER's. The ratio of the variance of the

29 The question of transitions between regimes is avoided here, as in Mussa, by excluding observations around the time of the breakdown of Bretton Woods. This issue is discussed in more detail in Section 3.4.

RER under fixed versus flexible regimes is about 1 to 12 for bilateral RER's, but the ratio is only about 1 to 2 for effective RER's.

As we mentioned above, a major problem with this sample of 16 industrialized countries is that most of the changes in the exchange rate regimes all occur at the same time (around the collapse of the Bretton Woods system). This is troubling because it is not clear that a finding of different behavior of the RER is due to a change in nominal exchange rate regimes or other contemporaneous changes in the world economy.[30]

We address many of these concerns by examining the behavior of the effective RER across a much larger set of countries. This has the added advantage that the changes in nominal exchange rate regimes are not strongly correlated over time. Before presenting the results of our analysis, we discuss the data in some detail in Section 3.3 below.

3.3 Data

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

3.3.1 Nominal Exchange Rate Regimes

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

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

The raw data on regimes classifies countries in each month according to one of over 25 possible descriptions of the exchange rate arrangements.[31] We simplify this classification scheme by aggregating categories into three broad groupings. Regime 1 is a fixed exchange rate including pegs to single currencies and pegs to the SDR or other baskets. Regime 2 allows for some flexibility in the nominal rate and includes countries in the EMS, pegs which are adjusted frequently (according to a set of indicators) and managed floating rates. Regime 3 consists of freely floating exchange rates (exact details are provided in section C.2.2 of appendix C.2). In practice, the classification scheme expresses relative degrees of flexibility rather than precisely delineating between alternative regimes.

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

The main concern about our classification scheme for regimes is the accuracy of the initial classification by the IMF. Member countries of the IMF are required to submit information regarding their exchange rate arrangements, although this information is not always very accurate. The IMF investigates any countries that appear to be providing misleading information and shifts these countries to the appropriate categories. This issue is discussed in more detail in Section 3.4.

Ideally, the classification of the nominal exchange rate regime would be based on a country having in place a broad set of policies which are consistent with a given regime. However, on occasion, a country will classify itself into a given regime but run policies which are inconsistent with this regime. For example, a country with very high inflation that attempts to be in regime 1, but does nothing to control inflation, is unlikely to be able to hold a fixed peg for any length of time. Therefore, such a country will display a highly variable RER simply because the peg has to be continuously adjusted. Such a country is

31 These are also an integral part of monetary and other policies which have a direct bearing on

really not a genuine regime 1 country. We address this problem by examining a subset of countries with low and stable inflation and stable growth rates that are most likely to be accurately classified in terms of their exchange rate regimes.

3.3.2 Effective RER's and Other Data

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

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

3.4 New Evidence

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

For each country we separate monthly percentage changes in the RER according to the regime under which these changes occurred. Then, for each country within each regime, we calculate the variances of these changes. Each variance for each regime constitutes an

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exchange rate management.

'observation' (countries that have experienced only one regime contribute only one observation). We then construct confidence intervals for the variances within each regime across all countries that experienced that regime. Figure C.2 (appendix C.1) shows the results for the full set of countries. Although the mean variance is higher under regime 3 than regime 1 and 2, this difference is not significant.

Regime Switching

Regime switches often involve large changes in both the nominal exchange rate and the RER. These transitions are problematic because it is not clear whether changes in the RER are associated with the new or the old regime (or simply because the regime is in transition). Indeed, a large depreciation may take place at the onset of a flexible regime but may be none other than a correction of a significant overvaluation from the fixed exchange rate regime. We control for this problem by deleting the last three months at the end of an old regime and the first three months at the beginning of a new regime.[32] Figure C.3 (appendix C.1) shows the results corrected for regime switching. The behavior of the RER is still independent of regimes; however, the confidence interval for regime 3 has fallen and narrowed substantially (which is consistent with the example discussed just above). All of the results that follow in this chapter are based on this correction for regime switching.[33]

High versus Low Inflation Countries

We divide the sample of countries between those with low inflation and those with high inflation. (We use a cutoff rate of 10 per cent per annum averaged over the sample from 1978 to 1994.) This will help to account for systematic differences across country types that might be relevant to the behavior of the RER but not necessarily related to the

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

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

nominal exchange rate regime.[34] The results shown in Figures C.4 and C.5 (appendix C.1) confirm our suspicion that high inflation countries have much higher variability in their RER's. We concentrate the rest of our analysis on the set of low inflation countries.

For this set of low inflation countries, regimes 2 and 3 display lower average RER variance than regime 1. This apparently perverse result occurs because many countries that have only experienced regime 1 have low but highly variable inflation (and highly variable growth rates), which naturally increases the variance of the RER for these countries.[35]

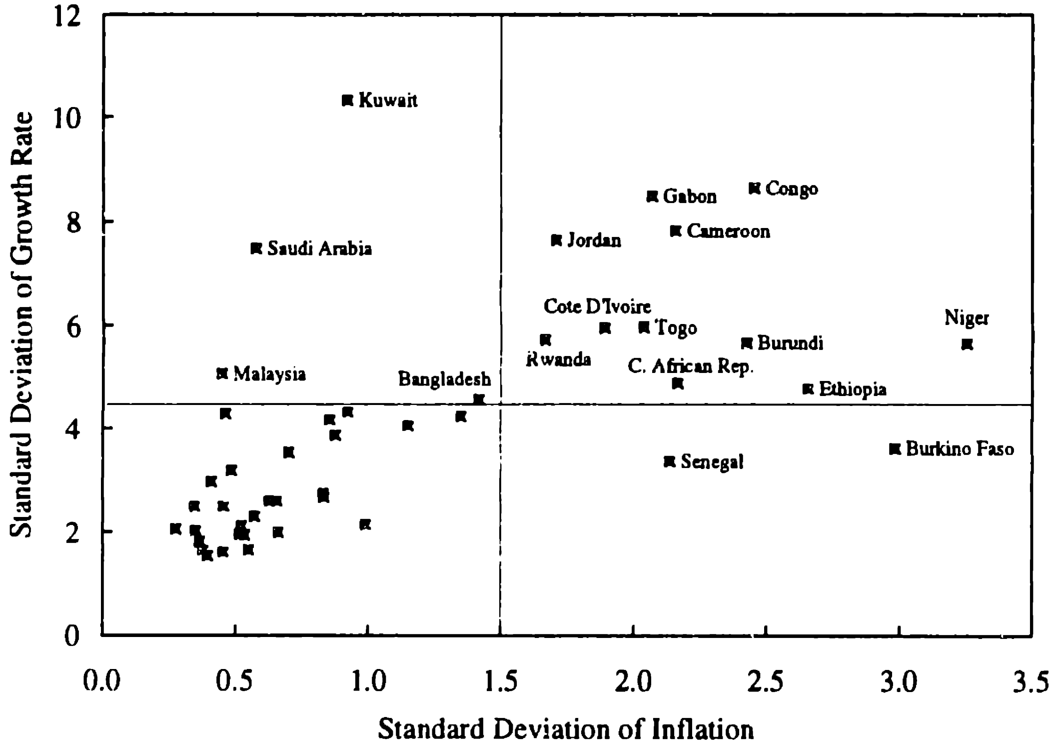
Low Inflation and Stable Growth Rate Countries

Figure 3.3 (below) shows a scatter plot of the standard deviation of both the inflation and the growth rates for the set of low inflation countries. We chose to exclude from our sample of low inflation countries all of those countries shown in the upper and right quadrants of Figure 3.3 (that is, countries with a standard deviation of growth greater than 4.5 per cent as well as Burkino Faso and Senegal).

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

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

Figure 3.3: Variability of Inflation and Growth for Low Inflation Countries



The results of the effective RER variance for 27 low and stable inflation and stable growth countries are shown in Figure 3.4 below. There is no significant difference across regimes in the average standard deviation of the percentage change in the RER.[36] The ratio of the average variance in regime 1 compared to regime 3 is 1 to 1.6.

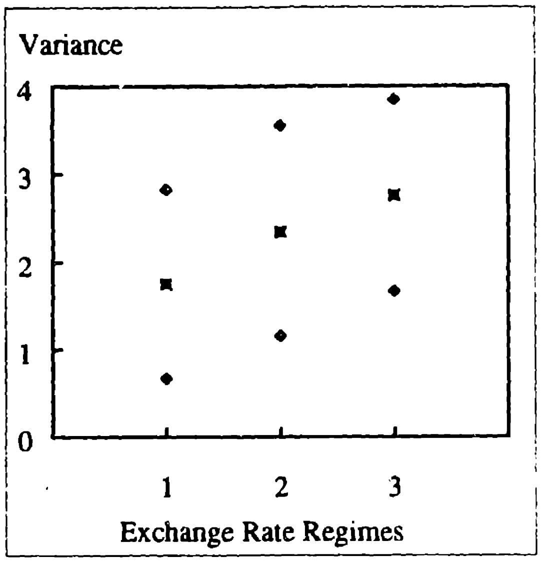
36 We excluded 3 observations that were based on a country being within a given regime for less than one year. Including these observations does not change the results in any important way.

Figure 3.4: Average Variance of Monthly Effective RER Changes

- 27 Low Inflation and Stable Growth Countries

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

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



The results shown in Figure 3.4 are supported by individual F-tests on the 16 countries in this sample that experienced more than one regime over the period. The results are shown in Table 3.1 below. Less than one-third of the countries had significantly more variable effective RER's under more flexible exchange rate regimes. Two countries actually displayed a significantly lower variance under more flexible regimes.

Table 3.1: F-Tests for Differences in Variances of Effective RER's across Regimes

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

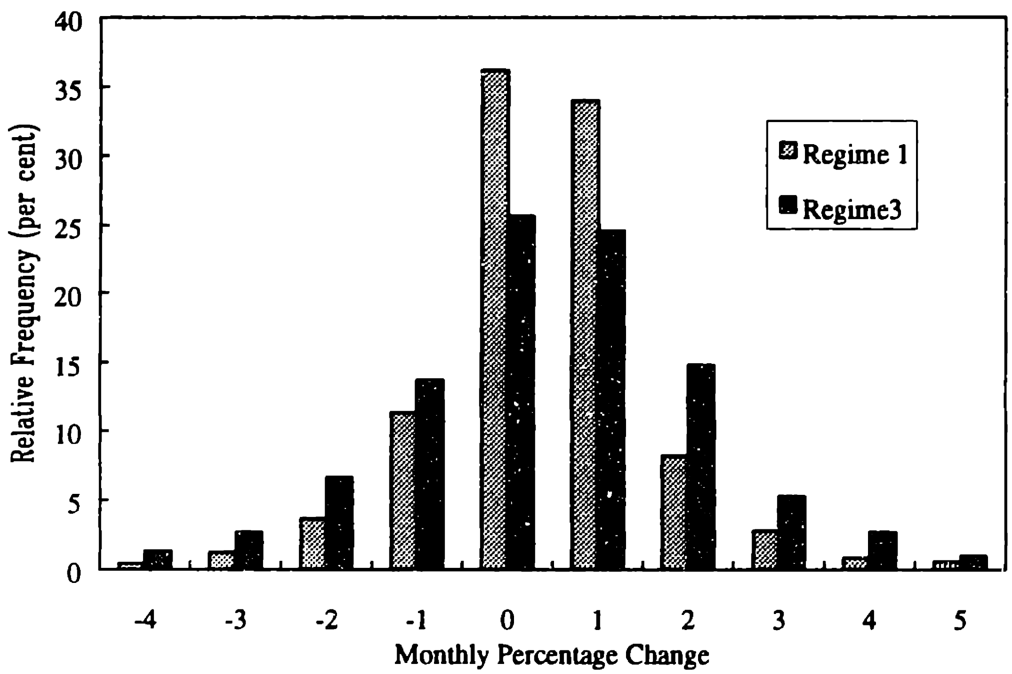
† A positive sign indicates that the variance is significantly higher for the more flexible exchange rate regime. A negative sign indicates the exact opposite result. A zero indicates no significant difference in the variance across regimes.

• Significant at the 5 per cent level.

3.5 Concluding Remarks

The results of Section 3.4 show that there is no significant difference between exchange rate regimes in terms of the variance of changes in the effective RER. One possible explanation is that the variance of the effective RER is high under regime 1 only because of large but infrequent changes in nominal parities. If this were true, then we would expect to see very fat tails in the distribution of the monthly percentage changes in the effective RER for regime 1 but not for regime 3. Figure 3.5 (below) shows that this is not the case: the distribution of monthly changes in the effective RER's is similar across regimes, with no fat tails.

Figure 3.5: Histogram of Monthly Percentage Changes in Effective RER



The results of F-tests on Mussa's sample of countries and his definitions of exchange rate regimes showed that the variance of the effective RER was significantly higher under the more flexible exchange rate regime for 11 of the 14 countries considered. In contrast, our sample of countries and definitions of regimes showed strong evidence that there was no systematic increase in variance of the effective RER for more flexible exchange rate regimes. One possible explanation is that the variance of the effective RER under fixed exchange rate arrangements depends on the extent to which major trading partners are also in a fixed exchange rate regime. In other words, regime 1 during Bretton Woods is quite likely to result in lower variance of the effective RER than regime 1 post-Bretton Woods. However, as our data set stands, there are almost no countries which are in regime 1 both during and after Bretton Woods and are fixed to a single currency. The few that we clearly can identify as remaining fixed post-Bretton Woods also simultaneously went from fixed to the US dollar to fixed to a basket of currencies – and experienced a fall in their effective RER volatility post-Bretton Woods.[37]

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

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

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

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

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

Appendix A

Further Results for Chapter 1

A.1 Descriptive Statistics

Table A.1: Maximum Undervaluations and Maximum Overvaluations

	Maximum Overvaluation (%)	on	Maximum Undervaluation (%)	on
Algeria	-21.83	Dec-93	31.42	Feb-91
Argentina	-40.37	Dec-74	117.33	Oct-75
Australia	-10.30	Nov-84	28.26	Aug-86
Austria	-6.41	Jun-62	5.85	Feb-74
Bahrain	-9.67	Jul-78	7.25	Nov-80
Bangladesh	-37.52	Oct-74	29.53	Dec-75
Belgium	-8.41	Jan-60	7.99	Aug-71
Bolivia	-88.29	Aug-85	78.32	May-73
Brazil	-31.92	Mar-90	29.03	Aug-87
Burkina Faso	-15.17	Jun-77	27.82	Aug-76
Burundi	-28.31	Mar-85	30.55	Sep-78
Cameroon	-8.10	Feb-68	8.64	Sep-69
Canada	-5.52	Jul-88	5.38	Oct-78
Central African	-12.64	Feb-86	90.24	Jan-94
Chile	-30.92	Aug-81	85.75	Jun-73
China	-21.63	Nov-89	19.07	Mar-74
Colombia	-17.64	Aug-79	27.91	Dec-62
Costa Rica	-24.04	Apr-74	50.74	Nov-81
Cote d'Ivoire	-20.99	Jul-74	37.93	Mar-85
Denmark	-8.97	Oct-76	10.77	Aug-71

Ecuador	-22.46	Aug-79	20.31	Sep-86
Egypt	-60.21	Apr-89	38.97	Feb-91
El Salvador	-28.60	Apr-90	49.57	May-86
Ethiopia	-40.66	Sep-92	40.80	Feb-75
Finland	-11.92	Dec-81	22.84	Oct-67
France	-8.20	Jul-69	9.67	Oct-71
Gabon	-16.83	Aug-78	22.26	Feb-74
Germany	-13.75	Jul-73	13.11	Jul-69
Ghana	-81.54	Aug-83	112.73	Jan-72
Greece	-19.18	Dec-73	9.68	Jul-73
Guatemala	-43.16	May-86	46.67	Sep-90
Haiti	-29.60	Jul-91	31.05	Jun-93
Honduras	-37.96	Feb-90	40.56	Oct-90
Hong Kong	-14.30	Jun-91	17.81	Oct-83
Hungary	-26.40	Jun-94	26.99	Dec-79
India	-33.62	May-66	19.32	Apr-93
Indonesia	-17.11	Sep-77	22.83	Oct-86
Iran	-89.04	Feb-93	153.30	Apr-93
Ireland	-9.82	Mar-79	7.10	Jul-85
Israel	-13.62	Oct-77	14.85	Aug-73
Italy	-11.12	Sep-74	11.68	Jul-73
Jamaica	-25.01	Oct-83	29.09	May-78
Japan	-17.95	Apr-74	16.31	Oct-82
Jordan	-12.59	Dec-82	13.27	Nov-88
Kenya	-22.73	Feb-93	19.30	May-93
Korea, Republic of	-43.37	Jan-60	25.89	Aug-73
Kuwait	-6.66	Jan-80	5.78	Mar-82
Liberia	-16.49	Feb-85	18.65	Dec-87
Madagascar	-25.88	Dec-93	64.40	Jul-87
Malawi	-17.34	Jan-92	32.20	Jul-94
Malaysia	-31.32	Dec-72	11.38	Nov-88
Mexico	-25.04	Jan-82	52.64	Sep-82
Morocco	-13.82	Dec-94	14.05	Jan-87
Netherlands	-6.02	Oct-73	4.80	May-81
New Zealand	-11.73	Jan-88	12.40	Dec-84
Niger	-24.90	Oct-86	37.84	Feb-85
Nigeria	-52.65	May-86	71.80	Aug-82
Norway	-7.95	Aug-74	8.20	May-72
Pakistan	-22.57	Aug-71	85.10	Jun-72
Papua N. Guinea	-12.49	Dec-73	11.45	Jan-71
Paraguay	-43.66	Sep-86	64.69	Jul-89
Peru	-59.65	Aug-88	39.45	Jul-73
Philippines	-27.59	Dec-61	25.55	Nov-72
Poland	-33.58	Mar-85	85.00	May-82
Portugal	-15.88	Sep-74	17.33	Jul-78

Rwanda	-57.86	Nov-65	51.00	Aug-92
Saudi Arabia	-6.63	Mar-92	7.56	Nov-90
Senegal	-18.72	Jun-73	18.49	Jun-71
Sierra Leone	-42.01	Sep-87	41.55	Apr-89
Singapore	-17.03	Jul-73	14.37	May-87
South Africa	-19.45	Dec-80	46.86	Oct-85
Spain	-12.07	Apr-65	13.45	Aug-93
Sri Lanka	-36.43	Aug-77	50.38	Jul-61
Sudan	-78.08	Jul-91	112.05	Dec-87
Sweden	-9.97	Jul-74	11.97	Nov-82
Switzerland	-16.35	Sep-78	10.83	May-92
Syrian	-51.55	Jul-87	37.93	Jan-88
Thailand	-13.66	Nov-66	18.29	Jul-86
Trinidad & Tobago	-23.42	Nov-85	24.06	Apr-93
Tunisia	-4.57	Sep-89	4.89	Oct-90
Turkey	-21.41	Jan-94	37.09	Aug-70
United Kingdom	-16.86	Jan-81	17.34	Feb-93
United States	-15.98	Feb-85	11.56	Jul-73
Uruguay	-37.60	Sep-65	60.09	May-73
Venezuela	-39.24	Feb-89	41.95	Mar-84
Zaire	-62.77	Aug-83	70.18	Sep-93
Zambia	-60.39	Oct-93	157.59	Apr-87
Zimbabwe	-11.47	Dec-92	37.02	Oct-91

A.2 The Mean-and-Standard-Deviation Approach: Nonparametric Estimation

This section contains additional kernel regressions pertaining to the mean-and-standard-deviation approach discussed in section 1.2.2.2. These fits were omitted from the main body of chapter 1 to avoid redundancy and ensure proper focus. Figure A.1 (Gaussian kernel, N=2432 observations) clearly shows that the higher the standard deviation of the percentage deviations of actual RER from its equilibrium level the lower the growth; and Figure A.2 (Cosine kernel, N=2417 observations) shows that the more (on average) the RER is over-appreciated or the more (on average) it is over-depreciated, the lower the growth. These results *together* imply that *any* deviation from RER equilibrium harms growth.

Figure A.1

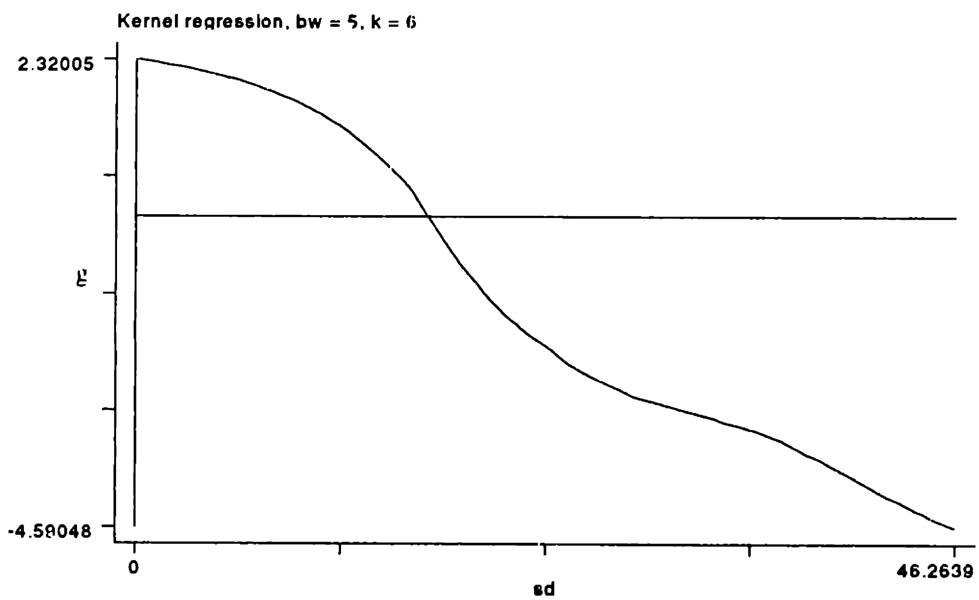
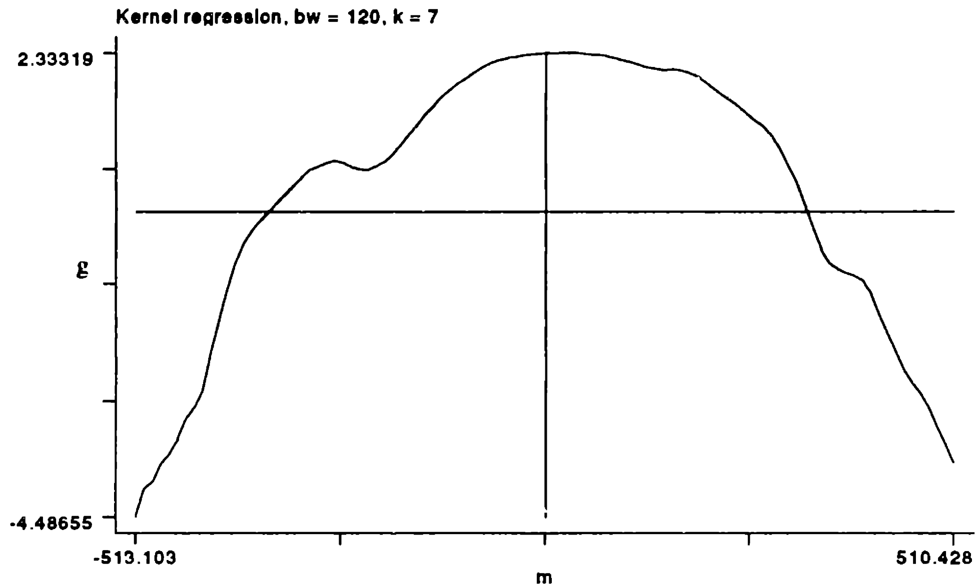


Figure A.2



A valid concern is that the effects of RER misalignment on growth could exhibit dynamics which may be obscured by temporal effects emanating, for example, from the business cycle. We hence consider 5-years based values of our standard deviation and average misalignment measures and explore their relationships with 5-years average growth. Figure A.3 (Gaussian kernel, N=424 observations) shows the result for the standard deviation measure.

Figure A.3

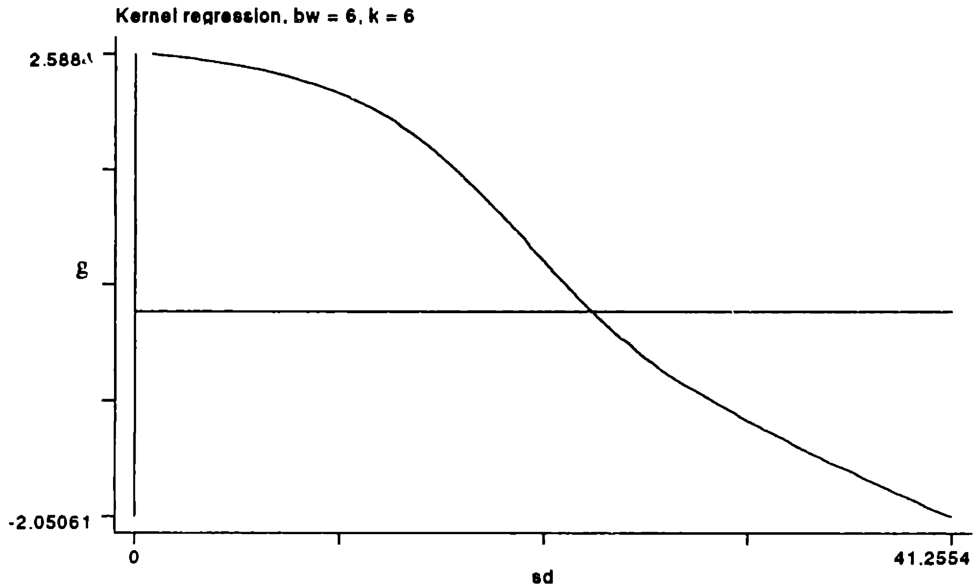
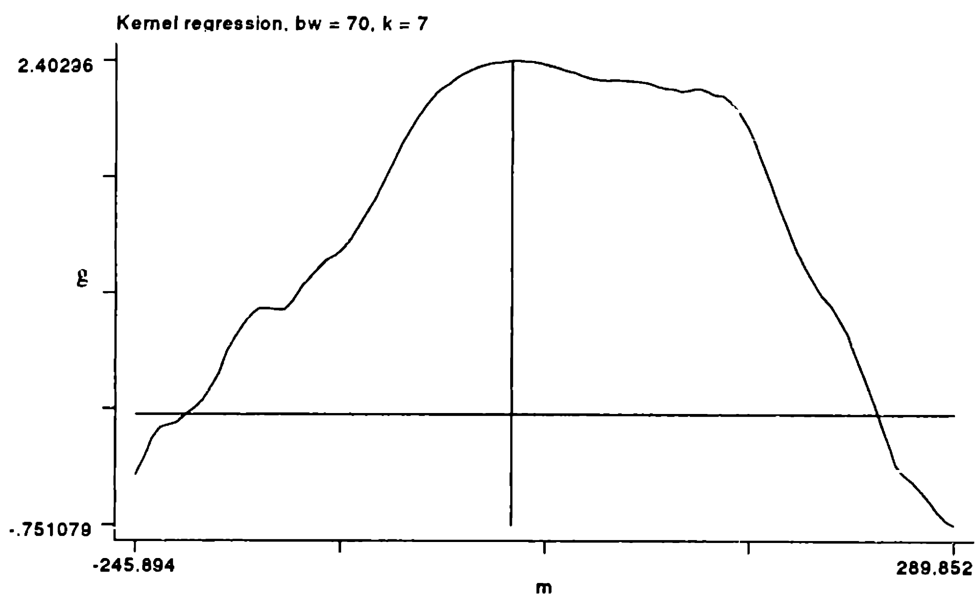


Figure A.4 (Cosine kernel, N=422 observations) shows the result for the average misalignment measure.

Figure A.4



These kernel fits, based on 5-years intervals, did *not* alter the qualitative message of our initial results.

We now address the concern that our variables are jointly determined by considering the effects of lagged values of our standard deviation and average misalignment measures on growth. Figure A.5 (Gaussian kernel, N=2315 observations) shows the result for the standard deviation measure.

Figure A.5

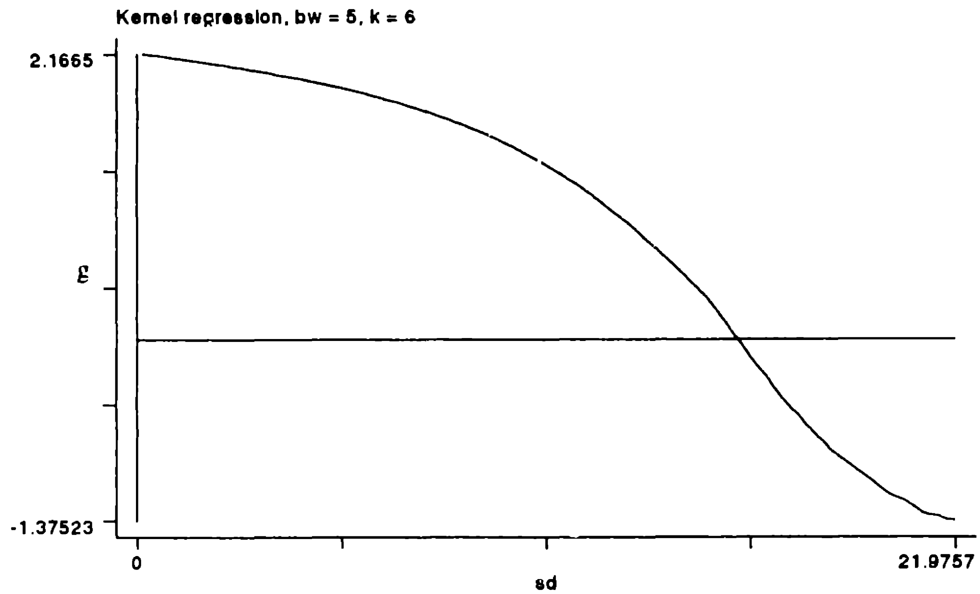
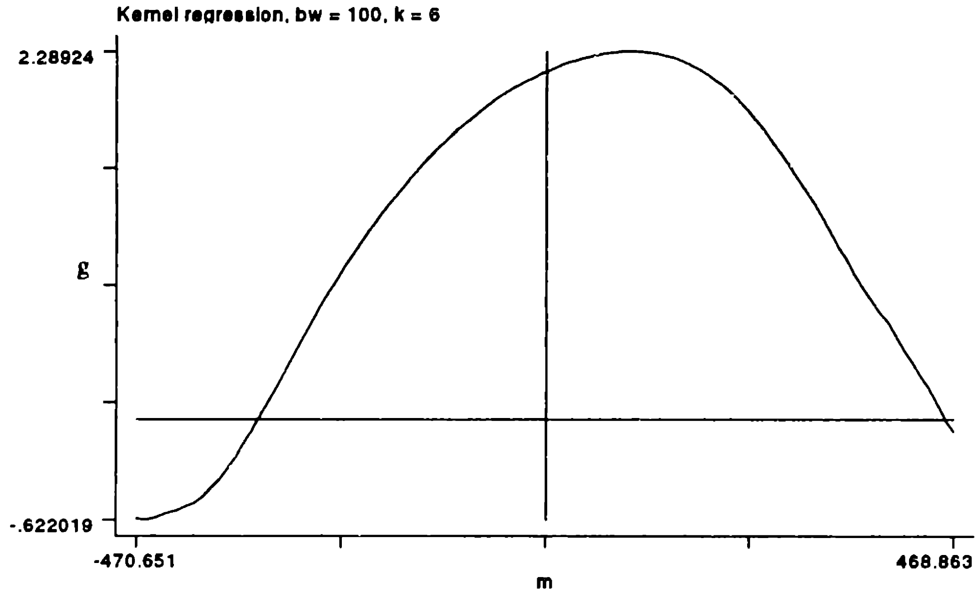


Figure A.6 (Gaussian kernel, N=2332 observations) shows the result for the average misalignment measure.

Figure A.6

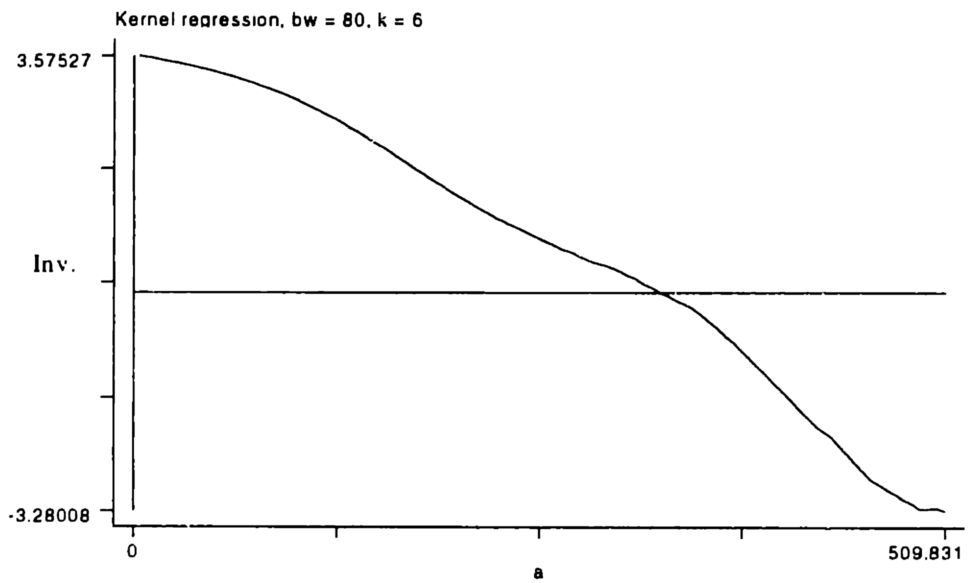


These kernel fits, based on lagged values of our standard deviation and average misalignment measures, did not alter the qualitative messages of our initial results as well.

A.3 The Investment Channel

Our understanding of the findings reported in sections 1.3.1-1.3.3 is significantly enhanced by considering the effect of RER misalignment on per capita investment growth. The first pass is to take yearly values of our absolute value measure *a* and consider its relationship with annual growth rate in per capita investment. Figure A.7 (Gaussian kernel, N=2246 observations) shows a kernel fit exploring the bivariate relationship between the annual absolute value measure and annual growth rate in per capita investment.

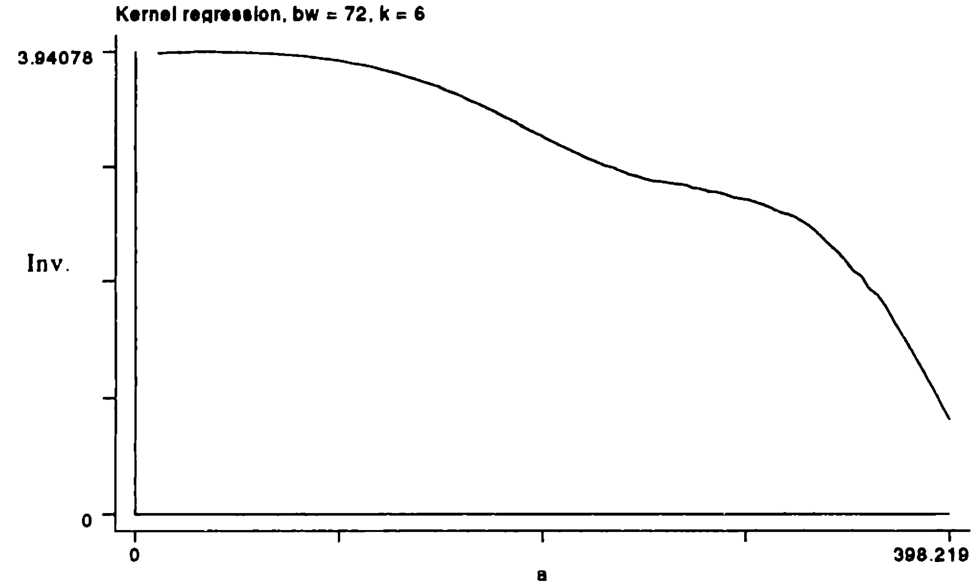
Figure A.7



Clearly, the larger the magnitude of RER disequilibrium the lower the growth rate in per capita investment.

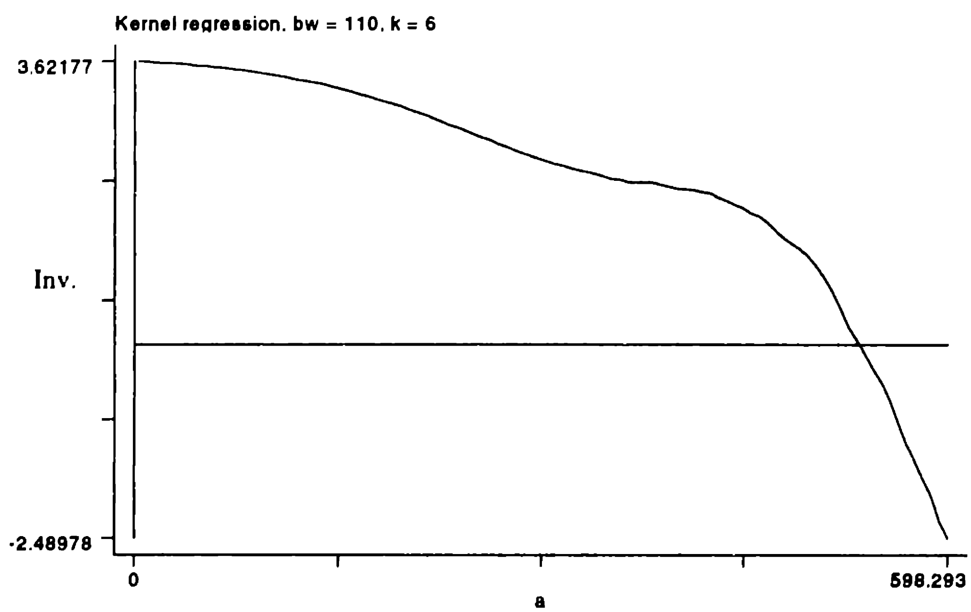
To control for business cycle (and other temporal) effects, we consider 5-years based values of our absolute value measure and explore its relationship with 5-years average growth rate in per capita investment. As figure A.8 (Gaussian kernel, N= 357 observations) shows,

Figure A.8



the qualitative message of our initial results remains unchanged. Next, we address the problem of joint-determinancy by considering the effects of lagged values of our absolute value measure on the growth rate in per capita investment. The kernel fit reported in figure A.9 (Gaussian kernel, N= 2248 observations) confirms our initial results as well.

Figure A.9



To summarize, nonparametric estimation gave clear indications that the larger the magnitude of the departure from RER equilibrium the lower the growth rate in per capita investment and the lower the rate of economic growth.

A.4 Variable Definitions for the Barro Regressions

	Definitions
GR	Average annual growth in real GDP per capita
INC	Log of Real GDP per capita, in 1985 international prices
INEQ	Inequality (measured by the Gini coefficient)
MALED	Average years of secondary schooling in the male population aged over 25
FEMED	Average years of secondary schooling in the female population aged over 25
PPPI	Price level of investment, measured as the (PPP of investment)/(exchange rate relative to U.S.)
BMP	The log of (1 + Black Market Premium), where Black Market Premium is measured as (Black Market Exchange Rate / Official Exchange Rate) – 1
EXP/GDP	Ratio of exports to GDP (in current international prices)
GCONS/GDP	Ratio of real government "consumption" expenditure net of spending on defense and education to real GDP
INV/GDP	Ratio of real domestic investment (private + public) to real GDP
LIFE EXP	Life expectancy at birth
POP>65	Proportion of the population aged over 65
PRIM	Total gross enrollment ratio for primary education
PSTAB	Political instability, calculated as (0.5*ASSASS) + (0.5*REVOLS)
ASSASS	Number of assassinations per million population per year
REVOLS	Total number of revolutions per year
REVCP	Total number of revolutions and coups per year
SEC	Total gross enrollment ratio for secondary education
POP GR	Population growth rate

A.5 Growth Regressions with the Average Misalignment Measure

Table A.2

	Levine & Renelt (1992)			Caselli et. Al. (1996)		Barro
m	-9.20E-06	-8.52E-06	8.88E-06	-0.0000113	-0.0000102	-0.0000155
	-0.31	-0.269	0.286	-0.383	-0.348	-0.59
m^2	-6.26E-07	-6.35E-07	-6.49E-07	-6.06E-07	-5.88E-07	-4.18E-07
	-2.417	-2.372	-2.244	-2.348	-2.303	-1.897
INEQ	0.0023529	0.0024119	0.0019202	0.002152	0.0024316	0.0021418
	3.017	2.916	2.375	2.87	3.249	3.846
INC	-0.0604416	-0.0595943	-0.0676799	-0.0578625	-0.0558412	-0.0350213
	-4.257	-3.994	-3.602	-4.155	-4.034	-3.243
MALED					0.0189713	0.0264798
					1.503	2.403
FEMED					-0.0092732	-0.0196306
					-0.696	-1.737
PPPI						-0.0144767
						-1.057
BMP			-0.0264537			
			-1.674			
EXP/GDP			0.127528			
			2.388			
GCONS/GDP		0.0316963	0.0231656			
		0.221	0.164			
INV/GDP	0.1242085	0.1664896	0.1916021	0.1331197	0.1300637	
	2.096	2.563	2.346	2.277	2.202	
PRIM		-0.0532441	-0.038544			
		-1.324	-0.917			
REVCP		0.0152847	0.0132276			
		1.527	1.305			
SEC	0.0268886	0.0072682	-0.0008125			
	0.947	0.236	-0.028			
POP GR	1.065132	1.049015	1.032047	0.9542138	0.7415446	
	1.356	1.285	1.323	1.229	0.95	
# OBS.	145	140	133	145	141	180

Notes: T-statistics are below the coefficients. The dependent variable is GR. See appendix A.4 for exact variable definitions.

Table A.3

	Alesina & Perotti (1994)			Deininger & Squire (1996)	Perotti (1996)	
m	-0.0000189	-0.0000231	-0.0000229	-0.0000172	-0.0000131	-0.0000144
	-0.712	-0.75	-0.747	-0.665	-0.501	-0.456
m^2	-4.43E-07	-4.68E-07	-4.71E-07	-4.72E-07	-4.12E-07	-5.23E-07
	-2.018	-1.787	-1.806	-2.202	-1.875	-1.756
INEQ	0.0018214	0.0020508	0.0020019	0.0018128	0.0021094	0.002321
	3.27	2.652	2.596	3.326	3.796	2.949
INC	-0.0380772	-0.0545192	-0.0555249	-0.0425774	-0.0381306	-0.0515131
	-3.524	-3.886	-3.965	-3.964	-3.459	-3.441
MALED					0.0290806	0.0238473
					2.605	1.791
FEMED					-0.0247417	-0.0138166
					-2.075	-0.938
PPPI					-0.0197384	-0.0057057
					-1.387	-0.333
INV/GDP				0.1341091		
				2.686		
LIFE EXP						0.0012079
						0.544
POP>65					0.3608834	
					1.31	
PRIM	-0.0186735	-0.0318221	-0.0351153			
	-0.595	-0.845	-0.933			
PSTAB		0.0283478				
		1.362				
PSTAB*INEQ			0.0008137			
			1.637			
# OBS.	184	145	145	186	180	141

Notes: T-statistics are below the coefficients. The dependent variable is GR. See appendix A.4 for exact variable definitions.

A.6 Growth Regressions with the Standard Deviation Measure

Table A.4

	Levine & Renelt (1992)			Caselli et. Al. (1996)		Barro
sd	-0.0015116	-0.001778	-0.0012258	-0.0015286	-0.0015925	-0.0019[illegible]1
	-3.396	-3.845	-2.317	-3.453	-3.678	-4.844
INEQ	0.0013937	0.0013087	0.0010615	0.0012739	0.0015686	0.001714
	1.926	1.773	1.421	1.831	2.284	3.346
INC	-0.0565452	-0.0550297	-0.0664011	-0.0550325	-0.0531924	-0.0426383
	-4.173	-3.955	-3.635	-4.141	-4.08	-4.229
MALED					0.0166671	0.0216577
					1.384	2.11
FEMED					-0.0063673	-0.0137687
					-0.502	-1.308
PPPI						0.0008032
						0.061
BMP			-0.0156555			
			-0.94			
EXP/GDP			0.0934232			
			1.776			
GCONS/GDP		0.0342389	0.0411337			
		0.264	0.299			
INV/GDP	0.0994824	0.1483388	0.2051708	0.1050943	0.1019339	
	1.713	2.408	2.565	1.837	1.786	
PRIM		-0.074487	-0.0667751			
		-1.951	-1.588			
REVCP		0.0216814	0.0205103			
		2.246	2.067			
SEC	0.017386	-0.0124585	-0.0124588			
	0.631	-0.426	-0.437			
POP GR	0.9266814	0.9385448	0.8733062	0.8669514	0.5850766	
	1.238	1.239	1.147	1.172	0.799	
# OBS.	145	140	133	145	141	180

Notes: T-statistics are below the coefficients. The dependent variable is GR. See appendix A.4 for exact variable definitions.

Table A.5

	Alesina & Perotti (1994)	Alesina & Perotti (1994)	Alesina & Perotti (1994)	Deininger & Squire (1996)	Perotti (1996)	Perotti (1996)
sd	-0.0018374	-0.0017252	-0.0017143	-0.0017364	-0.0018688	-0.0016722
	-4.914	-3.829	-3.842	-4.636	-4.704	-3.604
INEQ	0.001358	0.0012148	0.0011579	0.0013871	0.0016964	0.0016197
	2.633	1.726	1.648	2.715	3.31	2.209
INC	-0.0438685	-0.0553568	-0.0563702	-0.0471319	-0.0446579	-0.0496263
	-4.368	-4.246	-4.331	-4.669	-4.346	-3.704
MALED					0.0236415	0.0218483
					2.263	1.742
FEMED					-0.0176105	-0.0126575
					-1.575	-0.92
PPPI					-0.0033762	0.0007904
					-0.244	0.05
INV/GDP				0.1067434		
				2.251		
LIFE EXP						0.0001194
						0.063
POP>65					0.2611418	
					1.015	
PRIM	-0.0212349	-0.0451077	-0.0479621			
	-0.738	-1.284	-1.366			
PSTAB		0.0387832				
		1.949				
PSTAB*INEQ			0.0010228			
			2.158			
# OBS.	184	145	145	186	180	141

Notes: T-statistics are below the coefficients. The dependent variable is GR. See appendix A.4 for exact variable definitions.

Appendix B

Further Results for Chapter 2

B.1 Preferred Panel Regressions (2 lags)

Table B.1

	10% Threshold		25% Threshold	
	Original	Augmented	Original	Augmented
ΔRER_t	-.0388754 (-2.102)	-.0398028 (-2.153)	-.033747 (-1.877)	-.0351583 (-1.957)
ΔRER_{t-1}	.0479389 (2.567)	.0479348 (2.569)	.0512449 (2.830)	.050963 (2.817)
ΔRER_{t-2}	-.0082094 (-0.383)	-.0080033 (-0.373)	.0159633 (0.788)	.0157323 (0.777)
$\Delta \lvert RER_t\text{-}RER_t^{eq} \rvert$	.0000145 (0.610)	.0000806 (1.149)	.0000153 (0.646)	.0000831 (1.185)
$\Delta \lvert RER_{t-1}\text{-}RER_{t-1}^{eq} \rvert$	-.0000186 (-0.784)	-.0000581 (-0.674)	-.0000183 (-0.771)	-.0000599 (-0.695)
$\Delta \lvert RER_{t-2}\text{-}RER_{t-2}^{eq} \rvert$	-.000026 (-1.095)	-.0000948 (-1.282)	-.0000235 (-0.990)	-.0000783 (-1.061)
$\{\Delta \lvert RER_t\text{-}RER_t^{eq} \rvert\}^2$	--	-6.21e-21 (-1.717)	--	-6.34e-21 (-1.754)
$\{\Delta \lvert RER_{t-1}\text{-}RER_{t-1}^{eq} \rvert\}^2$	--	1.39e-10 (0.698)	--	1.41e-10 (0.707)
$\{\Delta \lvert RER_{t-2}\text{-}RER_{t-2}^{eq} \rvert\}^2$	--	1.89e-10 (0.936)	--	1.48e-10 (0.739)
Cross	--	-1.68e-07 (-0.357)	--	-1.69e-07 (-0.360)
Cross'	--	-2.29e-07 (-1.293)	--	-2.29e-07 (-1.295)
Cross''	--	-7.89e-09 (-0.017)	--	-2.56e-08 (-0.054)
$\Delta RER_t{*}d_u$	.0080254 (0.088)	-.008779 (-0.086)	-.15865 (-1.412)	-.4406932 (-2.861)
$\Delta RER_{t-1}{*}d_u$	-.1159032 (-2.102)	-.1439305 (-2.015)	-.1464442 (-2.028)	-.189517 (-1.685)
$\Delta RER_{t-2}{*}d_u$	.073187	.048113	.0353406	.0341769

	(2.010)	(1.258)	(0.912)	(0.839)
$\Delta\|RER_t-RER_t^{eq}\|*d_u$	.0052019 (0.439)	.0176233 (1.072)	.0377351 (1.950)	.1400239 (3.689)
$\Delta\|RER_{t-1}-RER_{t-1}^{eq}\|*d_u$	.0031406 (1.291)	.0119575 (1.723)	.0131471 (1.763)	.0143943 (0.487)
$\Delta\|RER_{t-2}-RER_{t-2}^{eq}\|*d_u$	.0040023 (3.003)	.0124761 (2.755)	-.000528 (-0.210)	-.0001419 (-0.015)
$\{\Delta\|RER_t-RER_t^{eq}\|\}^2*d_u$	--	-3.22e-10 (-1.572)	--	-6.25e-10 (-0.654)
$\{\Delta\|RER_{t-1}-RER_{t-1}^{eq}\|\}^2*d_u$	--	-1.97e-06 (-1.331)	--	4.40e-06 (0.257)
$\{\Delta\|RER_{t-2}-RER_{t-2}^{eq}\|\}^2*d_u$	--	-1.65e-06 (-1.898)	--	7.98e-07 (0.185)
Cross*d_u	--	.0000312 (0.516)	--	-.0002354 (-1.178)
Cross'*d_u	--	-.0000327 (-1.611)	--	-.00006 (-1.191)
Cross''*d_u	--	-.0000173 (-1.200)	--	-.0000148 (-0.308)
ΔRER_t*d_o	-.2152653 (-2.526)	-.2103562 (-2.235)	-.1007513 (-1.037)	-.1940106 (-1.566)
$\Delta RER_{t-1}*d_o$	.1858504 (2.016)	-.0280177 (-0.193)	-.4330939 (-2.612)	-.4217064 (-1.934)
$\Delta RER_{t-2}*d_o$	.10016 (1.105)	.1611437 (1.441)	.3086735 (2.090)	.3419943 (1.820)
$\Delta\|RER_t-RER_t^{eq}\|*d_o$	-.0503703 (-3.254)	-.0324542 (-1.715)	.0061095 (0.210)	-.0035984 (-0.087)
$\Delta\|RER_{t-1}-RER_{t-1}^{eq}\|*d_o$	.0001648 (0.063)	-.0305205 (-1.603)	-.1256792 (-4.041)	-.1425444 (-2.271)
$\Delta\|RER_{t-2}-RER_{t-2}^{eq}\|*d_o$	.0003382 (0.294)	.0083423 (0.812)	.059197 (2.720)	.0549824 (0.986)
$\{\Delta\|RER_t-RER_t^{eq}\|\}^2*d_o$	--	3.36e-09 (1.225)	--	7.15e-09 (1.702)
$\{\Delta\|RER_{t-1}-RER_{t-1}^{eq}\|\}^2*d_o$	--	.0000134 (2.764)	--	.0003588 (1.903)
$\{\Delta\|RER_{t-2}-RER_{t-2}^{eq}\|\}^2*d_o$	--	6.42e-08 (0.130)	--	.0001163 (0.898)
Cross*d_o	--	-.0006977 (-2.333)	--	-.0017558 (-2.881)
Cross'*d_o	--	-.0002486 (-1.936)	--	-.0007378 (-1.179)
Cross''*d_o	--	-.0001075 (-0.917)	--	-.0009027 (-1.826)
Number of Observations	5047	5047	5047	5047
Prob>F	0.0000	0.0000	0.0000	0.0000
R-squared	0.1070	0.1131	0.1070	0.1138
Adj R-squared	0.0691	0.0721	0.0692	0.0728

Notes: ΔIP is the dependent variable. T-statistics are in parentheses. Time and country fixed effects are filtered out.

B.2 Understanding the Effects of RER Movements on IP in the Short-Run

Table B.2: Regressions Including Lags of ΔIP – 10% Threshold

	l=0	l=1	l=2	l=3	l=4
ΔRER_t	-.0388754 (.0184932)	-.0415507 (.0181286)	-.0531817 (.0162055)	-.0422725 (.0146987)	-.0276366 (.013396)
$\sum\beta_{0k}$ – Sum	0.00085	-0.006353	-0.030714	-0.04479	-0.02274
$\sum\beta_{0k}$ – Prob>F	0.9786	0.8390	0.2724	0.0786	0.3236
$\sum\delta_{1k}$ – Prob>F	0.2993	0.3277	0.7821	0.9301	0.7469
$\sum\delta_{2k}$ – Prob>F	0.0011	0.0004	0.0023	0.0028	0.0070

Table B.3: Regressions Including Lags of ΔIP – 25% Threshold

	l=0	l=1	l=2	l=3	l=4
ΔRER_t	-.033747 (.0179824)	-.0370786 (0.176569)	-.0468841 (.0157775)	-.0376576 (.0142837)	-.0265519 (.0130062)
$\sum\beta_{0k}$ – Sum	0.033131	0.024381	-0.005	-0.02511	-0.01044
$\sum\beta_{0k}$ – Prob>F	0.2744	0.4166	0.8525	0.3033	0.6357
$\sum\delta_{1k}$ – Prob>F	0.0055	0.0048	0.0313	0.0129	0.0099
$\sum\delta_{2k}$ – Prob>F	0.0466	0.0141	0.0091	0.0003	0.0040

B.3 Costs of RER Realignments – Original Model

Table B.4: 10% Threshold -- Prob>F

Lags	$\Sigma\beta$	$\Sigma\delta$	$\Sigma\beta_1$	$\Sigma\delta_1$	$\Sigma\beta_2$	$\Sigma\delta_2$
0	0.069	0.483	0.615	0.501	0.020	0.001
1	0.7808	0.9414	0.2971	0.3942	0.6696	0.0012
2	0.9786	0.4711	0.7330	0.2993	0.5911	0.0011
3	0.7574	0.9198	0.7461	0.6491	0.5676	0.0020
4	0.2977	0.7923	0.1533	0.5293	0.3193	0.0027

Table B.5: 15% Threshold -- Prob>F

Lags	$\Sigma\beta$	$\Sigma\delta$	$\Sigma\beta_1$	$\Sigma\delta_1$	$\Sigma\beta_2$	$\Sigma\delta_2$
0	0.184	0.478	0.268	0.493	0.028	0.039
1	0.5480	0.9606	0.2449	0.4127	0.0180	0.0026
2	0.5334	0.5012	0.4933	0.3563	0.2317	0.0068
3	0.7980	0.9551	0.4818	0.7593	0.4431	0.0135
4	0.1293	0.7464	0.0808	0.6410	0.7204	0.0077

Table B.6: 20% Threshold -- Prob>F

Lags	$\Sigma\beta$	$\Sigma\delta$	$\Sigma\beta_1$	$\Sigma\delta_1$	$\Sigma\beta_2$	$\Sigma\delta_2$
0	0.151	0.482	0.127	0.178	0.037	0.059
1	0.6156	0.9522	0.0914	0.0890	0.0337	0.0051
2	0.4993	0.5020	0.1759	0.0777	0.5301	0.1234
3	0.8403	0.9572	0.1900	0.1874	0.6087	0.0718
4	0.1263	0.7460	0.0305	0.1565	0.8377	0.0673

Table B.7: 25% Threshold -- Prob>F

Lags	$\Sigma\beta$	$\Sigma\delta$	$\Sigma\beta_1$	$\Sigma\delta_1$	$\Sigma\beta_2$	$\Sigma\delta_2$
0	0.114	0.484	0.038	0.010	0.018	0.035
1	0.4678	0.9596	0.0094	0.0063	0.0030	0.0006
2	0.2744	0.5271	0.0200	0.0055	0.1930	0.0466
3	0.7751	0.9864	0.0366	0.0280	0.2928	0.0415
4	0.0856	0.7254	0.0029	0.0284	0.3480	0.1745

B.4 Costs of RER Realignments – Augmented Model (10% Threshold)

Table B.8: Chebyshev

	t-statistics						Prob>F	
Lags	γ	γ^{1}	γ^{2}	γ^{cross}	$\gamma^{cross'}$	$\gamma^{cross''}$	$\Sigma\beta$	$\Sigma\delta$
0	-1.271	--	--	--	--	--	0.066	0.149
1	-1.249	0.688	--	-0.369	--	--	0.7993	0.8672
2	-1.717	0.698	0.936	-0.357	-1.293	-0.017	0.9968	0.5294

Table B.9: Chebyshev (Undervaluation)

	t-statistics						Prob>F	
Lags	γ_1	γ_1^{-1}	γ_1^{-2}	γ_1^{cross}	$\gamma_1^{cross'}$	$\gamma_1^{cross''}$	$\Sigma\beta_1$	$\Sigma\delta_1$
0	-1.202	--	--	--	--	--	0.360	0.194
1	-1.147	-1.914	--	0.530	--	--	0.1401	0.1101
2	-1.572	-1.331	-1.898	0.516	-1.611	-1.200	0.3389	0.0167

Table B.10: Chebyshev (Overvaluation)

	t-statistics						Prob>F	
Lags	γ_2	γ_2^{-1}	γ_2^{-2}	γ_2^{cross}	$\gamma_2^{cross'}$	$\gamma_2^{cross''}$	$\Sigma\beta_2$	$\Sigma\delta_2$
0	-0.900	--	--	--	--	--	0.039	0.016
1	1.433	3.689	--	-2.332	--	--	0.0660	0.0011
2	1.225	2.764	0.130	-2.333	-1.936	-0.917	0.6017	0.0185

Table B.11: Uncorrected Model

	t-statistics						Prob>F	
Lags	γ	γ^{1}	γ^{2}	γ^{cross}	$\gamma^{cross'}$	$\gamma^{cross''}$	$\Sigma\beta$	$\Sigma\delta$
0	-1.456	--	--	--	--	--	0.062	0.108
1	-1.458	0.677	--	-0.385	--	--	0.8058	0.7156
2	-1.689	0.694	0.967	-0.373	-1.031	-0.049	0.9928	0.8062

Table B.12: Uncorrected Model (Undervaluation)

	t-statistics						Prob>F	
Lags	γ_1	γ_1^{-1}	γ_1^{-2}	γ_1^{cross}	$\gamma_1^{cross'}$	$\gamma_1^{cross''}$	$\Sigma\beta_1$	$\Sigma\delta_1$
0	-1.090	--	--	--	--	--	0.418	0.228
1	-1.141	-1.926	--	0.628	--	--	0.1607	0.1156
2	-1.933	-1.224	-1.898	0.876	-1.324	-1.360	0.3638	0.0111

Table B.13: Uncorrected Model (Overvaluation)

	t-statistics						Prob>F	
Lags	γ_2	γ_2^{-1}	γ_2^{-2}	γ_2^{cross}	$\gamma_2^{cross'}$	$\gamma_2^{cross''}$	$\Sigma\beta_2$	$\Sigma\delta_2$
0	-1.471	--	--	--	--	--	0.096	0.068
1	0.622	3.283	--	-1.748	--	--	0.0692	0.0021
2	0.526	2.439	0.218	-1.847	-2.080	-0.854	0.5999	0.0254

B.5 Costs of RER Realignments – Augmented Model (25% Threshold)

Table B.14: Chebyshev

	t-statistics						Prob>F	
Lags	γ	γ^{-1}	γ^{-2}	γ^{cross}	$\gamma^{cross'}$	$\gamma^{cross''}$	$\Sigma\beta$	$\Sigma\delta$
0	-1.277	--	--	--	--	--	0.109	0.146
1	-1.258	0.693	--	-0.386	--	--	0.4951	0.8700
2	-1.754	0.707	0.739	-0.360	-1.295	-0.054	0.3025	0.6319

Table B.15: Chebyshev (Undervaluation)

	t-statistics						Prob>F	
Lags	γ_1	γ_1^{-1}	γ_1^{-2}	γ_1^{cross}	$\gamma_1^{cross'}$	$\gamma_1^{cross''}$	$\Sigma\beta_1$	$\Sigma\delta_1$
0	-2.712	--	--	--	--	--	0.001	0.000
1	-1.385	0.297	--	-0.321	--	--	0.0001	0.0003
2	-0.654	0.257	0.185	-1.178	-1.191	-0.308	0.0001	0.0001

Table B.16: Chebyshev (Overvaluation)

	t-statistics						Prob>F	
Lags	γ_2	γ_2^{-1}	γ_2^{-2}	γ_2^{cross}	$\gamma_2^{cross'}$	$\gamma_2^{cross''}$	$\Sigma\beta_2$	$\Sigma\delta_2$
0	-1.112	--	--	--	--	--	0.082	0.419
1	1.413	1.164	--	-2.937	--	--	0.0018	0.0469
2	1.702	1.903	0.898	-2.881	-1.179	-1.826	0.1217	0.0616

Table B.17: Uncorrected Model

	t-statistics						Prob>F	
Lags	γ	γ^{-1}	γ^{-2}	γ^{cross}	$\gamma^{cross'}$	$\gamma^{cross''}$	$\Sigma\beta$	$\Sigma\delta$
0	-1.450	--	--	--	--	--	0.102	0.109
1	-1.449	0.685	--	-0.398	--	--	0.4997	0.7206
2	-1.702	0.698	0.766	-0.376	-1.015	-0.086	0.3018	0.9131

Table B.18: Uncorrected Model (Undervaluation)

	t-statistics						Prob>F	
Lags	γ_1	γ_1^{-1}	γ_1^{-2}	γ_1^{cross}	$\gamma_1^{cross'}$	$\gamma_1^{cross''}$	$\Sigma\beta_1$	$\Sigma\delta_1$
0	-2.852	--	--	--	--	--	0.001	0.000
1	-1.651	0.558	--	-1.053	--	--	0.0001	0.0001
2	-0.499	0.320	0.180	-1.570	-1.055	-0.320	0.0001	0.0001

Table B.19: Uncorrected Model (Overvaluation)

	t-statistics						Prob>F	
Lags	γ_2	γ_2^{-1}	γ_2^{-2}	γ_2^{cross}	$\gamma_2^{cross'}$	$\gamma_2^{cross''}$	$\Sigma\beta_2$	$\Sigma\delta_2$
0	-1.582	--	--	--	--	--	0.179	0.646
1	0.595	1.040	--	-2.236	--	--	0.0024	0.0702
2	0.448	1.496	0.876	-1.933	-1.757	-1.274	0.1793	0.0922

Appendix C

Further Results and Data for Chapter 3

C.1 Further Results

C.1.1 Average Variance of RER's - Figures and Confidence Intervals

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

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

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

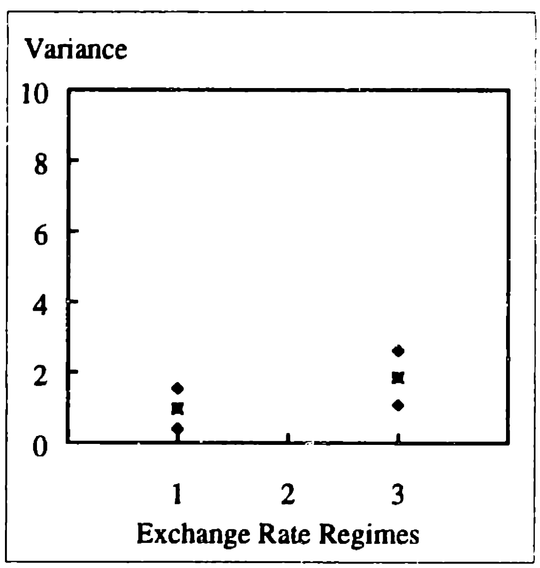


Figure C.2: Average Variance of Monthly Effective RER Changes

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

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

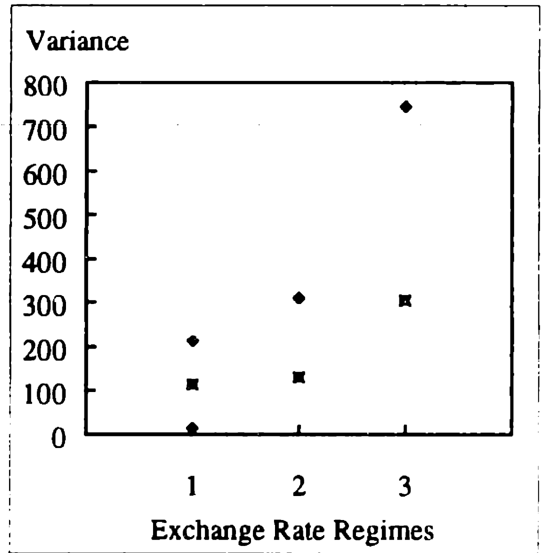


Figure C.3: Average Variance of Monthly Effective RER Changes

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

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

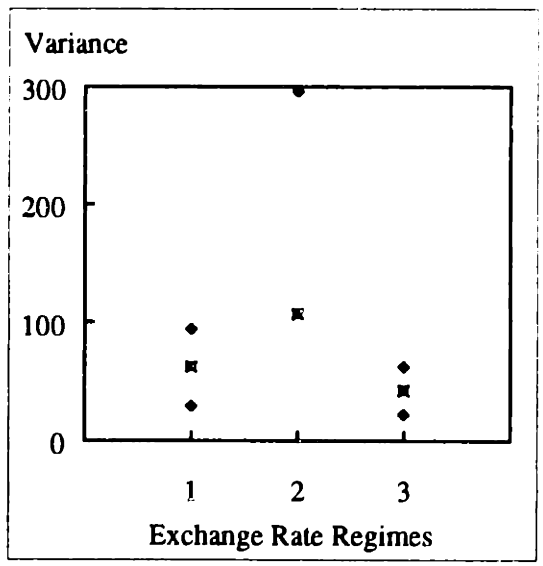


Figure C.4: Average Variance of Monthly Effective RER Changes

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

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

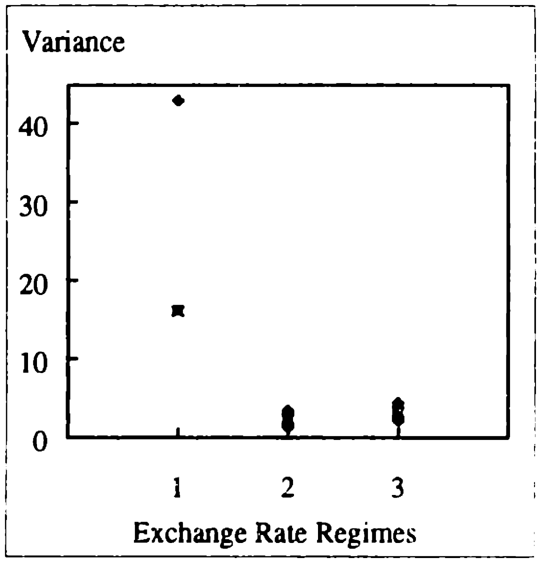
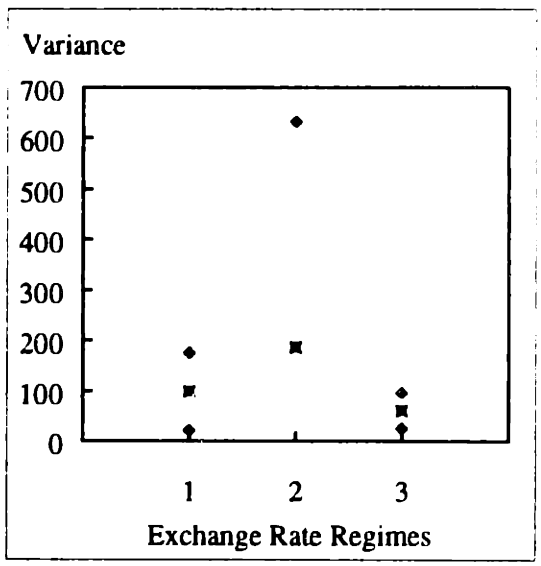


Figure C.5: Average Variance of Monthly Effective RER Changes

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

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



C.2 Data

C.2.1 Bilateral Exchange Rates and Regimes from Bretton Woods

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

Table C.1 indicates the classification scheme of the nominal exchange rate (versus the US dollar) that was adopted by Mussa and used in Section 3.2 of Chapter 3.

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

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

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

C.2.2 Nominal Exchange Rate Regimes

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

Table C.2: Nominal Exchange Regimes - IMF Descriptions

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

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

Bibliography

Alesina, Alberto, and Roberto Perotti. 1994. "The Political Economy of Growth: A Critical Survey of the Recent Literature." *World Bank Economic Review* 8(3): 351-71.

Barro, Robert J., and Xavier Sala-i-Martin. 1995. *Economic Growth.* McGraw-Hill, Inc.

Barro, Robert J., and Jong-Wha Lee. 1996. "International Measures of Schooling Years and Schooling Quality." *AEA Papers and Proceedings* 86(2): 218-223.

Barro, Robert J., and Jong-Wha Lee. 1997. Data Set for a Panel of 138 Countries. Data set available on disk from authors.

Baxter, M. and A. C. Stockman. 1989. "Business Cycles and the Exchange Rate System," *Journal of Monetary Economics*, 23, pp. 377-400.

Beaton, A.E. and J.W. Tukey. 1974. The fitting of power series, meaning polynomials, illustrated on band-spectroscopic data. Thechnometrics 16: 146-185.

Black, Stanley W. 1986. "Real Exchange Rates and Deviations from Purchasing Power Parity Under Floating Exchange Rates: A Comment," *Carnegie-Rochester Conference Series on Public Policy*, 25, pp. 215-220, North Holland.

Caballero, Ricardo J. 1993. "On the Dynamics of Aggregate Investment." In *Striving for Growth after Adjustment: The Role of Capital Formation,* edited by Luis Serven and

Andres Solimano. World Bank Regional and Sectoral Studies. Washington, D.C.: The World Bank.

Caballero, Ricardo J. 1997. "Aggregate Investment: A 90's View." Unpublished Manuscript.

Caselli, Francesco, Gerardo Esquivel, and Fernando Lefort. 1996. "Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics." *Journal of Economic Growth* 1: 363-389.

Deininger, Klaus, and Lyn Squire. 1996. "Measuring Income Inequality: A New Data-Base." The World Bank. Unpublished.

Dornbusch, Rudiger. 1997. "Brazil's Incomplete Stabilization and Reform." Unpublished Manuscript.

Dornbusch, Rudiger, and Alejandro Werner. 1994. "Mexico: Stabilization, Reform, and No Growth." In *Brookings Papers on Economic Activity*, edited by William C. Brainard and George L. Perry. Washington, D.C.: Brookings Institution.

Dornbusch, Rudiger, Ilan Goldfajn and Rodrigo O. Valdes. 1995. "Currency Crises and Collapses." In *Brookings Papers on Economic Activity*, edited by William C. Brainard and George L. Perry. Washington, D.C.: Brookings Institution.

Edwards, Sebastian. 1988. *Exchange Rate Misalignment in Developing Countries.* World Bank Occasional Papers, no.2 , new series. The Johns Hopkins University Press.

Edwards, Sebastian. 1989. *Real Exchange Rates, Devaluation, and Adjustment: Exchange Rate Policy in Developing Countries.* Cambridge, Massachusetts: The MIT Press.

Eichengreen, B. 1988. "Real Exchange Rate Behavior Under Alternative International Monetary Regimes: Interwar Evidence," *European Economic Review*, 32, pp. 363-371.

Eichengreen, Barry and Charles Wyplosz. 1988. The Economic Consequences of the Franc Poincaré. In Economic Effects of the Government Budget, edited by Elhanan Helpman, Assaf Razin and Efraim Sadka. The MIT Press: Cambridge, Massachusetts.

Flood, R. A. and A. K. Rose. 1995. "Fixing Exchange Rates: A Virtual Quest for Fundamentals," *Journal of Monetary Economics*, 36, pp. 3-37.

Forbes, Kristin. 1997. "Back to the Basics: The Positive Effect of Inequality on Growth." Unpublished Manuscript.

Frenkel, Jeffrey A. and Andrew K. Rose. 1995. "Empirical Research on Nominal Exchange Rates," in G. M. Grossman and K. Rogoff (eds), *Handbook of International Economics Vol. 3*, North Holland, Amsterdam.

Froot, Kenneth A. and Kenneth Rogoff. 1995. "Perspectives on PPP and the Long-Run Real Exchange Rates," in G. M. Grossman and K. Rogoff (eds), *Handbook of International Economics Vol. 3*, North Holland, Amsterdam.

Goldfajn, Ilan, and Rodrigo O. Valdes. 1996. "The Aftermath of Appreciations." NBER Working Paper No. 5650.

Hamilton, L.C. 1991. How robust is robust regression? Stata Technical Bulletin 2: 21-26. Reprinted in Stata Technical Bulletin Reprints, vol. 1, pp. 169-175.

Hardle, Wolfgang, and Oliver Linton. 1994. "Applied Nonparametric Methods." In *Handbook of Econometrics*, volume 4, edited by Robert F. Engle and Daniel L. McFadden. Elsevier.

Huber, P.J. 1964. Robust estimation of a location parameter. Annals of Mathematical Statistics 35: 73-101.

Johnston, Jack, and John DiNardo. 1997. *Econometric Methods.* Fourth Edition. The McGraw-Hill Companies, Inc.

Koenker, R. and G. Bassett, Jr. 1982. Robust tests for heteroscedasticity based on regression quantiles. Econometrica 50: 43-61.

Krugman, P. 1996. "Are Currency Crises Self-Fulfilling?" Paper presented at the NBER Macro Annual Conference, 1996.

Levine, Ross, and David Renelt. 1992. "A Sensitivity Analysis of Cross-Country Growth Regressions." *American Economic Review* 82 (September): 942-63.

Mark, Nelson C. and Doo-Yull Choi. 1997. Real Exchange-Rate Predictions over Long Horizons, Mimeo, The Ohio State University.

Mitchell, B. R. 1992. International Historical Statistics: Europe 1750-1988. Third Edition. Stockton Press.

Mohamad, Mahathir. 23 September 1997. "Highwaymen of the Global Economy." *The Wall Street Journal.*

Mussa, Michael. 1986. "Nominal Exchange Rate Regimes and the Behavior of Real Exchange Rates: Evidence and Implications," *Carnegie-Rochester Conference Series on Public Policy*, 25, pp. 117-214, North Holland.

O'Connell, Paul G. J. 1996. "The Overvaluation of Purchasing Power Parity," forthcoming in the *Journal of International Economics*.

Perotti, Roberto. 1996. "Growth, Income Distribution and Democracy." *Journal of Economic Growth* 1 (June): 149-87.

Salgado-Ugarte, Isaias Hazarmabeth, Makoto Shimizu, and Toru Taniuchi. 1996. "Nonparametric Regression: Kernel, WARP, and k-NN estimators." In *The Stata Technical Bulletin Reprints*, volume 5, edited by Sean Becketti. The Stata Corporation.

Savvides, Andreas. 1996. "CFA Franc Zone Membership and Exchange Rate Variability," *Journal of African Economics*, 5, pp. 52-68.

Street, J.O., R.J. Carroll, and D. Ruppert. 1988. A note on computing robust regression estimates via iteratively reweighted least squares. The American Statistician 42: 152-154.