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THE RELATIONSHIP BETWEEN THE REAL EXCHANGE RATE AND THE ECONOMIC GROWTH

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ABSTRACT

This thesis explores the complex relationship between the real exchange rate (RER) and economic growth, focusing on the mechanisms throug which fluctuations in the RER affect the macroeconomic environment. The first chapter reviews empirical studies analysing the RER-growth link in different economic contexts and historical periods, highlighting key findings by Aguirre and Calderón (2005), Chen (2010) and Di Nino, Eichengreen and Sbracia (2011). These studies emphasise the variable impact of RER on growth, depending on factors such as the level of economic development, industrial structure and institutional environment.

In the second chapter, an analysis of theoretical transmission channels is carried out, including export competitiveness, attraction of foreign direct investment (FDI), price stability and general macroeconomic equilibrium. Through these channels, it shows how RER can affect economic growth, with a focus on export-oriented sectors that often drive the development of emerging economies.

Finally, the thesis discusses the implications for economic policy, arguin that effective exchange rate management can foster sustainable growth. The evidence suggests that while a moderately undervalued exchange rate can stimulate exports and attract FDI, excessiv undervaluation can trigger inflationary pressures and destabilise the economy. The study concludes that exchange rate policies, if well-tuned to a country's specific economic evironment, can be helpful in promoting balanced growth, especially in emerging economies.

SOMMARIO

Questa tesi esplora la complessa relazione tra il tasso di cambio reale (RER) e la crescita economica, concentrandosi sui meccanismi attraverso i quali le fluttuazioni del RER influenzano il contesto macroeconomico. Il primo capitolo passsa in rassegna gli studi empirici che analizzano il legame RER – crescita in diversi contesti economici e periodi storici, evidenziado i risultati chiave di Aguirre e Calderón (2005), Chen (2010) e Di Nino, Eichengreen e Sbracia (2011). Questi studi sottolineano l'impatto variabile del RER sulla crescita, in funzione di fattori quali il livello di sviluppo economico, la struttura industriale e il contesto istituzionale.

Nel secondo capitolo viene effettuata un'analisi dei canali di trasmissione teorici, tra cui lacompetitività delle esportazioni, l'attrazione degli investimenti diretti esteri (IDE), la stabilità dei prezzi e l'equilibrio macroeconomico generale. Attraverso questi canali, mostra come la RER possa influire sula crescita economica, con particolare attenzione ai settori orientati all'esportazione che spesso guidano lo sviluppo delle economie emergeti.

Infine, la tesi discute le implicazioni per la politica economica, sostenendo che una gestione efficace del tasso di cambio può favorire una crescita sostenibile. I dati suggeriscono che mentre un tassso di cambio moderatamente sottovalutato può stimolare le esportazioni e attrarre IDE, una sottovalutazione eccessiva può innescare pressioni inflazionistiche e destabilizzare l'economia. Lo studio conclude che le politiche di cambio, se ben calibrate sul contesto economico specifico di un Paese, possono essere utili per promuovere una crescita equilibrata, soprattuto nelle economie emergenti.

TABLE OF CONTENT

INTRODUCTION

The relationship between the real exchange rate and economic growth is a major topic in international economics. Exchange rate fluctuations affect national economies in various ways, affecting not only international trade but also foreign investment, competitiveness and and, ultimately, overall economic growth. For this reason, real exchange rate analysis is essential to understand the dynamics that suppport or hinder a country's economic progress.

Several economists show scepticism about the idea that the relative price of two currencies can be a driver of growth in the long run. For many of them, in fact, the exchange rate is considered an endogenous variable, whose specific contribution to growth is complex to isolate. Most, however, agree that an undervaluation of the exchange rate can lead to short-term benefits for both developing and advanced economies. In the case of developing economies, an undervaluation can support the tradable sector, such as manufacturing, which is often the engine of growth. For advanced economies, on the other hand, the exchange rate can be a key factor in promoting exports and stimulating capital accumulation, thus supporting growth.

However, excesssive devaluation or a persistent misalignment of the exchange rate can generate negative effects, such as inflationary pressures and macroeconomic instability.

Thesis Objectives and Structure

This thesis aims to analyze the mechanisms through which the real exchange rate can influence economic growth, with a focus on the transmission channels and empirical evidence available in the literature. Specifically, the first chapter offer a detailed review

of the main transmission channels throug which the exchange rate can have direct and indirect effects on growth. These channels include the export channel, the attraction of foreign direct investment (FDI), the competitiveness of productive sectors and the impact on macroeconomic stability.

In the second chapter, the main empirical evidence is presented, analysing relevant studies that explore this relationship in different economic contexts. Both theoretical and empirical contributions are considered, with particular reference to the work of Aguirre and Calderón (2005), Chen (2010) and Di Nino, Eichengreen and Sbracia (2011), who highlighted the importance of the exchange rate for growth in different contexts and historical periods. The evidence suggests that the relationship betwen the exchange rate and growth is not unique and may vary depending on specific factors, such as the level of economic development, the structure of the economy and the institutional environment.

Research Contributions

The contributions of this thesis are mainly threefold: first, it provides a concise and clear picture of the main transmission channels, outlining how each of them may affect growth. Second, it offers an assessment of the most significant empirical evidence, highlighting any gaps or conflicting results in the literature. Finally, the thesis explores the implications of this evidence for economic policies, suggesting that appropriate exchange rate management can be a useful tool to foster sustainable economic growth.

CHAPTER 1

1. Empirical Evidence

The economic literature has extensively studied how exchange rate fluctuations affect the level of economic activity and overall economic progress, producing evidence ranging from positive and stimulating effects to potentially destabilizing impacts. This chapter examines the main empirical studies conducted on the relationship between the exchange rate and economic growth, with particular attention to developing countries where this relationship seems to be strongest.

The analysis of the relationship between the exchange rate and economic growth is complex because several factors influence this interaction. For example, in developing countries, an undervalued exchange rate can be a key lever to stimulate exports, increasing the competitiveness of local goods on international markets and improving the balance of trade. This dynamic is consistent with the forecasts of the export-oriented growth model, according to which a strong exporting sector can drive the entire economic system (Rodrik, 2008). However, other studies suggest that an exchange rate that is too devalued could lead to economic instability, fueling inflationary pressures and increasing the cost of imports, especially in sectors strategic for industrialization.

According to some empirical studies, a stable exchange rate can help create a favorable environment for investment, encouraging the transfer of technology and know-how, essential elements for sustainable growth and for the structural transformation of emerging economies (Alfaro et al., 2004). On the other hand, high exchange rate volatility can drive investors away, making it difficult to plan long-term investments.

The empirical literature has also examined the role of exchange rate management policies as a tool to support growth. In managed float economic models, where the central bank intervenes to keep the exchange rate within certain limits, it is observed that a flexible but controlled exchange rate regime can help avoid distortions due to a fixed exchange rate, while providing some economic stability. Recent studies show that, in contexts of low inflation and moderate growth, exchange rate management policies can provide the benefits of competitive exchange without the disadvantages of extreme devaluation (Gala, 2008).

This chapter aims to analyze the empirical evidence on the relationship between exchange rate and economic growth, considering the differences in results according to the economic context and the level of development of countries. In particular, the positive and negative effects of different exchange rate regimes and the conditions under which controlled devaluation or exchange rate stability can be effective tools for promoting economic growth will be examined.

2. The relationship in China

Real Exchange Rate and Economic Growth: Evidence from Chinese Provincial Data (1992-2008)" – Jinzhao Chen (2012)

The starting point is Chen's (2012) article on the real exchange rate and economic growth in China.

The article provides a detailed analysis of the relationship between the real exchange rate and economic growth in the Chinese provinces, using specific data over a significant period.

By analyzing data at the provincial level, the article offers insights into how different regions of China may respond differently to exchange rate fluctuations. This is crucial for understanding regional economic dynamics and development inequalities within the country.

The results of the article may have significant implications for economic policy formulation. Policymakers can use the evidence presented to consider the impact of exchange rate policies on economic growth and thus design more effective measures to support development.

Jinzhao Chen's article analyzes the effect of the real exchange rate on economic growth in Chinese provinces, using panel data for 28 provinces between 1992 and 2008. The study explores the relationship between exchange rate appreciation and economic growth, assessing how these dynamics vary between the coastal and inland provinces of China, a country characterized by significant regional economic disparities.

To test the hypothesis, Chen adopts a growth regression model inspired by Barro (1991), using dynamic panel estimates via the GMM (Generalized Method of Moments) method, which helps manage endogeneity in economic variables.

The growth regression used is as follows:

$$\Delta y_{i,t} = \alpha + \beta y_{i,t-1} + \delta X_{i,t} + f_t + f_i + \varepsilon_{i,t} \quad (1)$$

The GDP growth rate of a province is explained by:

- Its initial level of income.
- A set of explanatory variables that can include factors such as human capital, business openness, institutions, etc.
- Fixed individual and temporal effects that capture unobserved factors that influence economic growth.

Chen includes real GDP per capita to test the conditional convergence assumption that countries with a lower initial level of income per capita experience higher rates of economic growth, thanks to the possibility of exploiting higher marginal returns on capital. To capture the effect of human capital, it includes both the secondary school enrolment rate and the fraction of the population with higher education. Finally, it introduces a variable that measures commercial openness, assuming a positive impact on growth in line with neoclassical models and theories of endogenous growth. As far as the formulation of the exchange rate is concerned, in this work it is defined as the relative price of tradable goods, compared to non-tradable ones.

The dependent variable is the five-year average growth rate of GDP per capita (g). Explanatory variables include:

- Initial income level (ly_1): logarithm of GDP per capita at the beginning of the five-year period.
- Investment: share of gross and fixed capital formation in GDP (invest2gdp1, invest2gdp2).
- Human capital: Secondary school enrolment rate (school1) and share of population with higher education (school2).
- Population growth: natural population growth rate (popgr).
- Foreign direct investment (FDI): share of FDI in GDP and gross capital formation (fdi2gdp, fdi2invest).
- Trade openness: ratio of total international trade to GDP (trade2gdp).
- Policy preferences: Two dummy variables (policy_dum2, policy_dum3) derived from a categorical variable.

Using a fixed-effects model, the equation is estimated on three samples (all provinces, inland and coastal provinces). The results of the baseline model (*Table 1*), which includes initial income, investment, population growth and secondary education, show a conditional convergence for coastal provinces and for the entire sample, but not for inland provinces.

Variable	All provinces			Inland provinces			Coastal provinces		
ly_1	-0.091***	-0.093***	-0.104***	-0.035	-0.043	-0.053	-0.189***	-0.189***	-0.198***
	(-4.219)	(-4.403)	(-4.808)	(-1.204)	(-1.480)	(-1.906)	(-6.310)	(-6.564)	(-6.550)
invest2gdp1	0.097**		0.115**	0.110*		0.124*	0.060		0.058
	(2.727)		(3.174)	(2.077)		(2.668)	(1.358)		(1.346)
invest2gdp2		0.113**			0.131*			0.082	
		(3.362)			(2.599)			(1.922)	
school1	-0.050	-0.042		0.017	0.093		-0.267	-0.379	
	(-0.184)	(-0.158)		(0.045)	(0.248)		(-0.720)	(-1.033)	
school2			0.223			0.417*			0.089
			(1.817)			(2.462)			(0.746)
popgr	-4.112*	-3.790*	-5.008**	-6.503*	-6.451*	-7.667**	0.908	0.934	1.158
	(-2.159)	(-2.033)	(-2.694)	(-2.427)	(-2.467)	(-2.990)	(0.355)	(0.383)	(0.468)
ip2	0.033**	0.031**	0.032**	0.011	0.009	0.010	0.090***	0.091***	0.089***
	(3.033)	(2.933)	(3.031)	(0.849)	(0.664)	(0.825)	(5.957)	(6.206)	(5.926)
ip3	0.108***	0.102***	0.100***	0.055*	0.048	0.043	0.216***	0.214***	0.211***
	(5.427)	(5.240)	(5.037)	(2.086)	(1.859)	(1.741)	(7.951)	(8.160)	(7.762)
ip4	0.158***	0.152***	0.151***	0.072	0.068	0.060	0.315***	0.310***	0.314***
	(4.801)	(4.693)	(4.645)	(1.673)	(1.606)	(1.472)	(6.907)	(7.033)	(6.861)
Constant	0.817***	0.831***	0.886***	0.364	0.425	0.461*	1.703***	1.701***	1.748***
	(4.701)	(4.943)	(5.136)	(1.621)	(1.919)	(2.159)	(6.455)	(6.782)	(6.633)
Breusch–Pagan LM test	0.1971	0.1255	0.7158	0.3735	0.2332	0.1924	0.4663	0.7081	0.5225
Hausman spec. test	0.0094	0.0014	0.0007	0.9990	0.9990	0.6496	0.0000	0.0000	0.0000
Time fixed effects test	0.0000	0.0000	0.0000	0.0335	0.0588	0.1548	0.0000	0.0000	0.0000
Observations	112	112	112	72	72	72	40	40	40

Table 1: Panel baseline model. Source: Chen (2012)

Next (*Table 2*), we introduced additional variables such as FDI, trade openness, and real exchange rate. The results indicate a conditional convergence for all samples, and a significant role of human capital in the growth of all provinces except the coastal ones. Neither FDI nor trade openness seem to significantly affect the disparity in growth between provinces. Conversely, an appreciation of the real exchange rate (*lr1* and *lr2*) is associated with faster economic growth.

Variable	All provinces			Inland provinces			Coastal provinces		
ly_1	-0.092***	-0.108***	-0.072***	-0.071*	-0.072**	-0.028	-0.201***	-0.189***	-0.169***
	(-4.241)	(-5.170)	(-3.591)	(-2.515)	(-2.749)	(-1.063)	(-6.037)	(-6.253)	(-5.945)
invest2gdp1	0.085*	0.104**	0.130***	0.074	0.101*	0.133**	0.042	0.064	0.081
	(2.252)	(2.954)	(3.859)	(1.441)	(2.274)	(3.091)	(0.918)	(1.220)	(1.842)
popgr	-4.757*	-5.735**	-5.098**	-5.280	-6.426*	-6.043*	-0.118	0.342	-1.089
	(-2.548)	(-3.265)	(-3.117)	(-1.937)	(-2.662)	(-2.512)	(-0.045)	(0.131)	(-0.461)
school2	0.276*	0.201	0.254*	0.288	0.377*	0.355*	0.096	0.094	0.158
	(2.253)	(1.705)	(2.333)	(1.644)	(2.397)	(2.274)	(0.786)	(0.787)	(1.463)
fdi2gdp	0.308	0.379*	0.180	0.079	-0.065	-0.389	0.159	0.205	0.174
	(1.923)	(2.435)	(1.242)	(0.234)	(-0.209)	(-1.205)	(1.137)	(1.519)	(1.456)
open	-0.023			-0.241*			0.008		
	(-1.364)			(-2.175)			(0.623)		
ip2	0.029**	0.030**	-0.182***	0.017	0.016	-0.213**	0.089***	0.081***	-0.050
	(2.694)	(2.933)	(-3.860)	(1.317)	(1.352)	(-3.143)	(5.223)	(5.180)	(-0.896)
ip3	0.095***	0.099***	-0.125*	0.076*	0.063*	-0.179*	0.211***	0.198***	0.057
	(4.845)	(5.273)	(-2.445)	(2.680)	(2.630)	(-2.547)	(7.168)	(7.094)	(0.894)
ip4	0.140***	0.161***	-0.138*	0.117*	0.107*	-0.225*	0.318***	0.298***	0.120
	(4.341)	(5.131)	(-2.043)	(2.472)	(2.638)	(-2.413)	(6.394)	(6.453)	(1.405)
lr1		-0.050**			-0.064**			-0.029	
		(-2.977)			(-3.165)			(-0.962)	
lr2			-0.318***			-0.343**			-0.192*
			(-4.590)			(-3.348)			(-2.470)
Constant	0.790***	0.922***	-0.661	0.639**	0.622**	-1.106*	1.773***	1.660***	0.719
	(4.534)	(5.494)	(-1.841)	(2.863)	(3.046)	(-2.173)	(6.146)	(6.273)	(1.557)
Breusch–Pagan LM test	0.6577	0.3971	0.0936	0.3634	0.0598	0.0799	0.4634	0.5485	0.9027
Hausman spec. test	0.0093	0.0074	0.0000	0.4272	n.a.	0.0116	n.a.	0.0000	0.0000
Time fixed effects test	0.0000	0.0000	0.0000	0.0222	0.0178	0.0017	0.0000	0.0000	0.0000
Observations	112	112	112	72	72	72	40	40	40

Table 2. Panel evidence for effect of RER on growth. Source: Chen (2012)

The use of a fixed effects estimator can lead to an underestimation of the initial income ratio, especially in small samples with limited observation periods. To overcome this problem, Chen also uses a system-GMM estimator.

Starting from a basic model (Model 0), estimated by system-GMM, several additional variables are progressively introduced: the real exchange rate (Models 1, 3, 4, 5, 6), dummy variables for localization (Models 2, 3, 4) and for political preferences (Models 2, 5, 6). This strategy makes it possible to assess the impact of each variable on economic growth, both individually and in combination with the others.

Variable	Model 0	Model 1a	Model 1b	Model 2a	Model 2b	Model 3	Model 4	Model 5	Model 6
ly_1	-0.012	-0.015	-0.007	-0.037**	-0.026**	-0.047***	-0.028**	-0.031***	-0.017
	(0.319)	(0.291)	(0.583)	(0.001)	(0.009)	(0.001)	(0.037)	(0.010)	(0.097)
invest2gdp1	0.143*	0.152**	0.133**	0.150*	0.155*	0.163**	0.138**	0.165**	0.141**
	(0.013)	(0.012)	(0.012)	(0.013)	(0.015)	(0.012)	(0.012)	(0.013)	(0.014)
popgr	-1.232	-1.438	-1.408	-2.752	-2.292	-3.516	-2.559	-2.840	-2.225
	(0.638)	(0.599)	(0.554)	(0.202)	(0.368)	(0.118)	(0.193)	(0.284)	(0.345)
school1	0.447	0.600*	0.398	0.361	0.378	0.544**	0.332	0.542*	0.345
	(0.112)	(0.059)	(0.140)	(0.103)	(0.160)	(0.026)	(0.122)	(0.065)	(0.189)
lr1		-0.031				-0.044**		-0.038*	
		(0.192)				(0.046)		(0.069)	
lr2			-0.203				-0.257		-0.222
			(0.199)				(0.115)		(0.169)
loca_dum				0.025*		0.030***	0.023**		
				(0.017)		(0.009)	(0.034)		
policy_dum2					0.001			-0.001	-0.001
					(0.940)			(0.937)	(0.871)
policy_dum3					0.018*			0.019*	0.013
					(0.044)			(0.058)	(0.139)
Constant	0.099	0.116	-0.746	0.312**	0.212*	0.387**	-0.782	0.249**	-0.737
	(0.438)	(0.423)	(0.271)	(0.005)	(0.047)	(0.003)	(0.264)	(0.041)	(0.279)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects test	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Arellano–Bond AR(1) test	0.099	0.085	0.016	0.093	0.086	0.073	0.008	0.067	0.010
Arellano–Bond AR(2) test	0.488	0.296	0.253	0.382	0.416	0.154	0.151	0.204	0.199
Hansen statistic	0.451	0.433	0.364	0.530	0.706	0.497	0.455	0.630	0.528
Observations	112	112	112	112	112	112	112	112	112

Table 3: Panel evidence for effect of RER on growth (system-GMM). Source: Chen (2012)

The results in *Table 3* show that traditional growth drivers, such as investment and human capital, are significantly correlated with economic growth. In addition, geographical location has a major impact on growth, with coastal provinces tending to grow faster. As for the real exchange rate, however, it is significant in several models only when lr1 is represented.

Finally, we want to understand whether the impact of the real exchange rate on economic growth varies according to the geographical location (coastal vs. inland provinces) and the level of political preference of the provinces. To this end, the author introduces terms of interaction between variables.

Variable	Model 7		Model 8	
ly_1	-0.050***	(0.000)	-0.026*	(0.018)
invest2gdp1	0.174*	(0.014)	0.162*	(0.017)
popgr	-4.178	(0.083)	-2.419	(0.307)
school1	0.541*	(0.026)	0.436	(0.086)
lr1	-0.049*	(0.029)	-0.006	(0.869)
loca_dum × lr1	0.005	(0.936)		
loca_dum	0.029**	(0.008)		
policy_dum2 × lr1			-0.060	(0.122)
policy_dum3 × lr1			0.033	(0.570)
policy_dum3			0.016**	(0.009)
Constant	0.412**	(0.001)	0.213*	(0.048)
Time dummies	Yes		Yes	
Time fixed effects test	0.0000		0.0000	
Arellano–Bond AR(1) test: *p*-value	0.074		0.062	
Arellano–Bond AR(2) test: *p*-value	0.151		0.445	
Hansen statistic: *p*-value	0.483		0.597	
Observations	112		112	

Table 4. Panel evidence for effect of RER on growth (system-GMM with interaction terms). Source: Chen (2012)

The results in *Table 4* suggest that the impact of the real exchange rate on economic growth is relatively uniform across the territory analysed, regardless of geographical location and level of political preference. In other words, the appreciation of the RER has a positive effect on growth in both coastal and inland provinces.

Empirical analysis reveals the existence of a conditional convergence process of economic growth, limited within the coastal and inland province groups. Surprisingly, real exchange rate appreciation has been positively correlated with provincial economic growth, in contrast to traditional growth theories. This evidence could be explained by a reallocation of resources to non-tradable sectors, stimulated by the increase in the relative prices of non-tradable goods, and a consequent improvement in labor productivity.

Before economic reform, China, with the aim of industrializing rapidly, adopted a pricing policy that favored the industrial sector at the expense of agriculture. This choice, dictated by the need to generate revenue for the State, has led to a systematic undervaluation of agricultural products. With the economic opening, the abandonment of price controls has reversed this trend, realigning the prices of industrial goods with those of the primary sector.

Rising prices in non-tradable sectors, in addition to correcting existing distortions, can stimulate economic growth in several ways. First, the appreciation of the real exchange rate induces a reallocation of resources towards more efficient sectors, promoting more balanced economic growth over the long run. Secondly, it generates a wealth effect that stimulates aggregate demand, favoring the growth of all sectors. Finally, rising real wages improve living standards and further support domestic demand.

3. The misalignment of RER

"Real exchange rate misalignment and economic performance" – Aguirre, Calderon (2005)

The article offers an in-depth analysis of the concept of real exchange rate misalignment, i.e. when the exchange rate of a currency does not reflect its fundamental value.

Aguirre and Calderón use sophisticated econometric models to analyze the data, helping to develop methodologies for assessing exchange rate misalignment.

The study is particularly relevant for developing countries, which often face challenges related to exchange rate stability and international competitiveness.

Aguirre and Calderon's paper is a fundamental contribution to the economic literature that analyzes the link between real exchange rate (RER) misalignment and economic performance. In particular, the authors seek to determine whether and how the RER deviating from its "equilibrium" value (which reflects long-run economic fundamentals) affects a country's growth rate. Using a sample of 60 countries in the period 1965-2003.

Aguirre and Calderón start from the premise that an RER that is too high or too low compared to the equilibrium value can generate economic inefficiencies and negatively affect growth. Therefore, the main objective is to quantify the impact of the RER mismatch on economic growth, distinguishing between overvaluation and undervaluation of the exchange rate.

The research has a twofold objective. The first is to measure the degree of real exchange rate (RER) misalignment by estimating a long-run equation based on the theoretical

model of Obstfeld and Rogoff (1996). Using co-integration techniques on panel data, the relationship between the RER and a number of key variables, such as the ratio of net foreign assets to GDP, relative productivity, terms of trade and government spending, is analyzed. The second objective is to explore a possible causal relationship between RER misalignment and economic growth, also taking into account variations in the degree of misalignment.

The real exchange rate mismatch is, in this context, defined as the deviation of the effective RER from its equilibrium level. The latter is obtained by empirically estimating an econometric relationship between the RER and its fundamental determinants, in line with the theoretical models of the literature.

If we define the real exchange rate as: $Q = P/EP^*$, and express the data in logarithmic terms, we obtain the following econometric estimate of the RER long-run equation, in line with the theoretical model proposed by Aguirre and Calderón (2005):

$$q_t = \beta_0 + \beta_1 \, ln\left(\frac{F}{Y}\right)_t + \beta_2 ln\left(\frac{y_T}{y_T^*} / \frac{A_N}{A_N^*}\right) + \beta_3 ln\left(\frac{P_T^X}{P_T^M}\right)_t + \beta_4 ln\left(\frac{G}{G^*}\right)_t + \xi_t \quad (2)$$

$\left(\frac{F}{Y}\right)_t$: This term represents the ratio of net foreign assets (F) to GDP (Y).

$\left(\frac{y_T}{y_T^*} / \frac{A_N}{A_N^*}\right)$: This term captures the relative productivity between the tradable and non-tradable goods sectors, comparing domestic productivity (y_T) to foreign productivity (y^*_T), and the productivity of the non-tradable sector (AN) to foreign productivity (A^*_N).

An increase in productivity in the tradable goods sector, compared to the non-tradable one, usually leads to an appreciation of the real exchange rate (Balassa-Samuelson effect).

$\left(\frac{P_T^X}{P_T^M}\right)_t$: Indicates the ratio between the prices of exported goods (P^X_T) and those imported (P^M_T). This represents the terms of exchange. An improvement in the latter leads to an increase in real income, which in turn stimulates demand for tradable goods, while reducing the supply of labour in the non-commercial sector. This contraction in supply in the non-commercial sector leads to an increase in the relative price of non-tradable goods and, consequently, to an appreciation of the real exchange rate.

$\left(\frac{G}{G^*}\right)_t$: It is the ratio between domestic (G) and foreign (G*) government spending. Higher domestic government spending than abroad can increase demand for non-tradable goods and, therefore, lead to an appreciation of the real exchange rate.

ξ_t : An error term that captures other factors that affect the real exchange rate but are not directly included in the model.

As mentioned above, to obtain the measure of misalignment, the equilibrium RER is calculated as the expected value of the long-run equation, using the estimated coefficients and the actual values of the fundamental variables. Subsequently, this equilibrium value is subtracted from the actual RER observed in the market. Through this mode, it is possible to construct three sets of RER misalignment measures:

Fundamental Misalignment 1 (FRERM1): This measure is calculated using country-specific estimates, applying the Dynamic Ordinary Least Squares (DOLS) method to each country's individual time data. In other words, each country has its own unique set of

coefficients, so it is assumed that the relationship between RER and fundamentals can vary significantly from one country to another.

Fundamental mismatch 2 (FRERM2): In this case, the equilibrium RER is calculated using DOLS estimates on a panel of countries divided into two groups: industrialized and developing

Fundamental Misalignment 3 (FRERM3): Here, a single set of DOLS coefficients is applied to the entire sample of countries.

Variable	All Countries	Industrial Countries	Developing Countries
Economic Growth	1.84	2.70	1.52
	(2.82)	(1.70)	(3.07)
Fundamental Measures of RER Misalignment			
FRERM1 -- Time Series Techniques			
Misalignment 2/	0.071	0.041	0.089
	(0.07)	(0.05)	(0.08)
Overvaluation	0.039	0.020	0.050
	(0.07)	(0.03)	(0.08)
Undervaluation	-0.032	-0.021	-0.039
	(0.06)	(0.05)	(0.06)
FRERM2 -- Panel Cointegration by Groups			
Misalignment 2/	0.146	0.088	0.179
	(0.15)	(0.08)	(0.16)
Overvaluation	0.075	0.044	0.093
	(0.13)	(0.07)	(0.15)
Undervaluation	-0.071	-0.044	-0.086
	(0.12)	(0.08)	(0.14)
FRERM3 -- Panel Cointegration Full Sample			
Misalignment 2/	0.149	0.093	0.182
	(0.15)	(0.09)	(0.17)
Overvaluation	0.076	0.046	0.094
	(0.13)	(0.07)	(0.16)
Undervaluation	-0.073	-0.047	-0.087
	(0.12)	(0.08)	(0.14)

Table 5: RER misalignment and growth: Basic statistics. Source: Aguirre, Calderon (2005)

Table 5 shows the basic statistics of the analysis by Aguirre and Calderón (2005). Average economic growth is higher in industrialized countries than in developing countries (2.70% vs. 1.52%). This disparity is in line with expectations, as industrialized countries generally have stronger institutions, greater political and economic stability, and more developed markets, all of which are factors that favor growth.

The high standard error in growth in developing countries (3.07) reflects greater variability in economic performance in these countries, due to factors such as political instability, dependence on commodity exports and vulnerability to external shocks. The three misalignment measures (FRERM1, FRERM2, FRERM3) systematically show a greater misalignment in developing countries than in industrialized countries. This suggests that developing countries more frequently experience significant deviations from their real exchange rate relative to the equilibrium exchange rate.

Table 6 shows the results of the regression. The results indicate an inverse and statistically significant relationship between economic growth and real exchange rate misalignment, regardless of the measure used. For example, for FRERM1, the coefficient is -4.023, indicating that an increase in misalignment reduces growth by about 4 percentage points per unit of misalignment. The FRERM2 and FRERM3 measures show smaller but still significant effects, suggesting that countries with real exchange rates further away from their equilibrium value experience reduced growth.

A 5% increase in the degree of real exchange rate misalignment, calculated using the FRERM1 measure, is associated with a 20 basis point decrease in the annual growth rate. Similarly, a 5% increase in RER overvaluation, measured by FRERM2 or FRERM3, results in a reduction in growth of around 6 basis points. Conversely, a reduction in the

overvaluation of developing countries, bringing it to the levels observed in industrialized countries, would estimate growth at 0.5% using the dollar measure and 0.7% using the band-pass measure.

Structural variables such as secondary education and trade openness have positive and significant effects on economic growth, suggesting that long-term policies geared towards human capital and economic integration can foster growth.

Stabilization policies, such as high inflation and currency crises, have a significant negative effect on growth, confirming the need for macroeconomic stability for healthy economic development.

Variables	Fundamental Measures of Misalignment			Other Measures	
	FRERM1	FRERM2	FRERM3	Dollar (1992)	Band-Pass
Transitional Convergence:					
- Initial GDP per capita	-2.693 **	-2.861 **	-3.155 **	-2.321 **	-3.287 **
(in logs)	(0.41)	(0.24)	(0.23)	(0.17)	(0.20)
Cyclical Reversion					
- Initial Output Gap	-22.191 **	-17.902 **	-18.341 **	-15.171 **	-14.963 **
(log[actual / potential GDP])	(2.26)	(2.24)	(1.55)	(2.47)	(2.61)
Structural Policies					
- Human Capital	2.610 **	2.715 **	3.032 **	3.676 **	3.304 **
(Secondary Enrollment, logs)	(0.31)	(0.26)	(0.26)	(0.26)	(0.27)
- Financial Depth	0.977 **	1.242 **	1.346 **	0.860 **	1.187 **
(Private Credit / GDP, logs)	(0.14)	(0.13)	(0.13)	(0.22)	(0.12)
- Trade Openness	0.389 **	0.524 **	0.360 **	0.693 **	0.332 *
(Exports + Imports / GDP, logs)	(0.17)	(0.18)	(0.16)	(0.13)	(0.19)
Stabilization Policies					
- Lack of Price Stability	-1.836 **	-0.540 *	-0.365	-0.116	-0.873 **
(inflation rate, log[(1+inf)*100]])	(0.27)	(0.33)	(0.31)	(0.64)	(0.42)
- Currency Crises	-3.230 **	-3.831 **	-3.816 **	-4.642 **	-4.303 **
(frequency under crisis, 0-1)	(0.36)	(0.33)	(0.33)	(0.47)	(0.42)
- RER Misalignment	**-4.023 ** **	**-1.253 ** **	**-1.214 ** **	**-1.264 ** **	**-6.151 ** **
(log[actual / equilibrium RER])	**(0.36)**	**(0.11)**	**(0.07)**	**(0.18)**	**(1.21)**
External Shocks					
- Terms of Trade	0.065 **	0.081 **	0.086 **	0.076 **	0.075 **
(growth rate of ToT)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
- Period Shifts					
76-80:	-0.544 **	-0.541 **	-0.566 **	-0.830 **	-0.690 **
81-85:	-2.325 **	-2.582 **	-2.663 **	-2.862 **	-2.429 **
86-90:	-1.541 **	-1.725 **	-1.726 **	-2.026 **	-1.890 **
91-95:	-2.136 **	-2.280 **	-2.133 **	-2.390 **	-2.128 **
96-00:	-2.145 **	-2.333 **	-2.256 **	-2.674 **	-2.317 **
No. Countries	60	60	60	60	60
No. Observations	354	354	354	354	354
Specification Tests (p-values)					
- Sargan Test	(0.26)	(0.38)	(0.39)	(0.37)	(0.47)
- 2nd Order Correlation	(0.47)	(0.50)	(0.49)	(0.51)	(0.60)

Table 6: RER Misalignment and Economic Growth: Baseline Regression. Source: Aguirre, Calderon (2005)

Table 7 assesses the existence of an asymmetric relationship between real exchange rate mismatch (RER) and economic growth. The objective is twofold: to determine whether overvaluations of the RER have more pronounced negative effects on growth than the

positive effects of undervaluation and, second, to ascertain whether the intensity of this relationship is affected by the degree to which the RER deviates from its long-run equilibrium level.

To empirically investigate the differential impact of RER overvaluation and undervaluation on economic growth, the authors introduce two dummy variables: one for overvaluation and one for undervaluation. These variables are constructed based on the estimated equilibrium RER and the actual RER. The authors subsequently estimate a panel data regression model that incorporates these dummy variables among the explanatory variables. A negative and statistically significant coefficient on the overvaluation dummy would suggest that overvaluation has a negative impact on growth, while a positive and significant coefficient on the undervaluation dummy would indicate that undervaluation has a positive impact on growth.

In the linear specification, the RER Overvaluation variable has negative and significant coefficients in all three measures suggesting that RER overvaluation has a negative effect on economic growth. For example, in FRERM1, the coefficient is -11.146, indicating that an increase in RER overvaluation is associated with a reduction in growth.

	Linear Specification			Non-Linear Specification		
	FRERM1	FRERM2	FRERM3	FRERM1	FRERM2	FRERM3
Variables	[1]	[2]	[3]	[4]	[5]	[6]
Transitional Convergence:						
- Initial GDP per capita	-3.033 **	-3.299 **	-2.324 **	-3.079 **	-3.178 **	-0.929 **
(in logs)	(0.29)	(0.20)	(0.31)	(0.23)	(0.15)	(0.37)
Cyclical Reversion						
- Initial Output Gap	-15.166 **	-23.606 **	-19.413 **	-15.619 **	-37.084 **	-5.933 **
(log[actual / potential GDP])	(2.41)	(2.91)	(2.29)	(1.34)	(4.13)	(2.01)
Structural Policies						
- Human Capital	2.602 **	2.838 **	2.292 **	2.767 **	3.533 **	0.994 **
(Secondary Enrollment, logs)	(0.31)	(0.26)	(0.34)	(0.23)	(0.30)	(0.34)
- Financial Depth	0.515 **	0.969 **	0.750 **	0.728 **	1.171 **	0.730 **
(Private Credit / GDP, logs)	(0.13)	(0.15)	(0.16)	(0.16)	(0.13)	(0.13)
- Trade Openness	0.067	0.627 **	0.279 **	-0.089	0.502 **	0.691 **
(Exports + Imports / GDP, logs)	(0.12)	(0.13)	(0.11)	(0.20)	(0.11)	(0.17)
Stabilization Policies						
- Lack of Price Stability	-2.674 **	-0.982 **	-1.174 **	-2.437 **	-0.096	-1.595 **
(inflation rate, log[(1+inf)*100]])	(0.47)	(0.44)	(0.53)	(0.57)	(0.68)	(0.39)
- Currency Crises	-3.591 **	-2.737 **	-4.049 **	-4.034 **	-4.084 **	-4.623 **
(frequency under crisis, 0-1)	(0.27)	(0.50)	(0.37)	(0.41)	(0.35)	(0.23)
- RER Overvaluation	**-11.146 ** **	**-4.163 ** **	**-3.493 ** **	**1.274**	**0.930**	**3.668 ** **
	(0.60)	**(0.31)**	**(0.28)**	**(2.40)**	**(1.14)**	**(1.28)**
- RER Overvaluation Squared	---	---	---	**-37.713 ** **	**-8.042 ** **	**-6.651 ** **
				(9.67)	**(1.94)**	**(1.99)**
- RER Undervaluation	**3.208 ** **	**2.697 ** **	**0.781 ***	**-10.084 ** **	**-6.705 ** **	**-11.148 ** **
	(0.62)	**(0.48)**	**(0.49)**	**(4.23)**	**(1.54)**	**(2.10)**
- RER Undervaluation Squared	---	---	---	**-46.788 ** **	**-16.565 ** **	**-11.189 ** **
				(17.13)	**(3.11)**	**(3.98)**
External Shocks						
- Terms of Trade	0.047 **	0.072 **	0.072 **	0.057 **	0.063 **	0.052 **
(growth rate of ToT)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
- Period Shifts						
76-80:	-0.308 **	-0.771 **	-0.450 **	-0.433 **	-0.720 **	-0.369 **
81-85:	-1.643 **	-3.002 **	-2.604 **	-1.794 **	-3.156 **	-2.317 **
86-90:	-1.071 **	-1.757 **	-1.447 **	-1.330 **	-1.910 **	-1.667 **
91-95:	-1.506 **	-1.971 **	-1.712 **	-1.692 **	-2.488 **	-2.127 **
96-00:	-1.544 **	-1.878 **	-1.724 **	-1.638 **	-2.587 **	-2.299 **
No. Countries	60	60	60	60	60	60
No. Observations	354	354	354	354	354	354
Specification Tests (p-values)						
- Sargan Test	(0.39)	(0.28)	(0.37)	(0.59)	(0.41)	(0.36)
- 2nd Order Correlation	(0.78)	(0.49)	(0.48)	(0.73)	(0.81)	(0.78)

Table 7: RER Overvaluation, RER Undervaluation and Economic Growth. Source: Aguirre, Calderon (2005)

In the nonlinear specification, a Squared Overvaluation RER variable is also introduced to capture the effect of overvaluation with a different intensity. The RER Overvaluation Squared ratio is negative and significant (e.g., -37.713 in FRERM1), implying that the negative effect of overvaluation on growth intensifies as the level of overvaluation increases. This suggests a non-linear relationship, in which higher overvaluations have a stronger negative impact on economic growth.

The RER Undervaluation variable has positive and significant coefficients across all specifications (both linear and non-linear), indicating that RER undervaluation tends to favor economic growth. In the linear specification, the coefficient for FRERM1 is 3.208, which suggests that an increase in the undervaluation of the RER is associated with an increase in growth.

In the non-linear specification, RER Undervaluation Squared is also included, and its coefficient is negative (e.g., 46.788 in FRERM1) and significant. This suggests a non-linear relationship between RER undervaluation and economic growth, where small or moderate undervaluation promotes growth, but too high levels of undervaluation can become harmful or ineffective.

The authors' analysis reveals that developing countries have more misaligned real exchange rates than industrialized countries, a phenomenon that could be attributable to suboptimal macroeconomic, trade and currency policies. The results indicate that both overvaluations and undervaluation of the local currency have a negative impact on economic growth, although the negative effect of overvaluations is more pronounced. Reducing the degree of overvaluation to the levels observed in industrialized countries could stimulate growth of between 17% and 35% per year, while a reduction in

undervaluation could lead to an increase in growth of between 3% and 11% per year. Moreover, empirical analysis suggests that there is a nonlinear relationship between real exchange rate misalignment and economic growth: while moderate undervaluation can have a positive effect on growth, both excessive overvaluations and excessive undervaluation inhibit economic growth.

4. The relationship in Italy

"Real Exchange Rates, Trade, and Growth: Italy 1861-2011" - Virginia Di Nino, Barry Eichengreen and Massimo Sbracia (2011)

The article analyses the relationship between the real exchange rate (RER), trade and economic growth in Italy over an extremely long period, from 1861 to 2011. Their aim is to understand how the RER has influenced Italy's competitiveness and economic development over the course of more than a century and a half, going through different historical phases, including Italian unification, the two world wars, the fascist period, the post-war economic boom and finally European integration.

Through several sources, the authors collected data on exchange rates against the U.S. dollar, wholesale and consumer price indices, and real GDP per capita for 34 countries over the period 1861-1939. These data were then combined with those from the Penn World Table, extending the analysis to almost 150 years.

To calculate the real exchange rate mismatch, it is first necessary to correct the latter for the Balassa-Samuelson effect. This implies a regression of the real exchange rate to a proxy of the level of development, such as GDP per capita. Undervaluation is then defined as the variance between the actual value of the exchange rate and the value estimated by the model.

In line with Rodrik's (2008) approach, underestimation is estimated by regression:

$$rer_{n,t}^{PWT} = a + by_{n,t}^{pc} + c_t + \varepsilon_{n,t} \qquad (4)$$

$rer_{n,t}^{PWT}$ indicates the logarithm of the Penn World Table real exchange rate *of country n* at time *t* and is calculated as the ratio of the nominal exchange rate to the PPP exchange rate against the dollar.

$y_{n,t}^{pc}$ it is the logarithm of real GDP per capita, indicates a series of dummies and the error term. c_t $\varepsilon_{n,t}$

To examine whether undervaluation has effects on growth, the following regression is estimated:

$$g_{n,t} = \alpha_n + \beta y_{n,t-1}^{pc} + \delta u_{n,t}^{PWT} + d_t + \eta_{n,t} \quad (5)$$

Two additional definitions of the real exchange rate are also provided:

$$rer_{n,t}^{WPI} = ln \frac{xrat_{n,t} WPI_{us,t}}{WPI_{n,t}}$$

$$rer_{n,t}^{CPI} = ln \frac{xrat_{n,t} CPI_{us,t}}{CPI_{n,t}}$$

To construct alternative measures of the real exchange rate, we utilize the wholesale price index (WPI) and the consumer price index (CPI). We can substitute (alternatively) these two definitions in place of u in the empirical model (5). These measures, while not explicitly designed to capture misalignment, can provide valuable insights when incorporated into our growth regression model, as proposed by Woodford (2008).

These two rates can also be substituted in (4) instead of to obtain two further measures of undervaluation. $rer_{n,t}^{PWT}$

In conclusion, five different measures are compared to assess undervaluation: the corrected measures $u_{n,t}^{PWT}, u_{n,t}^{WPI}, u_{n,t}^{CPI}$ and the weakly corrected measures, and $rer_{n,t}^{WPI}$ and $rer_{n,t}^{CPI}$

Table 8 shows in detail the results of the estimates obtained for the entire period considered (1861-2009), with a breakdown for the various groups of countries and for the different measures of underestimation used in the analysis.

	All Countries				Developing Countries			
	u^{CPI}	u^{WPI}	rer^{CPI}	rer^{WPI}	u^{CPI}	u^{WPI}	rer^{CPI}	rer^{WPI}
y_{t-1}	-0.032	-0.036	-0.031	-0.035	-0.039	-0.029	-0.037	-0.025
	[7.77]***	[3.79]***	[7.27]***	[3.56]***	[5.85]***	[1.83]*	[5.50]***	[1.61]
undervaluation	0.008	0.015	0.004	0.009	0.008	0.026	0.005	0.018
	[2.69]***	[1.80]*	[2.43]**	[1.08]	[2.81]***	[3.24]***	[3.11]***	[2.24]**
Constant	0.256	0.222	0.242	0.184	0.186	0.269	0.152	0.167
	[9.50]***	[3.84]***	[8.40]***	[2.86]***	[4.30]***	[1.95]*	[3.38]***	[1.32]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1419	729	1419	729	827	350	827	350
Number of countries	161	80	161	80	130	59	130	59
R-squared	0.39	0.48	0.38	0.47	0.36	0.51	0.35	0.49

Table 8: economic growth and undervaluation (1861-2009). Source: Di Nino, Eichengreen, Sbracia (2011)

The estimated undervaluation coefficient is positive and statistically significant at the 5% or 1% threshold in many of the estimated specifications. In general, measures of undervaluation based on price indices ($u^{CPI,}$ u^{WPI}) seem to provide more robust results than measures based on real exchange rates ($rer^{CPI,}$ $rer^{WPI).}$ Estimates indicate that a 30% undervaluation, as measured by u^{WPI} and u^{CPI}, is associated with an increase in real GDP of between 1.5% and 4.5% over a five-year period. This effect is statistically significant and economically significant. In addition, the results remain valid even considering other measures of underestimation and restricting the analysis to the post-war period.

Table 9 shows that the positive effect of undervaluation on growth persists even in the pre-war period, although it is less pronounced, and estimates are less precise. The subgroup analysis confirms that the impact is greatest in the least developed countries.

	All Countries		Less Developed Countries (2)	
	u^{CPI}	u^{WPI}	u^{CPI}	u^{WPI}
y_{t-1}	-0.084	-0.082	-0.09	-0.085
	[4.69]***	[5.34]***	[3.86]***	[3.43]***
undervaluation	0.001	0.017	0.010	0.022
	[0.12]	[1.45]	[0.83]	[0.92]
Constant	0.613	0.61	0.609	0.575
	[4.75]***	[5.34]***	[3.85]***	[3.43]***
Country fixed effects	Yes	Yes	Yes	Yes
Period dummies	Yes	Yes	Yes	Yes
Observations	209	191	83	64
Number of countries	33	31	19	19
R-squared	0.54	0.56	0.51	0.45

Table 9: economic growth and undervaluation before WW2 (1861-1939). Source: Di Nino, Eichengreen, Sbracia (2011)

Although the results show a positive correlation, they do not allow a causal link to be established. To address this limitation, a dynamic GMM panel model is estimated, using variable lags as tools. The results are shown in *Table 10*.

	Whole sample All Countries		Whole sample Developing countries (2)		Whole sample Less developed countries (3)		Pre WW II period All Countries	
	u^{CPI}	u^{WPI}	u^{CPI}	u^{WPI}	u^{CPI}	u^{WPI}	u^{CPI}	u^{WPI}
y_{t-1}	0.242	0.24	0.199	0.147	0.3	-0.066	0.407	0.248
	[8.80]***	[6.63]***	[5.05]***	[2.51]**	[4.51]***	[0.59]	[5.37]***	[2.94]***
$\ln(GDP_{t-1})$	-0.043	-0.041	-0.033	-0.026	-0.026	-0.01	-0.003	0.004
	[15.05]***	[10.70]***	[8.30]***	[5.21]***	[3.55]***	[1.26]	[1.03]	[0.85]
undervaluation	0.006	0.021	0.006	0.025	0.009	0.044	0.004	0.004
	[3.40]***	[3.53]***	[3.26]***	[2.82]***	[1.90]*	[4.57]***	[0.38]	[0.22]
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1121	577	651	275	277	80	157	145
Number of countries	156	77	123	56	60	23	32	29
Sargan test	73.72	89.4	78.79	129.31	70.8	67.66	90.38	89.82
P value	0.45	0.09	0.30	0.00	0.26	0.01	0.00	0.00
AR (2)	-1.97	-1.96	-2.82	-2.92	-1.35	-1.47	-3.12	1.53
P value	0.049	0.05	0.005	0.003	0.176	0.141	0.002	0.126

Table 10: Economic growth and undervaluation (dynamic panel). Source: Di Nino, Eichengreen, Sbracia (2011)

The use of instrumental variables in dynamic panel models confirms the positive causal relationship between undervaluation and economic growth. The estimated coefficients are significantly positive and are higher for countries with lower per capita income, particularly in the post-war period.

Figure *1* shows the evolution of the real exchange rate and several measures of exchange rate undervaluation for Italy from 1861 to 2011. It highlights how the value of the lira has been subject to significant fluctuations over time, alternating long periods of undervaluation with phases of overvaluation. In particular, the lira was undervalued for about a century, before undergoing substantial appreciation starting in the 80s. "The rigidity of prices and the expectations of economic agents are two key factors that influence the persistence of the effects of a devaluation. However, other factors have contributed to maintaining this imbalance for so long. Indeed, the oversupply of labour,

especially during the economic boom, has put downward pressure on wages and, consequently, on prices.

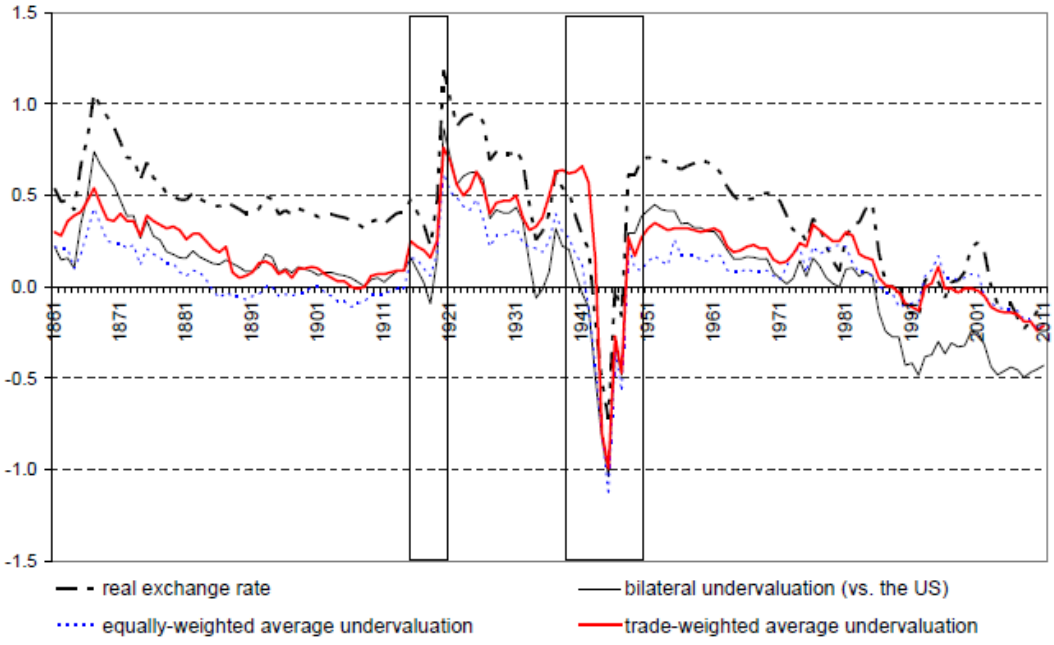

Figure 1: Real exchange rate and measures of undervaluation of Italy.s currency: 1861-2011. Source: Di Nino, Eichengreen, Sbracia (2011)

In addition, fiscal policies have also played a crucial role in determining the price level and, consequently, the competitiveness of the lira. Periods of restrictive policies, such as in the 1950s and 1960s, contained inflation, while more expansionary policies, especially after the 1970s, generated inflationary pressures.

In order to examine the factors that have influenced the lira/euro mismatches since 1861, a time series analysis is carried out in which the dependent variable is the undervaluation index of the Italian currency. The main determinants of attention are the orientation of

fiscal and monetary policy, the supply of labour to the manufacturing sector, the liberalisation of capital and trade openness. The model that is estimated is therefore:

$$\Delta u_t = b_0 + b_1 \Delta \left(\frac{A_t}{M_t}\right) + b_2 \Delta deficit_t + b_3 \Delta i_t^R + b_4 \Delta K_t + b_5 \Delta O_t + b_6 g_{LPt} + \varepsilon_t \qquad (6)$$

Table 11 shows the estimates of equation (6) for different historical periods. The results obtained on the entire sample (1861-2009) are substantially confirmed also in the pre- and post-World War II subsamples, despite the different availability of data and the reduction in the number of observations. In particular, the sign and significance of the ratios relating to labour supply in the manufacturing sector, debt to GDP, the real interest rate, capital account liberalisation and trade openness remain stable over time. The only slightly less robust result is that relating to labor productivity, which shows a negative sign but with a significance that varies slightly between the different periods.

Time span:	1861-2009	1861-1939	1950-2009	1920-2009
Δagric./manuf.	**0.066**	**0.064**	0.178	-0.012
	[2.51]**	**[2.22]****	[1.07]	[0.28]
Δdeficit	**-0.080**	**-0.101**	-0.138	**-0.142**
	[1.88]*	**[2.12]****	[0.80]	**[2.67]*****
Δreal interest rate	**0.014**	**0.043**	**0.013**	**0.011**
	[3.30]***	**[2.92]*****	**[3.67]*****	**[2.52]****
Δ KA liberalization	**-0.014**	**-0.021**	-0.003	**-0.010**
	[2.60]**	**[3.19]*****	[0.28]	**[1.73]***
Δopenness	**0.859**	**1.160**		**0.778**
	[5.86]***	**[4.78]*****		**[4.30]*****
labor productivity growth	**-0.266**	**-0.216**	**0.437**	**-0.243**
	[3.39]***	**[2.25]****	**[2.55]****	**[2.64]****
constant	-0.002	0.006	-0.016	-0.008
	[0.35]	[1.01]	[2.23]**	[1.24]
Observations	118	69	59	67
R-squared	0.38	0.43	0.34	0.50

Table 11: Determinants of undervaluation. Source: Di Nino, Eichengreen, Sbracia (2011)

By comparing the graphical data presented in Figures 1 and 2, it is possible to identify any relationship between the undervaluation of money and economic growth.

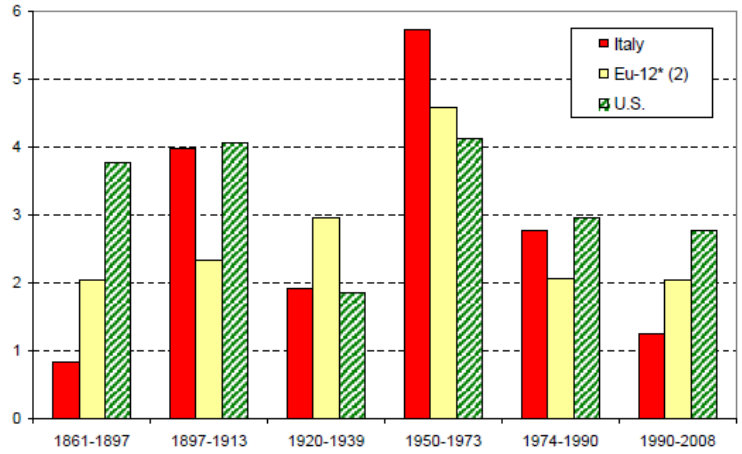

Figure 2: Real GDP growth in selected areas. Source: Di Nino, Eichengreen, Sbracia (2011)

Figure *1* shows how the undervaluation of the lira was a characterizing element of the period of the Italian economic miracle. As mentioned earlier, in the 1950s and 1960s, an average undervaluation estimated at around 30% provided a boost to economic growth, contributing to annual GDP growth of about 0.6-1.2%.

During the two periods of sustained growth, the Italian currency was either in equilibrium (1895-1913) or undervalued (1970s and 1980s), although these achievements were achieved through very different policies. In the first period, nominal exchange rate stability was supported by consistent policies: between 1897 and 1913, the debt-to-GDP ratio fell from around 130% to less than 80%. In the second period, however, the nominal exchange rate was subject to repeated depreciations to compensate for the relatively high inflation. The fiscal deficit, which in the 1950s and 1960s had averaged below 3%, rose to 13% between 1973 and 1978. From 1970 to 1978, government spending nearly doubled, from 28% to 52% of GDP. In the 1970s and 1980s, wages grew at an annual rate higher than labour productivity, exceeding 10% for the first and only time since the birth of united Italy.

The undervaluation of the lira in the first decades after unification did not translate into sustained economic growth due to the many challenges that Italy was facing: political instability, industrial backwardness, the need to import essential goods. The country was still under construction and lacked the infrastructure and expertise needed to take full advantage of the competitive advantage offered by the undervalued currency.

Italy's interwar economic growth was held back by a combination of internal and external factors. The contraction in international trade, combined with domestic economic policies

characterized by rigid labour markets and protectionism, has contributed to prolonging a period of slow growth.

Since the 1990s, Italy's economic growth has been weaker than that of its main trading partners, in a context of marked overvaluation of the lira/euro. Excessive wage rigidity and low productivity growth, aggravated by the 2008 crisis, have further eroded the competitiveness of the Italian economy.

In summary, Italian economic growth was more vigorous in periods when the currency was competitive, i.e. undervalued or in equilibrium. However, undervaluation alone has not been enough to ensure sustained growth. The results obtained confirm the hypothesis that a competitive currency is a favourable condition, but not a guarantee, for economic growth.

5. The causality of relationship

"The Real Exchange Rate and Economic Growth: Revisiting the Case Using External Instruments" - Habib, Mileva and Stracca (2016)

The article examines the relationship between the real exchange rate (RER) and economic growth, seeking to improve estimates over previous studies through the use of external tools to address the problem of causality. The basic idea is that, while many studies suggest that an underestimation of the RER can promote economic growth, establishing a causal relationship between these two variables is complex and risks being distorted by endogenous factors.

The analysis is based on a large sample of about 150 countries, considering non-consecutive five-year periods in the post-Bretton Woods era (1970-2010). As with the work of Di Nino, Eichengreen and Sbracia (2011), the dependent variable is GDP per capita growth. In addition, the regressed real exchange rate to GDP per capita is used as a proxy for the fundamental value of the exchange rate, in order to take into account the Balassa-Samuelson effect. In order to compare the behaviour of countries with different exchange rate regimes, the classification of Reinhart and Rogoff (2004) is adopted, which allows to identify countries with fixed exchange rates and those with flexible exchange rates. After an initial estimation with OLS, the model is re-estimated using instrumental variables to address potential endogeneity issues in the explanatory variables.

The model used is as follows:

$$\Delta y_{it} = \alpha_i + \lambda_t + \beta RER_{it} + \delta R_{it} + \zeta z_{it-1} + \varepsilon_{it} \qquad (7)$$

The growth of real GDP per capita (y) is a function of the bilateral real exchange rate against the dollar, the nominal short-term interest rate (R) and a set of controls (z). The national interest rate is included to control the indirect effects of monetary policy on growth through the real exchange rate.

In regressions, net capital inflows are also checked to ensure the validity of the tool used in the analysis. For the instrument used to be valid, capital flows must be exogenous to economic growth. If this were not true, the estimate would be skewed due to a correlation between the instrumental variable and the error term. In addition, the study by Blanchard et al. (2015) argues that interventions by monetary authorities in foreign exchange markets are able to mitigate the effects of excessive appreciation of the national currency, caused by large capital inflows; For this reason, the growth rate of foreign exchange reserves is used as a proxy for exchange rate interventions.

Table 12 shows the main results obtained using the OLS method.

	(1) Baseline	(2) Advanced	(3) Excluding advanced	(4) Pegs	(5) Floats	(6) REER	(7) Overval. RER
Real exchange rate (RER) vs. USD	-0.177	0.972	0.208	-1.037	1.086		
	(0.475)	(1.880)	(0.546)	(0.735)	(0.918)		
Real effective exchange rate (REER)						0.057	
						(0.526)	
Overvaluation of RER vs. USD							-0.665
							(0.476)
De jure financial openness (t-1)	0.217*	-0.156	0.371**	0.221	0.324	0.238*	0.273*
	(0.128)	(0.207)	(0.154)	(0.143)	(0.341)	(0.127)	(0.156)
Monetary policy rate	0.001***	-0.071	0.001***	-0.024	0.001***	0.001***	0.001***
	(0.000)	(0.041)	(0.000)	(0.026)	(0.000)	(0.000)	(0.000)
Net capital inflows to GDP	0.158***	-0.017	0.169***	0.174***	0.013	0.158***	0.188***
	(0.041)	(0.055)	(0.040)	(0.038)	(0.071)	(0.041)	(0.047)
Initial GDP per capita level	-5.793***	-11.063***	-5.420***	-5.692***	-5.989***	-5.756***	-7.139***
	(0.660)	(1.565)	(0.633)	(0.853)	(1.292)	(0.642)	(0.894)
Inflation	-0.022***	0.014	-0.019***	0.007	-0.026***	-0.023***	-0.018***
	(0.006)	(0.060)	(0.005)	(0.036)	(0.007)	(0.006)	(0.005)
Saving ratio	0.151***	0.191***	0.142***	0.157***	0.070*	0.150***	0.163***
	(0.036)	(0.059)	(0.036)	(0.042)	(0.042)	(0.036)	(0.038)
Trade openness	0.030***	0.024	0.030***	0.031***	0.061***	0.029***	0.039***
	(0.007)	(0.016)	(0.008)	(0.009)	(0.016)	(0.007)	(0.008)
Observations	742	158	584	492	204	742	526
Countries	146	23	123	129	70	146	97
R2	0.438	0.685	0.459	0.488	0.383	0.440	0.524

Notes. The table reports OLS estimates with robust standard errors clustered by country, including time and country fixed-effects. The sample period is 1970-2010, using non-overlapping 5-year averages. ***,**,* indicate statistical significance at the 1, 5, 10 per cent level. See Table 1 for a description of the variables.

Table 12: Real per capita GDP growth. Source: Habib, Mileva and Stracca (2016)

Estimates do not support the existence of a causal link between the real exchange rate and economic growth, as can be seen from the lack of significance of all real exchange rate coefficients. As for the other variables, financial openness, commercial openness and capital inflows have a significant positive effect in the basic specification and other specifications, suggesting that greater financial and commercial openness and greater capital inflows can foster growth.

To verify the causality of the relationship, the regression is also estimated through the method of instrumental variables, the results of which are shown in *table 13*.

	(1) Baseline	(2) Advanced	(3) Excluding advanced	(4) Pegs	(5) Floats	(6) REER	(7) Overval. RER
Real exchange rate (RER) vs. USD	-11.712***	-7.094	-14.743**	-12.239***	8.104		
	(4.008)	(15.551)	(6.972)	(4.275)	(10.100)		
Real effective exchange rate (REER)						-9.721**	
						(4.941)	
Overvaluation of RER vs. USD							-11.222***
							(3.691)
De jure financial openness (t-1)	0.693***	0.200	0.538**	0.647**	-0.141	0.759**	0.664***
	(0.240)	(0.698)	(0.270)	(0.278)	(0.735)	(0.308)	(0.224)
Monetary policy rate	0.000	-0.046	0.000	-0.025	0.002	0.000	0.000
	(0.001)	(0.082)	(0.001)	(0.050)	(0.001)	(0.001)	(0.001)
Net capital inflows to GDP	0.174***	0.010	0.188***	0.188***	-0.028	0.191***	0.168***
	(0.033)	(0.074)	(0.036)	(0.030)	(0.098)	(0.041)	(0.032)
Initial GDP per capita level	-2.716*	-8.641	-2.375	-2.389	-8.996**	-5.252***	-4.405***
	(1.392)	(5.318)	(1.789)	(1.607)	(4.571)	(1.248)	(0.923)
Inflation	-0.034***	-0.058	-0.036**	-0.049	-0.033***	-0.021*	-0.032***
	(0.013)	(0.149)	(0.017)	(0.070)	(0.012)	(0.012)	(0.012)
Saving ratio	0.129***	0.219***	0.125***	0.156***	0.142	0.132***	0.123***
	(0.033)	(0.083)	(0.036)	(0.037)	(0.105)	(0.036)	(0.032)
Trade openness	0.000	0.015	-0.011	0.004	0.112	0.017	0.001
	(0.014)	(0.025)	(0.023)	(0.016)	(0.074)	(0.015)	(0.014)
Observations	731	158	573	471	177	522	731
Countries	140	23	117	109	46	94	140
F first stage	9.478	0.539	4.101	11.74	0.548	3.841	10.35
J test (p-value)	0.822	0.171	0.288	0.096	0.822	0.064	0.830
CLR test H_0: β=0 (p-value)	0.000	0.360	0.004	0.001	0.346	0.005	0.000

Table 13: Real per capita GDP growth. Source: Habib, Mileva and Stracca (2016)

In column (1) of the baseline model, the RER coefficient is significantly negative (-11.721), indicating that a real depreciation of the exchange rate is associated with higher GDP per capita growth. The negative effect is also robust in subsets, such as in countries excluding advanced economies (column 3) and in countries with peg exchange rate regimes (column 4). In these cases, the negative coefficient becomes even more pronounced, suggesting that the effect of RER depreciation on growth is particularly strong in developing countries and countries with tighter exchange rates.

The exchange rate has a significant impact only for countries with fixed exchange rate regimes.

Financial openness and capital inflows continue to have a positive and significant impact on economic growth. On the other hand, the initial level of GDP per capita has a significant negative effect, supporting the convergence hypothesis, i.e. that countries with a lower initial level of GDP tend to grow faster. Similarly, inflation also has a negative effect on growth in all specifications, consistent with economic theory that associates high inflation with economic uncertainties and distortions.

Table 14 aims to deepen the analysis of the impact of the real exchange rate on GDP per capita growth, in particular considering the presence of possible nonlinearities in the relationship between the two variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Appreciations	Depreciations	Appreciations & Peg	Depreciations & Peg	Excl. large depreciations	Excl. large appreciations	Excl. large appr. & depr.
Real exchange rate (RER) vs. USD	-5.197*	-7.839*	-3.573	-10.113	-8.815***	-13.001***	-10.000***
	(3.104)	(4.753)	(3.381)	(9.494)	(3.023)	(4.156)	(3.198)
De jure financial openness (t-1)	0.265	0.864***	0.130	1.199**	0.594***	0.760***	0.662***
	(0.206)	(0.277)	(0.228)	(0.493)	(0.195)	(0.242)	(0.202)
Monetary policy rate	-0.000	-0.009	0.001	-0.504*	0.000	0.000	0.000
	(0.001)	(0.011)	(0.025)	(0.276)	(0.001)	(0.001)	(0.001)
Net capital inflows to GDP	0.075**	0.069***	0.085**	0.070***	0.175***	0.156***	0.160***
	(0.036)	(0.021)	(0.040)	(0.023)	(0.033)	(0.029)	(0.029)
Initial GDP per capita level	-4.283***	-4.431***	-4.167***	-1.182	-3.636***	-2.416*	-3.289***
	(1.167)	(1.379)	(1.370)	(2.789)	(1.147)	(1.386)	(1.150)
Inflation	-0.025***	-0.023**	-0.016	0.100	-0.022**	-0.026**	-0.021**
	(0.009)	(0.011)	(0.094)	(0.113)	(0.009)	(0.012)	(0.009)
Saving ratio	0.096***	0.071	0.093***	0.058	0.141***	0.090***	0.107***
	(0.028)	(0.043)	(0.033)	(0.051)	(0.031)	(0.029)	(0.027)
Trade openness	0.006	0.028*	0.019	-0.003	0.007	0.006	0.009
	(0.012)	(0.015)	(0.013)	(0.029)	(0.012)	(0.014)	(0.011)
Observations	386	295	259	161	704	696	672
Countries	115	92	86	55	140	131	130
F first stage	17.00	4.567	12.99	1.268	13.15	9.532	11.93
J test (p-value)	0.654	0.908	0.013	0.115	0.991	0.393	0.536
CLR test H_0: β=0 (p-value)	0.072	0.058	0.153	0.214	0.001	0.000	0.000

Table 14: Robustness of IV estimates: non-linearity. Source: Habib, Mileva and Stracca (2016)

In general, the results suggest a negative effect of the real exchange rate on growth, i.e. an appreciation of the exchange rate tends to reduce economic growth. The effect is more pronounced for depreciations than for appreciation, suggesting a certain asymmetry in the relationship. Columns (5) and (7) in *Table 14* exclude observations of extreme changes in appreciation and depreciation to analyse the effect of more stable changes in the exchange rate. Column (5) excludes large changes in appreciation and still shows a negative impact of the RER on growth (-8,815), but slightly less intense than in situations of extreme appreciation. This suggests that extreme overvaluations are particularly harmful.

The results obtained show that real exchange rate depreciations have a positive and statistically significant effect on economic growth, especially in developing countries and countries with fixed exchange rate regimes. Although the effects of appreciation are less obvious, the analysis suggests that large write-downs can have a particularly strong impact on growth momentum. In general, the analysis confirms Rodrik's (2008) thesis that the impact of the exchange rate on growth is more pronounced in developing countries, where economies are more sensitive to changes in relative prices.

6. The relationship in OECD countries

Currency Devaluation and Output Growth: An Empirical Evidence from OECD Countries" - Kalyoncu, Artan, Tezekici and Ozturk (2008)

The article explores the effect of currency devaluation on economic growth in OECD countries. Through the application of unitary root and co-integration tests to data from 23 OECD countries, from 1980 to 2005, the aim is to verify the existence of a long-term relationship between devaluations and the level of production.

The model used to study the relationship is very simple: the level of output (Y) is modelled as a function of the real exchange rate (rer).

$$logY_t = \alpha + \beta logrer_t + u_t \quad (8)$$

The Augmented Dickey-Fuller test assesses the stationarity of the time series of the 23 countries. With the exception of Mexico and the United Kingdom, the time series of the other countries are integrated in the same order, so the Engle-Granger test is used to assess the presence of cointegration. Table *15* shows the results.

Country	*Constant*	*log RER*	*ADF*
Australia	0.631 (30.43)	0.702 (5.24)	-0.155 [1]
Austria	1.149 (10.53)	– 0.341 (3.43)	-1.792 [1]
Belgium	1.547 (9.93)	– 0.146 (1.46)	-0.743 [4]
Canada	0.838 (55.45)	0.950 (7.24)	-0.567 [3]
Denmark	0.628 (8.33)	– 0.231 (2.58)	-1.178 [4]
Finland	-0.067 (0.88)	0.372 (3.39)	-1.675 [4]
France	1.294 (18.69)	0.014 (0.16)	-0.662 [2]
Germany	0.953 (160.79)	0.160 (6.36)	-1.970 [0]
Hungary	2.680 (10.22)	– 0.491 (4.41)	-1.840 [4]
Italy	1.130 (3.20)	– 0.140 (1.28)	-0.924 [1]
Japan	4.836 (40.50)	– 0.570 (9.95)	-1.440 [0]
Korea	-0.383 (0.33)	1.099 (2.82)	-1.118 [5]
Netherlands	0.300 (8.26)	– 0.141 (1.18)	-0.187 [2]
New Zealand	2.358 (95.10)	0.254 (2.39)	-0.272 [3]
Norway	0.067 (0.47)	0.420 (2.48)	0.657 [4]
Poland	3.525 (31.07)	– 0.451 (2.34)	-2.261 [4]
Portugal	3.983 (12.43)	– 1.039 (7.42)	-1.928 [0]
Spain	2.922 (10.00)	– 0.286 (2.13)	-0.122 [2]
Sweden	0.381 (5.15)	0.320 (3.73)	-2.049 [0]
Switzerland	0.017 (1.60)	– 0.274 (4.60)	-1.627 [1]
Turkey	2.394 (66.15)	– 0.346 (2.00)	-2.464 [2]

Notes: Number inside the parentheses next to each coefficient is the absolute value of the *t*-satistics. Number inside the square bracket next to ADF statistic is number of lags in the ADF test. Lag order was determined using the Schwarz criterion (BIC). ADF test for a unit root in the model no constant/ no trend. The critical values for ADF test are -1.94 and -1.61 at %5 and %10 statistical level respectively.

Table 15: Engle-Granger cointegration results. Source: Kalyoncu, Artan, Tezekici and Ozturk (2008)

Cointegration tests show that there is a long-term relationship in Germany, Poland, Sweden and Turkey at the significance level of 5%, and in Austria, Finland, Hungary, Portugal and Switzerland at 10%. The results show a clear heterogeneity in the impact of currency devaluation on output among the countries analysed. While in Austria, Hungary, Poland, Portugal, Switzerland and Turkey a statistically significant negative effect is observed, in Finland, Germany and Sweden the effect is positive and equally significant.

Finally, an error-correction test is carried out for those countries for which the model variables have been co-integrated; the results are visible in *table 16.*

Country	$\Delta Log\ RER_t$	$\Delta Log\ RER_{t-1}$	EC_{t-1}	R^2
Austria	-0.031 (-0.77)	-0.002 (-0.04)	-0.028* (-2.46)	0.91
Finland	-0.076*** (-1.72)	0.019 (0.43)	-0.015 (-1.32)	0.85
Germany	-0.019 (-0.79)	-0.056** (-2.37)	-0.052 (-1.37)	0.33
Hungary	0.250*** (1.87)	0.090 (0.67)	0.112** (2.34)	0.86
Poland	-0.046 (-0.45)	0.099 (1.04)	-0.111** (-2.10)	0.95
Portugal	-0.022 (-0.36)	-0.048 (-0.80)	-0.006 (-0.52)	0.05
Sweden	-0.029 (-0.76)	-0.031 (-0.78)	-0.005 (-0.44)	0.94
Switzerland	-0.013 (-0.82)	0.027*** (1.71)	-0.006 (-0.68)	0.11
Turkey	-0.420* (-4.21)	0.067 (0.62)	-0.095 (-1.38)	0.97

Notes: Number inside the parentheses next to each coefficient is the absolute value of the *t*-satistics. Lag order was determined using the Schwarz criterion (BIC). *, **, *** indicate significance at the 1%, 5% and 10% levels, respectively.

Table 16: Error-correction test results. Source: Kalyoncu, Artan, Tezekici and Ozturk (2008)

The results indicate that currency devaluation does not have a unique effect on economic growth. Some countries, such as Hungary and Switzerland, benefit from a devaluation, while others, such as Finland, Germany and Turkey, are negatively affected.

In general, the impact of the devaluation on production is contradictory depending on the time horizon considered. In the long term, a negative effect prevails, while in the short term, more heterogeneous results are observed, with some countries experiencing growth and others contracting.

7. The relationship in South Asian countries

"Currency Devaluation and Output Growth: An Empirical Analysis for South Asian Economies" - Shafiq-ur-Rehmana, Muhammad Atiq-ur-Rehman and Muhammad Shahid Maqbool

Shafiqur Rehman, Muhammad Atiqur Rehman & Muhammad Shahid Maqbool (2021) use the same method as Kalyoncu, Artan, Tezekici and Ozturk to estimate the relationship for South Asian economies. After carrying out the cointegration test for Bangladesh, Bhutan, India, Nepal and Pakistan, only for the first there is fragile evidence of cointegration in the long and short term. The study concludes that currency devaluation has not proved to be an effective tool to promote economic growth and improve the trade balance in the SAARC countries. The nature of exports to these countries, mainly consisting of raw materials and products with low added value, are the main reason for this result.

CHAPTER 2

1. Transmission channels

Changes in exchange rates, such as the depreciation or appreciation of a currency, have significant and often complex effects on various aspects of a country's economy, from trade competitiveness to inflationary dynamics to overall economic growth. The tightening of monetary policy to combat inflationary pressures resulting from a devaluation may lead to a reduction in domestic demand and slow growth. In summary, exchange rate changes act on a multiplicity of economic channels, each of which can have opposing effects, making it necessary to carefully and balanced manage macroeconomic policies. The way in which these fluctuations are transmitted within an economy is through a series of transmission channels, each of which impacts a specific sector or particular economic variables.

In this context, the analysis of transmission mechanisms offers an in-depth understanding of how economic policies, currency changes and international dynamics can affect the stability and development of an economy. Correctly interpreting these mechanisms is essential to maximise the benefits of exchange rate changes and minimise risks, ensuring sustainable economic growth in the long term.

2. Export competitiveness

One of the most important transmission channels is export competitiveness. The literature has often examined how a depreciated exchange rate can boost export competitiveness, contributing to economic growth. A currency depreciation makes a country's exports cheaper and more competitive in international markets and could boost foreign demand. This increase in foreign demand could, in turn, boost domestic output, boost employment, and improve the trade balance. Conversely, the appreciation of a currency can reduce the competitiveness of exports, with negative consequences for growth and employment in export-oriented sectors.

The paper "*The Real Exchange Rate and Economic Growth*" by Dani Rodrik (2008) explores how an undervalued real exchange rate can stimulate economic growth, particularly in developing countries. Rodrik argues that periods of exchange rate undervaluation are associated with faster economic growth in these countries, thanks to the promotion of the competitiveness of the tradable goods sector, especially the industrial sector. To prove his hypothesis, he examines data from 188 countries and 11 five-year periods from 1950–54 to 2000–04. To estimate the relationship between undervaluation and economic growth, use the following regression:

$$growth_{it} = \alpha + \beta \ ln \ RGDPCH_{i,t-1} + \delta \ UNDERVAL_{it} + f_i + f_t + u_{it} \qquad (1)$$

Where:

RGDPCH indicates the initial income per capita

UNDERVAL is the undervaluation index constructed from the real exchange rate and adjusted for the Balassa-Samuelson effect.

Table 1 below shows the regression results:

Table 1. Baseline Panel Regressions of Economic Growth on the Undervaluation Measure[a]

	Sample					
Independent variable	*All countries, 1950–2004* 1-1	*Developed countries,[b] 1950–2004* 1-2	*Developing countries, 1950–2004* 1-3	*All countries, 1950–2004* 1-4	*Developing countries, 1950–79* 1-5	*Developing countries, 1980–2004* 1-6
ln initial income	−0.031***	−0.055***	−0.039***	−0.032***	−0.062***	−0.065***
	(−6.67)	(−6.91)	(−5.30)	(−7.09)	(−3.90)	(−4.64)
ln *UNDERVAL*	0.017***	0.003	0.026***	0.086***	0.029***	0.024***
	(5.21)	(0.49)	(5.84)	(4.05)	(4.20)	(3.23)
ln initial income × ln *UNDERVAL*				−0.0087***		
				(−3.39)		
No. of observations	1,303	513	790	1,303	321	469

Source: Author's regressions.

a. The dependent variable is annual growth in GDP per capita, in percent. Observations are five-year averages. All regressions include time and country fixed effects. Countries with extreme observations for *UNDERVAL* (Iraq, Laos, and North Korea) have been excluded from the samples. Robust *t* statistics are in parentheses. Asterisks indicate statistical significance at the *10 percent, **5 percent, or ***1 percent level.

b. Developed country observations are those with real GDP per capita exceeding $6,000.

Table 1: regression results. Source: Rodrik (2008)

1. *In Initial income*

Regarding initial income: the coefficient is negative and statistically significant in all specifications, indicating that a higher level of initial income (RGDPCH) is associated with slower economic growth. This is consistent with convergence theory, according to which countries with lower incomes tend to grow faster than richer countries.

For example: In specification 1-1 (all countries from 1950 to 2004), the coefficient is -0.031 with a t-statistic of -6.67. This suggests that a 10% increase in starting income is associated with a reduction in economic growth of about 0.31%.

2. *ln UNDERVAL*

- All countries (1-1 and 1-4): The coefficient is positive and significant in these specifications, suggesting that greater real exchange rate undervaluation is associated with higher economic growth. For example, in the 1-1 specification, the coefficient of 0.017 implies that an exchange rate undervaluation of 10% is associated with higher economic growth of 0.17%.

- Developed Countries (1-2): Here, the coefficient is not significant, suggesting that in developed countries, the undervaluation of the exchange rate does not have a major impact on economic growth.

- Developing countries (1-3, 1-5, 1-6): In these specifications, the coefficient is positive and significant, indicating that the undervaluation of the exchange rate has a positive effect on economic growth in developing countries. This effect is observed both in the period 1950-79 (specification 1-5) and in the period 1980-2004 (specification 1-6).

3. *ln lnitial income x ln UNDERVAL*

Coefficient (specification 1-4): In this specification, the interaction between initial income and exchange rate undervaluation is negative and significant (-0.0087). This suggests that the positive effect of exchange rate undervaluation on growth diminishes as initial income increases. In other words, the undervaluation of the exchange rate has a greater impact on growth in countries with lower incomes.

The paper emphasizes that tradable sectors, i.e. those that produce internationally tradable goods and services (such as manufacturing), are crucial for economic development. Rodrik suggests that an undervaluation of the exchange rate makes these sectors more profitable, increasing profits and investment. This leads to an expansion of the industrial sector, which is essential for long-term economic growth.

Undervaluation acts as a second-best mechanism for overcoming institutional and market failures that hinder growth in developing countries. Rodrik explores two main explanations:

- Institutional weakness: tradables suffer the most due to institutional weakness that limits bargaining and legal capacity in poor countries.
- Market failures: Undervaluation alleviates problems of coordination and information in markets, allowing countries to diversify their economies and improve their production structure.

Rodrik concludes that, in developing countries, maintaining an undervalued exchange rate can be an effective economic development strategy, but one that requires careful management to avoid unwanted side effects such as inflation or over-reliance on exports. Rodrik stresses that exchange rate policy must be accompanied by other structural reforms to be sustainable in the long run.

However, not all economists agree with what emerged from Rodrik's work. The possibility that a devaluation leads to a reduction in production has been known to international economists for many years, although theoretical studies on the subject are rare. In the model proposed by *Meade (1951)*, which influenced most theoretical analyses

of devaluation until the mid-1960s, it was believed that a contraction could occur only if the Marshall-Lerner condition was not met, an eventuality generally ruled out by hypothesis. As early as 1949, however, Hirschman had highlighted the need to change this condition in the presence of an initial trade deficit, arguing that, in such circumstances, a devaluation made a contractionary effect more likely. In this regard, the article "Contractionary effects of devaluation" by Krugman and Taylor is very interesting, in which the two authors show in a formal model how devaluation can cause a contraction of economic activity, more precisely to fall in output. By diverting income to individuals with a high marginal propensity to save, devaluation can generate an excess of savings and a consequent reduction in the Keynesian multiplier. The result is a contraction in production and imports. The authors refer to three circumstances in which a devaluation leads to a reduction in economic activity:

- When a country with a trade deficit devalues its currency, the prices of imported goods rise, eroding the purchasing power of domestic consumers. At the same time, exports become more competitive, increasing the real income of other countries. This imbalance in income flows leads to an increase in foreign savings and a contraction in domestic aggregate demand, resulting in lower imports. The magnitude of these effects is directly proportional to the initial level of the trade deficit.
- If foreign trade is initially in equilibrium, devaluation raises the prices of traded goods relative to domestic ones, creating windfall profits for exporting and import-competing industries. Devaluation, in a context of wage rigidity, generates a vicious circle: the increase in the costs of intermediate imports pushes up domestic prices, eroding real wages and weakening domestic demand. Given the

higher marginal propensity to save profits over wages, devaluation, by generating a redistribution of income from workers to entrepreneurs, leads to a contraction in aggregate demand and imports. The extent of the consequent economic contraction depends on the difference between the propensities to save of the two classes.

- When there are proportional taxes on the value of international trade, the devaluation, in addition to its effects on the distribution of income between sectors, generates an increase in tax revenues. Since the state, in the short run, tends to save the additional revenue entirely, there is a further redistribution of income from the private sector to the public sector

Effects of a devaluation.

	$e = 1.0$	$e = 1.25$	% change
Nominal *GDP* at factor cost	127.7	124.5	−2.5
GDP at constant prices	127.7	119.8	−6.2
Price of home goods	1.47	1.575	+7.1
Output of home goods	102.7	96.0	−6.5
Trade balance in dollars	−10.7	−9.0	+15.9
Trade balance in domestic money	−10.7	−11.2	−4.7

Table 2: Effects of a devaluation on output and trade balance. Source: Krugman, Taylor (1978)

Table 2 shows the effects of a 25% devaluation of the domestic currency against the foreign currency. The three columns represent respectively the pre-write-down scenario,

the post-write-down scenario and the percentage change of each variable following the write-down.

Interesting is the change in GDP at constant prices, which contracted by 6.2 percentage points. This represents a significant reduction in real output as a result of devaluation, consistent with the thesis of the contractionary effect of devaluation, where devaluation reduces purchasing power and overall output.

The prices of household goods increased from 1.47 to 1.575, an increase of 7.1%. Devaluation leads to higher domestic prices, mainly due to the increase in the cost of imports and the potential passing on of these costs to locally produced goods.

The production of household goods fell by 6.5%. This result reflects the fact that devaluation, although theoretically stimulating exports, can reduce output due to reduced domestic demand, higher production costs (more expensive imports) and redistribution of income.

The trade balance in dollars improved, from -10.7 to -9.0, an improvement of 15.9%. This suggests that the devaluation has indeed improved the trade balance in terms of foreign currency, as exports have become more competitive and imports have fallen.

However, the trade balance in domestic currency worsened slightly, from -10.7 to -11.2, a reduction of 4.7%. This is because, although the balance in dollar terms improves, in terms of domestic currency the increase in import prices reduces the net value of the trade balance in national currency.

These results confirm Krugman and Taylor's hypothesis that, in some cases, devaluation can lead to a reduction in real income and domestic output, especially when structural imbalances such as an initial trade deficit or heavy dependence on imports exist.

3. Imports and inflation

As already shown, the effects of a devaluation are not always beneficial: it can also increase import costs, leading to inflationary pressures through exchange rate pass-through. This mechanism describes the degree to which changes in the exchange rate are reflected in the domestic prices of imported goods, affecting the overall price level and the purchasing power of consumers. Inflation, in fact, can erode consumers' spending power and increase production costs, curbing economic growth. However, if substitution of imports by domestic goods is possible, domestic production could grow, offsetting the negative effects.

Rudiger Dornbusch's 1987 article, entitled "*Exchange Rates and Prices*", examines the relationship between exchange rates and domestic prices, with a particular focus on how exchange rate pass-through can affect inflation and, consequently, economic growth. The proposed analysis is based on a partial equilibrium model that assumes an exogenous movement of the nominal exchange rate (the author is well aware that this hypothesis does not represent reality, but it is a useful approximation to understand the changes in relative prices). The interaction between this variation and the rigidity of the money wage generates a specific cost shock for firms operating in both domestic and foreign markets, necessitating sectoral price adjustment. The price response to cost shocks can be analysed through two models: the Cournot model, which focuses on competition between firms producing homogeneous goods, and the Dixit-Stiglitz (1977) model, which emphasizes product differentiation and consequent imperfect substitutability. Analysing the Cournot model, it can be seen that foreign suppliers are at an advantage when their marginal cost is reduced due to exchange rate appreciation. This leads to an increase in foreign sales and a contraction in domestic production, resulting in lower overall prices. In the Dixit-

Stiglitz model, on the other hand, each firm sets its own price with a constant markup compared to the costs of production and prices respond more rigidly to costs, influenced by the exchange rate.

In general, the change in prices in response to a change in the exchange rate is influenced by:

- The relative number of foreign companies compared to domestic ones.
- The share of imports in total sales. An increase in the exchange rate leads to a fall in domestic prices, but less than proportionately, depending on the competitiveness of the market.

Dornbusch outlines exchange rate pass-through as a complex and variable mechanism, dependent on multiple economic and structural factors. Understanding how and when changes in exchange rates affect prices is crucial for effective economic policy formulation, especially in the context of inflation or disinflation. Dornbusch emphasizes that, for many countries, the degree of pass-through is incomplete and subject to delays, making forecasting of exchange rate effects more difficult to manage.

Studies conducted in the 1990s revealed an unexpected phenomenon: changes in exchange rates seemed to have a surprisingly limited impact on consumer prices, even in contexts of high economic openness.

The economist John Brian Taylor, in 2000, with his article entitled "*Low inflation, pass-through and the pricing power of firms*" tries to provide an explanation for this phenomenon. Specifically, the author analyses whether lower inflationary volatility is related to a decrease in the ability of firms to pass on their costs to prices, including those

induced by external shocks such as changes in exchange rates. Empirical studies converge in demonstrating a lower sensitivity of consumer prices to exchange rate fluctuations; a phenomenon that was particularly evident in the United Kingdom, Sweden and Brazil during the 1990s. In the United Kingdom, the sharp exchange rate changes in 1992 and 1996 did not significantly alter the inflationary trend, which stood at around 2.5%. Comparing McCarthy's results in his paper "*Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies"* for the different OECD countries, a clear picture emerges: in the period 1983-1998 the exchange rate pass-through decreased significantly compared to the period 1976-1982, in all the countries considered, although with varying intensity.

Although there is no consensus, some economists argue that the decline in corporate market power played a crucial role in keeping inflation low in the United States at the turn of the millennium.

During the Humphrey-Hawkins hearing on February 23, 1999, Alan Greenspan, former chairman of the Federal Reserve, argued:

"In the current economic setting, businesses sense that they have lost pricing power and generally have been unwilling to raise wages any faster than they can support at current price levels. Firms have evidently concluded that if they try to increase their prices, their competitors will not follow, and they will lose market share and profits. Given the loss of pricing power, it is not surprising that individual employers resist pay increases."

This analysis reflects a structural change in business behaviour compared to previous years, when inflation was higher, and costs were easily passed on to consumers.

Pricing is often seen by companies as a strategic decision, influenced by the perception of having some market power. This perception depends on the specificity of the product, its substitutability with other goods and the probability of competitive reactions. In order to analyse changes in firms' market power, a model is needed that captures the impact of three types of shocks on pricing decisions: changes in production costs, changes in the prices charged by competitors and changes in market demand.

We hire a company that offers a differentiated good, such that consumer preferences place a positive value on that differentiation. In this context, the individual demand curve is linearly dependent on the difference between the price of the good in question and the average price of competing goods. The demand curve is as follows:

$$y_t = \varepsilon_t - \beta(x_t - p_t) \qquad (2)$$

y_t represents production, *xt* the price of the individual good, *pt* the average price of other firms, and $\mathcal{E}t$ an exogenous demand shock. Let's assume that the firm decides the price every quarter, and that price remains valid for the entire following year. In this case, the price *p* is an arithmetic average of the prices set by the four groups of firms in the previous four periods.

Since *ct* is the average cost, the expected profit of the firm for the four periods in which the price fixed in period *t* is applied is given by:

$$\sum_{i=0}^{3} E_t(x_t y_{t+i} - c_{t+i} y_{t+i}) \quad (3)$$

Substituting the equation (2) in (3) and differentiating with respect to x_t we get:

$$x_t = 0.125 \sum_{i=0}^{3} (E_t\, c_{t+i} + E_t\, p_{t+i} + E_t\, \varepsilon_{t+i}/\beta) \quad (4)$$

Note that the coefficient of 0.125 implies that a unit increase in the price at other firms (p_t through p_{t+3}) and in average cost (c_t through c_{t+3}) results in the same unit increase in the representative firm's price x_t. If only c_t through Ec_{t+3} rise by one unit, then the price x_t will rise by 0.5 units. A firm's propensity to increase its price in response to an increase in marginal cost depends on the perception of the duration of that increase. Similarly, the firm's reaction to an increase in competitors' prices is influenced by the estimation of the continuation of that increase. Firms' pricing decisions are influenced by expectations about the persistence of external shocks. A currency depreciation, if considered transitory, will lead to less passing on of the increase in costs to selling prices.

4. Foreign direct investment flows

Another important transmission channel concerns foreign direct investment (FDI) flows. A stable or undervalued exchange rate can attract more foreign investment, advanced technologies, and know-how by improving a country's productive capacity. Conversely, currency appreciation can reduce a country's attractiveness to foreign investors by limiting the flow of capital needed for economic development. Blonigen (1997) in his article "Firm-specific assets and the link between exchange rates and foreign direct investment" analyzes how FDI responds to exchange rate changes. Chart 1 shows: on the left the total foreign acquisitions and multilateral exchange rate while on the right the Japanese acquisitions and the dollar-yen exchange rate.

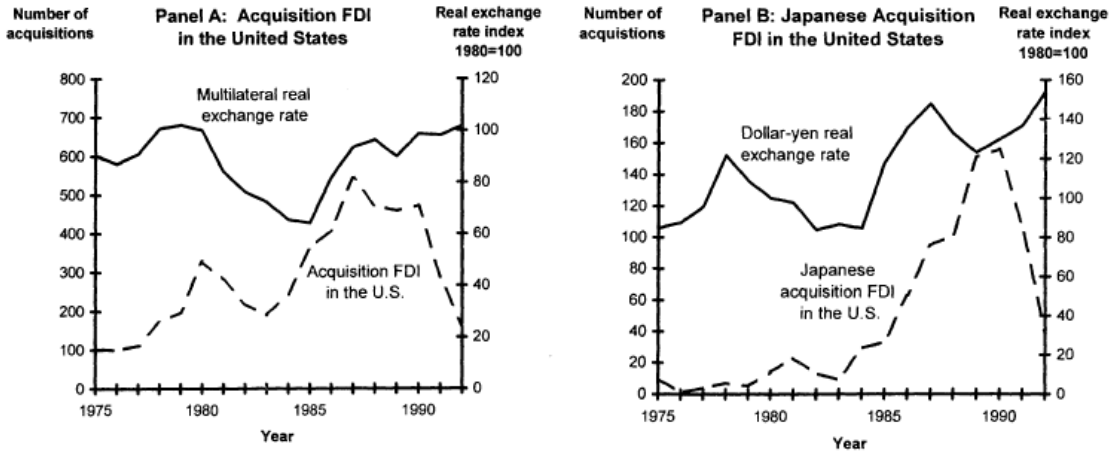

Figura 3: Numbers of acquisitions in the US by all foreign countries and by Japan, 1975-1992. Source: Blonigen (1997)

Traditional economic theory does not support the hypothesis of a relationship between exchange rate changes and FDI, however, the reduction in comparative costs and the increase in transaction costs do not seem to be able to explain such a rapid increase in

foreign acquisitions. Numerous empirical studies, including Froot and Stein (1991), have revealed a relationship between the depreciation of the dollar and higher FDI in the United States. At the same time, many economists have traditionally rejected the idea of a direct link between exchange rates and FDI, based on a seemingly solid argument. According to this logic, the value of an asset does not depend on its nominal price in foreign currency, but on the rate of return it generates. Therefore, a change in the exchange rate should not affect investment decisions, as both the price and the return of the asset vary proportionally. However, the reality is more complex, as many assets are exposed to currency risk, especially those with a high export or import component.

Froot and Stein (1991) are among the first to relate exchange rate fluctuations to FDI flows. The two show how information asymmetries make external financing more expensive than domestic financing, generating a mechanism through which changes in exchange rates can trigger FDI flows.

Blonigen (1997) believes that if both foreign and domestic firms have equal opportunities to buy certain assets in the domestic market, but different chances of obtaining returns in foreign markets, then currency fluctuations can affect relative valuations. When the domestic firm does not have the same access to foreign markets, this asymmetry can cause exchange rate movements to affect the level of acquisitions of these assets by foreign firms in different ways. To illustrate this concept, consider a scenario where a U.S. target firm has a valuable innovation that can increase productivity. If a Japanese firm and a U.S. firm are competing to acquire this target, exchange rate fluctuations can influence the relative valuations. A weaker dollar would make the acquisition more attractive for the Japanese firm, as its gains would be converted into yen, while the U.S. firm's valuation would remain unaffected.

The goal of the foreign firm is to maximize profits: where $II_F = P^*Y_F - W^*X_F P^*$ is the price of the product in foreign currency, *YF* is the output, and $W*$ are the costs of variable inputs *XF*. The production function is expressed as $Y_F = F(X_F, Z)$ where Z represents fixed capital (non-variable inputs, such as assets or firm-specific capital).

The foreign firm minimizes costs by choosing *XF* inputs, and then maximizes profit by determining the optimal level of *YF production. Minimum costs are expressed as* $C(Y_F;\ W^*, Z)$, which depend on input costs and fixed assets.

The foreign firm can increase fixed capital *Z* by acquiring a U.S. firm, thereby improving its productive capacity, i.e $F(X_F, Z_1) > F(X_F, Z_0)$. The difference in profits before and after the acquisition is represented by *ΔΠ,* which reflects the potential gain from the capital increase.

The bilateral exchange rate (*e*) between the dollar and the foreign currency influences the foreign firm's ability to acquire assets in the United States. The foreign firm has a reserve price (*RF)* in dollars, which is influenced by the exchange rate and the return on safe alternative investments (*p*). For comparison, the U.S. firm has the same production technology and fixed capital, but maximizes profit in dollars and faces dollar-denominated (*p,w*) prices.

The foreign firm's dollar reserve price can be expressed as:

$$R_F \leq \frac{(ep^*)\,\Delta II_F\,(1, \frac{w^*}{p^*}, Z^0, Z^1)}{1+\rho} \qquad (5)$$

Assuming identical production technology and capital stock, the U.S. firm's reservation bid is:

$$R_{US} \leq \frac{p\Delta II_{US}\left(1,\frac{w}{p}, Z^0, Z^1\right)}{1+\rho} \quad (6)$$

The two equations just presented highlight how a depreciation of the dollar gives the foreign company a competitive advantage in acquisitions. The weaker domestic currency makes buying U.S. assets less expensive in terms of the foreign firm's currency, allowing it to bid higher than domestic firms. The model suggests that there is a time frame during which the foreign firm can benefit from the depreciation of the dollar, before the markets fully adjust. This advantage is temporary, as the Law of one price ends to rebalance prices in the long run. However, in the short to medium term, the foreign firm can use this opportunity to make profits, especially if the depreciation specifically affects the sector in which the target asset operates.

The proposed model indicates that the probability that a foreign firm will acquire a US company is a function of the reserve prices of the two firms: foreign and domestic; This can be written as:

$$Prob\ (foreign\ acquisition) = f(RER_{it})$$

RER indicates the real exchange rate in year *t* for enterprises operating in sector *i*.

The equation is modified to make it compatible with the available data, thus becoming:

$$Prob = f(RER_{it}, \Omega_{it}, \Psi_{it}\ )$$

The variables and represent, respectively, the breadth of supply of potential targets and the strength of demand for acquisitions in sector $\Omega_{it}\Psi_{it}$ i at year t. The equation models the probability distribution of the total number of foreign acquisitions at the sector level, limiting the possible values to non-negative integers.

Table 3 presents the results of the econometric study that analyses the determinants of the number of Japanese acquisitions in the United States between 1975 and 1992, differentiating between manufacturing and non-manufacturing sectors. Each column shows the results of different statistical models (Negative Binomial and NEGBIN Random Model) used to estimate the number of Japanese acquisitions in the United States. The dependent variable is the number of Japanese acquisitions in the United States; independent variables include economic factors that could influence these acquisitions, such as the real exchange rate, Japanese GDP growth, and the value added of the industrial sector.

Variables	Dependent variable: Japanese acquisitions in the United States, 1975–1992					
	All industries		Nonmanufacturing		Manufacturing	
	Negative binomial	Random NEGBIN	Negative binomial	Random NEGBIN	Negative binomial	Random NEGBIN
Constant	−6.948*** (0.328)	−4.559*** (0.346)	−7.252*** (0.562)	−4.718*** (0.642)	−6.431*** (0.425)	−3.272*** (0.758)
Real exchange rate	0.219** (0.570)	0.851* (0.480)	0.382 (1.124)	0.385 (0.802)	2.292*** (0.692)	1.548** (0.657)
Domestic acquisitions	0.068*** (0.008)	0.017*** (0.002)	0.059*** (0.018)	0.009* (0.006)	0.079*** (0.009)	0.042*** (0.008)
Industry value-added share	1.086*** (0.196)	2.334*** (0.397)	0.737 (0.449)	1.235* (0.736)	0.316*** (0.046)	0.526*** (0.117)
Japan real GDP growth	0.174*** (0.046)	0.140*** (0.039)	0.236*** (0.073)	0.200** (0.088)	0.120* (0.067)	0.129*** (0.046)
Japan stock market	0.779*** (0.292)	0.900*** (0.283)	0.719 (0.535)	0.534 (0.542)	0.785* (0.415)	0.761** (0.307)
U.S. protection	0.159 (0.332)	0.688 (0.519)	−0.807 (10.801)	0.124 (13.339)	−0.230 (0.227)	−0.180 (0.281)
Time trend	0.193*** (0.014)	0.188*** (0.012)	0.226*** (0.023)	0.206*** (0.023)	0.158*** (0.016)	0.164*** (0.015)
Alpha	4.592*** (0.311)		11.381*** (1.096)		1.182*** (0.213)	
a		4.333*** (0.671)		3.753*** (0.778)		18.762 (12.180)
b		0.458*** (0.057)		0.390*** (0.067)		1.009*** (0.249)
Log-likelihood (LogL)	−1900.9	−1676.5	−871.5	−754.2	−949.7	−894.4
Restricted LogL[a]	−3020.1	−2441.3	−1501.2	−1237.1	−1464.3	−1204.2
Likelihood ratio test[b]	2238.4	1529.6	1259.4	965.8	1029.2	619.6
Observations	6498	6498	3978	3978	2520	2520

Table 3: determinants of number of Japanese acquisitions in the United States, 1975-1992. Source: Blonigen (1997)

- Constant: The term constant represents the estimated average value of acquisitions when all other variables are zero. It is negative in all columns. For example, for the "All industries" model, the coefficient of the constant in the Random NEGBIN model is -4.559, which suggests that without other factors, one would expect fewer acquisitions than the baseline average.

- Real exchange rate: A positive coefficient means that an increase in the real exchange rate (i.e. a devaluation of the dollar against the Japanese yen) is associated with an increase in the number of Japanese acquisitions. For example, in the case of all sectors, the coefficient in the random model is 0.851, implying that a devaluation of the dollar increases the likelihood of acquisitions.

- Japan real GDP growth: A growing Japanese GDP is positively correlated with the number of acquisitions, with coefficients of 0.140 for the Random NEGBIN model in the case of all sectors. An increase in Japan's GDP favours the ability of companies to make acquisitions abroad.

- Industry value-added share: This factor is one of the most relevant. In the "All industries" column, the coefficient is 2.334 for the NEGBIN Random model, indicating that sectors with a higher share of added value attract a higher number of acquisitions.

- U.S. protection: U.S. market protection (e.g., tariff barriers) has a slightly negative effect on acquisitions in the manufacturing sector, with a coefficient of -0.230 for the NEGBIN model.

The time trend is significant across industries, indicating that the number of acquisitions has increased over time. For example, in the NEGBIN model for "All industries", the coefficient is 0.188, indicating that for each time unit (e.g. every year), the number of acquisitions grew by 18.8%.

5. Stimulation of domestic demand

The exchange rate also has a direct effect on domestic demand through the process of import substitution. When a currency depreciates, imported goods become more expensive, incentivizing consumers to turn to domestic products. This stimulus to domestic production can benefit key sectors of the economy and create jobs. However, in economies that are heavily dependent on imports, such as those that import energy or capital goods, rising costs can dampen growth.

Palazzo (2024) examines the role of the real exchange rate in promoting episodes of import substitution using the case of the large and sustained depreciation of the real exchange rate in Argentina after the end of the convertibility regime.

Following the deep economic crisis of 2001-2002 and the consequent devaluation of the peso, Argentina experienced a period of sustained economic recovery. This process was accompanied by a significant depreciation, in real terms, of the Argentine peso, which shrank by about 50% compared to the previous decade, improving the competitiveness of Argentine exports and stimulating economic growth. The author hypothesizes that a significant and sustained depreciation of the real exchange rate should stimulate import substitution, especially in sectors that heavily use non-tradable inputs, such as labor. This is due to the increased competitiveness that comes with it; In economies rich in natural resources and with a shortage of labor, this effect could lead to a diversification of production. However, the presence of existing production capacities amplifies the effect of an exchange rate appreciation, making import substitution in those sectors more likely. To test these hypotheses, an algorithm is used which, through a quantitative analysis of

deviations from historical trends, identifies sectors characterized by a marked reduction in imports, indicative of substitution processes.

However, changes in national income significantly influence the level of imports, so it is necessary to isolate the component of imports that is not explained by these changes. To this end, the income elasticity of imports is estimated and income-related effects are subtracted. Subsequently, strict criteria are applied to identify cases where real substitution episodes have occurred. The analysis focused on the period 2003-2008, a time frame characterized by a stable and competitive real exchange rate, considered sufficient to allow investments to mature and translate into an increase in the supply of tradable domestic goods. To avoid distorting the results, the financial crises of 2002, characterized by a collapse in imports of about 50%, and 2009, triggered by the subprime crisis, were excluded from the analysis period.

Of the 130 sectors analyzed, classified as ISE (import substitution episodes), which represent 30% of the total and absorb 28.8% of total imports (43,182 million dollars), there was a 13% reduction in volume of imports compared to the period 1996-2001. This contraction was particularly marked in the primary products and low-tech manufacturing sectors, with declines of 34% and 28% respectively. The decrease in imports in these sectors is a generalized phenomenon, which manifests itself both in terms of quantities adjusted for the income effect and in terms of absolute quantities. On the contrary, in the non-ISE sectors there was a 17% growth in imports. Under the (simplifying) assumption of international price taking and the law of the single price, a depreciation of the real exchange rate increases the revenue in national currency of firms producing tradable goods. The presence of non-tradable costs, mainly related to labour, amplifies the positive

effect on profitability, especially in labour-intensive sectors. As a result, depreciation stimulates domestic production of tradable goods. Sectors with higher labour use tend to react more sensitively to the incentive offered by a more competitive real exchange rate. In a resource-rich country, this would lead to diversification from sectors with comparative advantages. However, imports are unlikely to be substituted in sectors without pre-existing production capacities. Hausmann and Klinger (2006) and Hidalgo et al. (2007) highlight how countries tend to develop new production activities in sectors that share skills, technologies or resources similar to those in which they already have a comparative advantage, facilitating the process of transition and economic growth. Therefore, in addition to profitability, the production structure must be able to take advantage of these improvements.

	(1) ISE b/se	(2) ISE b/se	(3) ISE b/se	(4) ISE b/se	(5) ISE b/se	(6) ISE b/se	(7) ISE b/se
ln (labor intensity)	.0625* (.0331)	.0725** (.0314)	.0794** (.0312)	.0687** (.0314)	.0798** (.0314)	.0825** (.0334)	.0743** (.0331)
Agnostic relatedness		.1199*** (.0282)	.1248*** (.0290)			.1246*** (.0284)	.1190*** (.0276)
RCA 1996			−.0128 (.0771)	−.0051 (.0716)	−.0106 (.0783)	−.0166 (.0668)	
Agnostic relatedness (RCA ≥p50)				.1329*** (.0240)			
Agnostic relatedness (RCA ≥1)					.1190*** (.0306)		
Constant	.3101*** (.0924)	.1542 (.0953)	.1434 (.0961)	.1807* (.0923)	.1469 (.0972)		
Lall Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	444	444	441	441	441	441	444
R2	.024	.060	.064	.084	.058	.056	.051
Model	LPM	LPM	LPM	LPM	LPM	Probit (dy/dx)	Probit (dy/dx)
vcetype	Robust	Robust	Robust	Robust	Robust	Robust	Robust

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors between parenthesis.

Table 4: Determinants of import substitution events. Source: Palazzo (2024)

Table 4 shows the results of the econometric analysis carried out to determine which factors affect import substitution events, focusing on variables such as sectoral labour intensity and past capacities. The results seem to support the assumptions made: labor intensity is positively and significantly correlated with import substitution events in almost all models. The *Agnostic relatedness* variable measures the degree of technological similarity between sectors. A positive and significant value suggests that technologically similar industries are more likely to experience replacement events. The *1996 RCA variable,* on the other hand, measures the comparative advantage revealed by a country in a given sector in 1996. The analysis of the RCA index provides an indication, although not entirely confirmed by statistical tests, in favor of the hypothesis that a competitive exchange rate can favor diversification from traditional sectors.

In order to assess the robustness of the results obtained, a series of robustness exercises are conducted over different periods. In particular, periods characterized by an overvalued real exchange rate are analyzed to verify whether the transmission mechanisms identified during the SCRER period (stable and competitive real exchange rate) remain stable. The absence of a meaningful relationship between episodes of import substitution and the real exchange rate in these periods would constitute further evidence to support the hypothesis that the mechanisms identified are specific to the SCRER period.

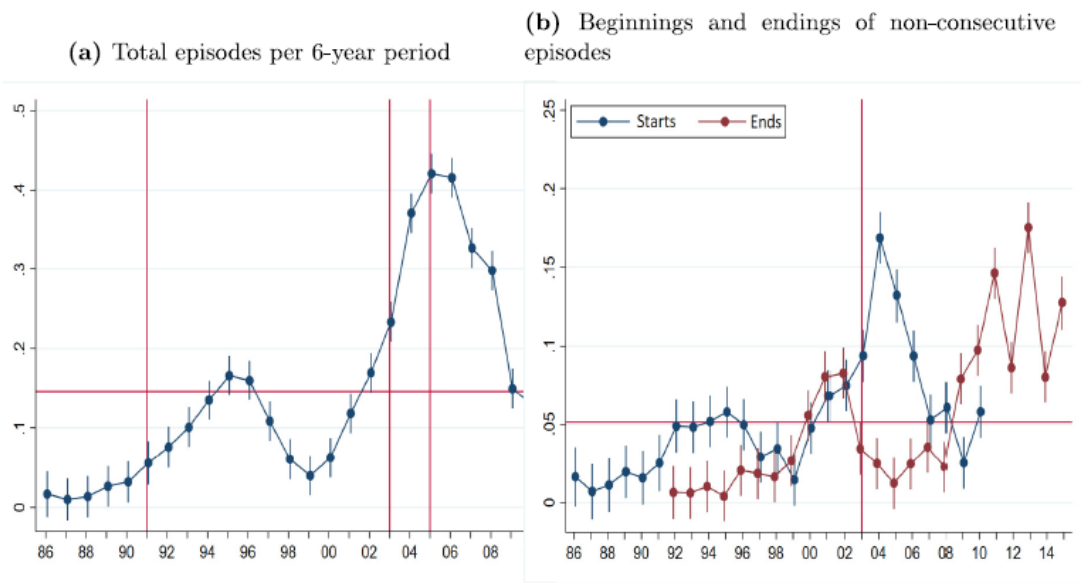

Fig. 1: Percentage of industries with ISE. Source: Palazzo (2024)

Figure 1a shows the frequency of sectors with ISEs over each six-year period. The horizontal axis indicates the beginning of each six-year period, while the vertical axis indicates the frequency or number of episodes that occur during that period. The graph shows a general trend of increasing the number of episodes until it reached a peak around the year 2004, followed by a decrease. Significant fluctuations in the number of episodes are observed from one period to the next, suggesting that the phenomenon in question does not occur constantly but is subject to variation over time. In 2004-2008, the total frequency of episodes reached its maximum (about 0.4), signalling a major wave of import substitution.

Figure 1b provides more detailed information about the behaviour of episodes over time, showing the beginning and end of non-consecutive episodes separately. In 2004 there was the highest percentage of incidents of import substitution initiated, a figure that stands out clearly compared to other years. At the same time, the conclusion of these episodes is in

line with expectations: with the appreciation of the real exchange rate (RER) and the slowdown of the economy, the performance of sectors that produce goods that can be replaced by imports is starting to deteriorate, showing a decline in the ability to compete in the domestic market.

6. Balassa – Samuelson effect

The Balassa-Samuelson hypothesis is based on the existence of a positive correlation between real exchange rate and economic growth. Fast-growing countries are therefore expected to typically experience real exchange rate appreciation relative to slow-growing countries. This theory has been subjected to numerous empirical tests and has proved to be relevant in some countries, for example, Japan and Korea. Bela Balassa's 1964 article, "*The Purchasing Power Parity Doctrine: A Reappraisal*", revisits the purchasing power parity (PPP) doctrine, discussing its "absolute" and "relative" interpretations. Balassa, in his work, aims to empirically verify the validity of PPP, considering possible deviations from this theory and trying to identify factors that can influence the relationship between exchange rates and price levels. The author refers to two interpretations of PPP, one absolute and one relative. According to absolute PPP, if we compare the baskets of goods of two countries, the cost of these baskets, expressed in a common currency, should be the same. This would imply that the exchange rate would have to accurately reflect the difference in price levels between the two countries. The relative interpretation of PPP states that while not necessarily equal to equilibrium exchange rates, changes in exchange rates should move in the same direction and proportional to changes in relative prices between countries. The article is based on some fundamental assumptions:

- Law of the single price: An identical good, in the absence of transport costs and trade barriers, should have the same price in all markets.
- Representative basket of goods: It is possible to construct a basket of goods that is representative of the average consumption of a country.
- Presence of an untraded good (services)

The prices of tradable goods tend to balance through international trade. However, non-tradable services and goods (such as local services) are not subject to the same international competitive pressure, and therefore their price can vary significantly between countries.

In countries with higher productivity, especially in tradable goods sectors, the level of wages is higher. However, because productivity in non-tradable goods sectors tends to be lower, higher wages are reflected in higher prices for services. This creates a difference in overall pricing levels between countries with different productivity levels.

Since the prices of tradable goods balance between countries, but the prices of non-tradable goods (such as services) remain higher in high-productivity countries, this means that the level of general prices (which includes both tradable and non-tradable goods) is higher in the most productive countries. The purchasing power parity, defined as the ratio between the price level of two countries, will therefore be lower than the equilibrium exchange rate.

Consequence: The equilibrium exchange rate, which reflects the actual value of currencies based on trade and investment flows, will be higher than the ratio of price levels, since non-tradable goods do not participate in the same degree of international price adjustment.

Thus, economies with higher productivity levels in tradable sectors tend to have currencies that appear to be "overvalued" according to PPP.

Balassa concludes that the rigorous application of PPP, especially in absolute form, may be wrong for determining equilibrium exchange rates. However, it does provide useful guidance for assessing whether a currency is undervalued or overvalued.

Paul Samuelson comes to the same conclusion in his article "*Theoretical Notes on Trade Problems*" del 1964. He employs mathematical equations to formalize the relationships between wages, prices, and productivity across countries, and then derives conclusions about how exchange rates and price levels are determined. Samuelson concludes that in countries with higher overall productivity (especially in traded goods), the relative price of non-tradables (services) will be higher. This leads to deviations from purchasing power parity, as the higher productivity in traded goods results in higher wages, which are then reflected in the higher cost of non-tradables.

7. Effect on trade balance

A change in the real exchange rate can affect a country's trade balance, as it changes the competitiveness of domestically produced goods and services compared to those produced abroad. Tunaer Vural in his article "*Effect of Real Exchange Rate on Trade Balance: Commodity Level Evidence from Turkish Bilateral Trade Data"* assesses the short- and long-term effects of real exchange rate changes on the trade balance of 99 Turkish industries, covering more than a decade from with data, from 2002 to 2014. According to economic theory, when the Marshall-Lerner condition is met, a devaluation should improve the trade balance. However, the British devaluations of 1967 and the US devaluations of 1971 were followed by a deterioration in the trade balance, despite the Marshall-Lerner condition being met. This phenomenon can be explained through the J curve. The J-curve effect highlights this dynamic: in the short run, the immediate impact of a depreciation is often a deterioration in the trade balance, as the price effect outweighs the quantity effect. In the longer run, as price adjustments occur and export volumes increase, the quantity effect becomes dominant, leading to an improvement in the trade balance.

Following Rose and Yellen (1989), a trade balance model is constructed for a sector *i* in which the trade balance depends on domestic industrial production (Y_{TR}), the industrial production of the main trading partner (Y_f) (Germany in this case) and the real exchange rate.

$$lnTB_{i,t} = \alpha + \alpha_1 lnY_{TR,t} + \alpha_2 lnY_{f,t} + \alpha_3 lnRER_t + \varepsilon_t \quad (8)$$

Equation (8) is then expressed through an error-correction model in order to capture short-run dynamics as well.

$$\Delta lnTB_{i,t} = \beta + \sum_{j=1}^{n} \beta_1 \Delta lnTB_{i,t-j} + \sum_{j=0}^{n} \beta_2 \Delta lnTB_{TR,t-j} + \sum_{j=0}^{n} \beta_3 \Delta lnTB_{f,t-j} + \sum_{j=0}^{n} \beta_4 \Delta lnRER_{t-j} + y_1 lnTB_{t-1} + y_2 Y_{TR,t-1} + y_3 Y_{f,t-1} + y_4 RER_{t-1} + \vartheta_{i,t} \qquad (9)$$

Table 5 shows estimates of short- and long-run coefficients for each of the 96 ITC industry categories. A positive sign of the coefficient indicates an inverse relationship between exchange rate depreciation and the trade balance. A negative sign indicates a direct relationship.

For 20 categories, those in which Turkey tends to have a comparative advantage in production and exports, an initial deterioration in the trade balance is followed by an improvement in the long run. For 15 categories, however, the phenomenon seems to be reversed with a worsening of the trade balance in the long term; these sectors are those in which Turkey is heavily dependent on imports.

SITC Commodity Groups	Short-run Coefficients for RER				Long-run Coeff. for RER
	$\Delta \ln RER_t$	$\Delta \ln RER_{t-1}$	$\Delta \ln RER_{t-2}$	$\Delta \ln RER_{t-3}$	$\ln RER$
01-Live Animals	0.75***	1.92***	-2.12**	-1.83*	-0.35***
02-Meat and Edible Meat Offal	0.41				0.08
03-Fish,Crustaceans, Molluscs, Aquatic Invertebrates nes	-0.11	0.09			0.19
04-Dairy Products, Eggs, Honey, Edible Animal Product new	-0.33**	-0.29**	-0.67		0.23
05-Products of Animal Origin, nes	1.02	0.88			-0.11
06-Live Trees, Plants, Bulbs, Roots, Cut Flowers etc	-0.45**				-1.22**
07-Edible Vegetables and Certain Roots and Tubers	1.11***	0.70***	0.93**	-1.02*	-2.34***
08-Edible Fruit, Nuts, Peel of Citrus Fruit, Melons	0.67	0.81	1.11		-3.12***
09-Coffee, Tea, Mate and Spices	-0.45				0.14
10-Cereals	-3.02				-1.76**
11-Milling Products, Malt, Starches, Inulin, Wheat Gluten	0.88	0.23	0.65	0.52	-1.13***
12-Oil Seed, Oleic Fruits, Grain, Seed, Fruit, etc, nes	0.95**	-0.25			-2.19***
13-Lac, Gums, Resinsin,Vegetable Saps and Extracts nes	-2.02*				-3.12**
14-Vegetable Plaiting Materials, Vegetable Products nes	-1.44				-2.30***
15-Animal, Vegetable Fats and Oils, Cleavage Products, etc	-0.99***				-1.92***
16-Meat, Fish and Seafood Food Preparations new	-1.11				-2.44***
17-Sugars and Sugar Confectionery	0.12	0.55**	0.91***	1.11**	-1.87***
18-Cocoa and Cocoa Preparations	-0.66				-1.31
19-Cereal, Flour, Starch, Milk Preparations and Products	0.58***	1.59***	1.39***	-0.98**	-2.49***

Table 5: short-run and long-run coefficient estimates. Source: Tunaer Vural (2015)

CONCLUSIONS

Throughout this thesis, we have analyzed both the transmission channels through which the exchange rate influences growth and the empirical evidence in the economic literature, with a focus on development contexts and regional dynamics. In this concluding section, we summarise the main findings of the research, highlighting the key contributions of the literature and the implications for economic policies.

Results and Literature Contributions

The article by Jinzhao Chen (2012) showed how real exchange rate appreciation can be associated with faster growth in Chinese provinces, pointing out that the positive effects of the exchange rate on growth are not uniform but depend on the regional economic environment. Chen showed that although exchange rate devaluation can foster growth through increased exports, in China's more developed provinces, the appreciation had a positive effect in terms of productivity, stimulating the reallocation of resources to non-exporting sectors.

The importance of the real exchange rate for economic stability was also emphasised by Aguirre and Calderón (2005), who explored the relationship between exchange rate misalignment and economic performance. Their study confirmed that excessive misalignment, whether in the form of over- or undervaluation, can hinder economic growth, with effects more pronounced in developping countries. In particular, Aguirre and Calderón's analysis suggests that although moderate undervaluation can be beneficial, excessive devaluation can generate macroeconomic instability and inflationary pressures.

In the second chapter, we examined the transmission channels through which the real exchange rate affects economic growth. Among these, the most relevant are export competitiveness, attraction of foreign direct investment (FDI), inflation control and overall macroeconomic stability.According to Dani Rodrik (2008), an undervalued real exchange rate can act as a catalyst for economic growth in developing countries by stimulating the competitiveness of the manufacturing sector. His study showed that developing countries particularly benefit from a competitive exchange rate, mainly because this bosts employment and increases the returns of the export sector. This result has been confirmed by numerous empirical analyses and remains a key benchmark for understanding the importance of the exchange rate in promoting economic growth.

These findings riterate the need for exchange rate policies that avoid significant misalignments and keep the real exchange rate in line with the country's economic fundamentals..

Implications for Economic Policy

The results presented in this thesis have several implications for economic policies. First, exchange rate management policies must be carefully designed to balance the benefits of a competitive currency with the risks associated with excessive devaluation. The literature shows that an exchange rate policy favouring a moderately undervalued currency can be beneficial for developing countries, where it is crucial to sustain export growth and attract foreign investment. However, excessive or prolonged undevaluation can generate adverse effects, as shown by Aguirre and Calderon (2005), where excessive devaluation led to a slowdown in growth.

Moreover, empirical evidence suggests that relative exchange rate stability can create a favourable investment environment, particularly for emerging economies, where exchange rate instability can discourage long-term investment. Such stability is particularly relevant in capital- and technology-intensive sectors, which depend on FDI inflows to develop.

A further relevant aspect concerns the effect of the exchange rate on the trade balance and growth. As shown by the analysis of Di Nino, Eichengreen and Sbracia (2011) in the Italian context, a competitive exchange rate had positive effects on growth in Italy during periods of intense economic development, such as the post-war period. This study highlights how a well-calibrated exchange rate policy can foster export competitiveness and stimulate domestic aggregate demand.

General Conclusion

The findings of the literature confirm that an effective exchange rate policy requires a balanced approach that carefully considers domestic economic conditions and the international environment. Real exchange rate management, if well calibrated, can help promote balanced and sustainable economic growth, but it requires continuous attention to signs of misalignment. In general, as pointed out by Eichengreen (2007), a competitive and stable exchange rate can facilitate economic growth, but it is not a sufficient condition. Other economic policies must be implemented to fully exploit the currency's potential.

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