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Monetary Policy, Fundamentals and Risk in Brazil

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Abstract

We present a model that incorporates the effect of monetary policy on the real interest rate and the marginal product of capital of a small open economy. The actions of the Central Bank, by smoothing interest rates and reacting to price or exchange rate changes, are shown to augment the negative effects of risk aversion on the stock of capital *per unit* of effective labor. Standards of living will not grow in response to a more liberalized market in comparison to a similar risk-free economy with higher savings, everything else remaining constant. On the empirical side, we provide some data that supports the underlying equation of our model. We also discuss the negative dynamics effects on growth if risk premium is time varying and if the behavior of monetary authorities is not constant.

Keywords: Income, Risk, Balance of Payments Constraint.

JEL Classification codes: F43, F15, E43

Resumo

O artigo apresenta um modelo que incorpora o efeito do risco de default e da política monetária sobre o produto marginal do capital e a taxa de juros real de uma economia aberta. O prêmio de risco reduz o estoque de capital por unidade de trabalho efetivo em comparação com uma economia em que o risco é igual a zero, enquanto que a prática de suavizar as taxas de juros nominais potencializa este efeito do risco. A economia com taxas de risco mais altas apresenta uma renda *per capita* menor, *ceteris paribus.* O artigo mostra que não é o que as autoridades monetárias fazem com as taxas de juros, mas como elas fazem que afeta o lado real da economia de uma maneira persistente. O trabalho também discute o efeito negativo sobre a dinâmica do crescimento , desde que o prêmio de risco varie com o tempo e que o comportamento das autoridades monetárias não seja constante.

Palavras-chave: Crescimento Econômico, Risco, Neutralidade da Moeda. Área ANPEC: Crescimento, Desenvolvimento Econômico e Instituições

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Introduction

Although the debate regarding the effects of monetary policy on output seems so settled in the mainstream economics that there is a reduced space for contribution, Keynesian demand constrained models have been successful in terms of predicting long-term income growth rates. Challenging the current view on the long-term impact of money is extremely difficult since economists are taught, from undergraduate courses, that the long run real and monetary dichotomy holds. It is in the short run, according to the bulk of theoretical and empirical literature, that lays an open field for research. Although, this conclusion could be robust, there is at least one important reason for concern in the case it is not correct. If monetary policy leaves long run effects on output, economies under strict programs of stabilization might be severely affected. In other words, if money is not neutral, nominal interest rates set by a monetary policy committee could cause long-lasting effects to an economy.

There is now a relevant amount of work showing that a monetary problem can affect the real side of the economy on the long-run. For example, there is an extensive empirical and theoretical literature developed from the paper of Thirlwall (1979)[2]. Mostly, authors have been worried with testing the Balance of Payments (BoP) constraint model. The fit of the simple model is so impressive that it has long ago gained the status of a law. Current research focus on investigating whether income elasticities are indeed structural and the direction of causality between income and exports. Our concern in this paper is different: assuming that monetary problems have impacted on long run growth via its constraint on demand, then what could be the channel through which money affects the real side of the economy? Put in another way, what would be the market mechanism triggering income adjustment in an open(ed) economy? On the other hand, we also want to understand why the recent lifting of the foreign constraint in Brazil, given by high export growth, has not been reflected in higher income growth. We investigate if the actual behavior of monetary authorities, for example smoothing interest rates and reacting to exchange rate changes, is connected to this fact.

The paper contributes to the literature of demand constrained models (or export led growth models) by investigating the channel through which monetary problems affects growth. As one of the main determinants of income in Keynesian analysis is the real interest rate, we turn our attention to the understanding of its dynamics. Because we are specifically worried about income growth differentials, we focus on the equilibrium real interest rate differential between an emerging open economy and the rest of the world. Furthermore, we attempt to make a link between monetary (for example, BoP) problems, real interest rate differentials and developments on the supply side of the economy.

The rest of the paper is divided as follows: in the first part we motivate the analysis

[2]Other works such as Blackburn (1999), Stadler (1990), King et al. (2002) and Fatas (2000) are examples of how money could affect income in the context of endogenous growth.

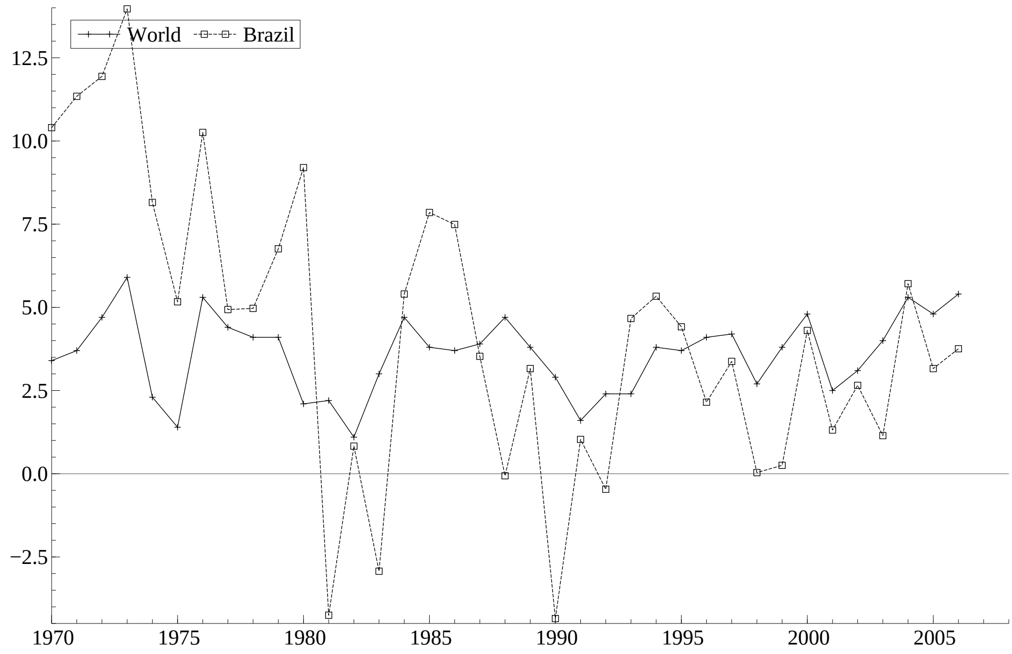
and present a modification of the benchmark Solow (1956) model incorporating risk. Furthermore, we include the possibility that the memory of the nominal interest rate process, as explained by the smoothing component of interest rate setting, enlarges the conditional risk impacting on both standards of living and income growth (the latter when risk is time-varying). The empirical approach is shown in the following session and, finally, we conclude.

The Brazilian Case

At the extent to which the assumption of perfect markets hold, arbitrage and speculation guarantee that flows of capital equalize real returns across economies. Under free capital mobility and risk neutral agents, governments should not worry about financing a current account deficit. Marginal differences in nominal interest rates would trigger an infinite capital flow movement which would close the BoP gap. In other words, the whole world would be in the same savings function. Hence, after the financial liberalization, we should not expect any binding current account constraint but, on the other hand, higher income growth. This would be especially true in countries that were BoP constrained in the past. Furthermore, the equalization of real interest rates and the marginal product of capital would follow from the more liberalized economy. In practice however, we had seen a different path for some of the variables. *Ex ante* and *ex post* real interest rates are higher in Brazil. On the other hand, as observed in Graph 1, Brazilian income growth in the last thirty years was below its historical level. Graph 2 shows that Brazil's recent growth experience is also poorer than the world's.

One can reasonably assume that sticky prices and risk aversion are main features underlying the dynamics of emerging open-economies. Hence, the failures of these crucial frictionless market assumptions do not corroborate the predictions of the benchmark theory as put above. Moreover, the behavior of Central Banks has recently changed. The smoothing of interest rates and the reaction against price and exchange rate changes became predominant features of Brazilian monetary policy. We believe that this pattern of conduction has imputed persistence in the dynamics of real exchange rates which might have also impacted on equilibrium real interest rates and, thus on income growth differentials.

This could have been the case of Brazil in the last two decades. The economy passed through several monetary problems during the 1980s and 1990s, including periods of current account deficits and public account imbalances. Many shocks also impacted on the country's default risk premium. At the same time, Brazil had the worst average income growth rates since the 1950s. During the 1990s, markets were opened up to trade and financial flows, but the economy still faced low income growth and high real interest rates. In the 2000s the constraint on demand was relaxed via rising exports mainly due to faster development in the rest of the world. However, income growth has not yet risen to its historical levels. In fact, alongside the hike in real returns, average growth was smaller than in the 1980s, which can be seen in the table below. The table also shows that income



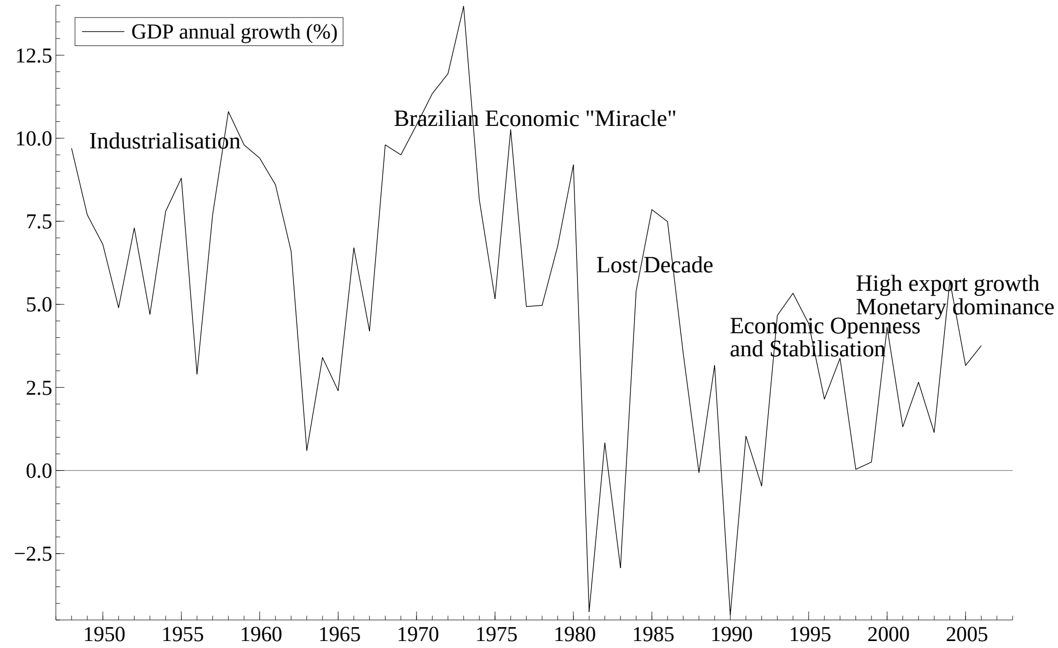
Graph 1: **GDP Growth: Brazil x World** Source: Ipeadata

per capita and capital *per* worker have been steadily decreasing.

Table 1. Average Growth (%)				
Variable	**1970s**	**1980s**	**1990s**	**2000s**
Income	8,78	3,02	1,64	3,11
Income *per capita*	5,87	1,08	0,05	1,63
Capital per Worker	4,82	-2,47	-2,73	-1,16

Source: averages calculated using data from IPEA, Institute of Applied Economic Research, Federal Government, Brazil.

The data shown above suggests that capital growth has been halted. From the production function, we know that output and thus income would also be impacted. These facts suggest a formal investigation of the connection between risk, monetary policy and the determinants of income in an opened economy. We present a model that shows how some monetary problems, for example, inertia in interest rate setting and a positive risk premium, are translated into a permanent decrease in standards of living when the open economy approaches the steady state. Furthermore, the model is developed to incorporate the finding of an autoregressive stationary (with a positive mean) real interest rate differential between an emerging economy like Brazil and the US. Our model is inspired on the idea of Thirlwall (1979) in which monetary problems can affect the real side of the economy through disequilibriums in the BoP. We show that the Keynesian features of our



Graph 2: **GDP Growth in Brazil** Source: Ipeadata

model, especially the slow adjustment of the real exchange rate (caused by sticky prices) and risk premium, in addition to the action of Central Banks can explain these facts in an extended Solow (1956) setting.

1 The model

Suppose that equilibrium in the assets market of an open-economy is given by the uncovered parity hypothesis under imperfect capital mobility and rational expectations, i.e.

$$i_t = i_t^* + \Delta s_{t+1} + \rho + v_t. \tag{1}$$

The variable i_t is the nominal interest rate paid on a one-period bond; S is the nominal exchange rate, defined as the domestic price of the foreign currency. The asterisk denotes an exogenous determined foreign variable or the rest of the world (which we will alternatively refer to as the larger economy or the foreign economy[3]); Lower case variables, except interest rates, are natural logarithms and Δ stands for the first difference. We assume that $s_{t+1}^e = s_{t+1} + v_t$, where v_t is a white-noise forecast error. Imperfect capital mobility is represented by the inclusion of ρ which prevents an infinite capital flow movement for small differences in expected returns.

[3]By larger economy, we mean that it started with a higher stock of capital per unit of effective labor (and, hence, a higher output *per capita*).

The hypothesis for Δs_{t+1} is $\Delta s_{t+1} = \pi_{t+1} - \pi^*_{t+1}$, where π is the inflation rate. Substituting the process for Δs_{t+1} in (1) to obtain

$$r_t = r^*_t + \rho + \upsilon_t, \tag{2}$$

where r_t is the real interest rate defined as $r_t = i_t - \pi_{t+1}$ and $\pi_{t+1} = p_{t+1} - p_t$; P is the price level.

Given that i^*_t is the interest that matures at time $t+1$, $i^*_t - \pi^*_{t+1}$ will be equal to the *ex post* foreign real interest rate defined as r^*_t. If there was perfect capital mobility, $\rho = 0$, and the following would hold in equilibrium, $r_t = r^*_t$. The latter expression is analogous to an international Fisher (1930) condition. Recent work, for instance, Singh & Banerjee (2006) shows that the estimated equilibrium is statistically significant and positive for some emerging markets (including Brazil). The finding of an equilibrium differential suggests that the hypothesis of perfect asset substitutability is strong and that uncovered interest rate parity under risk is a more reasonable assumption.

We incorporate the supply side of the economy by assuming that goods and services are produced according to a typical Cobb-Douglas production function

$$Y_t = K^\alpha_t (A_t L_t)^{1-\alpha}. \tag{3}$$

By typical we mean that there are constant returns to capital and labor and we also assume decreasing returns to the individual factors of production, i.e., $Y_{KK} < 0$, and $\partial\left(\frac{\partial Y}{\partial K}\right)/\partial K = Y_{KK}$. Technology and population growth are represented by g_a and n, respectively[4]. Standard investment theory predicts that $Y_K = r_t$ and $Y^*_K = r*$. In the absence of risk $Y_K = Y^*_K$, but under our assumptions we have

$$Y_K = Y^*_K + \rho. \tag{4}$$

Given (3), we can write

$$\alpha k^{\alpha-1}_t = \alpha^* k^{*\alpha^*-1}_t + \rho \tag{5}$$

where $k_t = (K_t/A_t L_t)$, $Y_K = \alpha\left(\frac{A_t L_t}{K_t}\right)^{1-\alpha} = \alpha k^{\alpha-1}_t$ and there is an analogous condition for the rest of the world.

The idea of the model that we present is that capital might not flow from the rest of the world to the small open economy because the higher return would also involve a higher risk. Hence, the predictions that financial openness would diminish the gap between standards of living would be conditioned on the existence of a idiosyncratic country risk. Hence, the risk term impacts on the difference between the stock of capital in both economies and, as shown below, on standards of living. That is, the probability of a country default will impact on the supply of capital **for investment**.

[4]This version of the production function aims to simplify the analysis. Other extensions, including the possibility of endogenous growth, could be considered. As the main purpose of the paper is to analyze whether differences in standards of living could be due to differences in risk given the slow adjustment of real exchange rates, this possibility is not taken into account in our model. This is left for future research.

Solving equation (5) while assuming, for simplification, that the small open economy and the rest of the world have similar reproducible capital shares gives

$$k_t = \left(\frac{1}{1 + \frac{\rho}{\alpha} k_t^{*1-\alpha}} \right)^{\frac{1}{1-\alpha}} k_t^*. \tag{6}$$

1.1 Monetary Policy

Another finding regarding the real interest rate parity hypothesis is that the real interest rate differential is not an independently distributed stochastic variable. In fact, its dynamics is well approximated by an autoregressive and stationary (weakly dependent) process that converges in distribution to normality with mean and variance

$$rid_t \xrightarrow{\mathrm{d}} N\left(\frac{\rho}{1-\gamma}, \frac{\sigma^2}{1-\gamma^2} \right),$$

where $rid_t = r_t - r_t^*$, γ is the first order autoregressive parameter and note that $t \to \infty$. Let us suppose that the constant term is an equilibrium risk ρ weighted by $1 - \gamma$. It is possible to see from the above and using (6) that as long as $|\gamma| < 1$, the memory of the real interest rate differential process will enlarge the effects of the risk premium over the stock of capital per unit of effective labor

$$k = \left(\frac{1}{1 + \frac{\rho}{1-\gamma} \frac{k_t^{*1-\alpha}}{\alpha}} \right)^{\frac{1}{1-\alpha}} k^*. \tag{7}$$

As far as there are decreasing returns to factor inputs, k^* will be constant and also k. If the term in parenthesis is also constant, the economy's growth rate will not be affected by either risk or γ. On the other hand, if risk is time varying and/or γ is not a fixed parameter then output growth will be explained not only by the growth of population and technology, but also by the term in parenthesis.

The explanation for an autoregressive real interest rate differential can be associated with departures from any of the hypothesis underlying the real interest rate parity. For example, price sluggishness is a typical friction that causes purchasing power parity to be violated in the short-run. The Dornbusch (1976) model of sticky prices, for example, shows that a real interest rate arises whenever the exchange rate overshoots. The overshooting model implies a correlation between the real interest rate differential and the real exchange rate [this is why this model is also known as the "real exchange / real interest rate differential model" which was later investigated by Frankel (1979) and Isaac & Mel (2001)] based on the hypothesis of a slower speed of adjustment in the goods market.

Benigno (2004) has shown that there is no proportional relationship between price stickiness and the persistence of real exchange rate when monetary shocks are white noise. On the other hand, Benigno (2004) emphasizes the role of the conduction of monetary policy, especially "smoothing" interest rates in generating serial correlation between real exchange rates across time. In monetary policy, smoothing is generally understood as the high serial correlation between nominal interest rates which arises from the actions of Central Banks in changing interest rates "in sequences of small steps in the same direction and reverse the direction of interest rate movements only infrequently" [Sack & Wieland (2000), p.205]. In other words, it is not what Central Banks do, but how they do monetary policy that might affect the real side of the economy. From the above, we can infer the following relationship

$$\Delta q_{t+1} = \gamma \Delta q_t, \tag{8}$$

where Q_t is the real exchange rate. We infer from Benigno (2004) that the parameter γ is due to the smoothing of nominal interest rates practiced by the Central Bank; $|\gamma| < 1$ and we assume a deterministic process in (8) for simplification. On the other hand, real exchange rates are linearly and proportionally related to real interest rate differentials. This can be seen by subtracting expected inflation differentials from (1) as below

$$rid_t = \Delta q_{t+1} + \xi_t + \varepsilon_t, \tag{9}$$

where ε_t is the rational expectations error (note that we are implicitly assuming a one-period maturity bond) and ξ_t is a time-varying risk premium. The last two equations imply that

$$rid_t = \gamma rid_{t-1} + \xi_t + (1-\gamma)\varepsilon_t. \tag{10}$$

The equilibrium risk was a constant ρ but now it is a time-varying process (hence, the equilibrium real interest rate differential will be conditioned on the value of the risk premium). Hence, this formulation suggests that the conduct of monetary policy slowing changing interest rates or not reacting to market conditions in the same speed of the change in economic fundamentals impacts on risk. The more conservative a Central Bank is, the closer γ is to one, and the stronger is the effect on the risk premium. Even more important is the fact that, if γ changes with time, then income growth is affected. In other words, if Central Banks do change their behavior along time, growth will be impacted. It must be stated that γ is limited by the upper barrier 1, if real interest rate differentials are to be stationary. Hence, the scope for increase is limited. However, a small change in the behavior of the monetary authorities can explain changes in the rate of growth for a sufficient long period, as it will be shown shortly.

1.2 Monetary Problems

Another interesting question refers to the impact of changes in monetary macroeconomic fundamentals on both standards of living and income growth. In order to explain this idea, we assume that the time-varying stationary risk follows an autoregressive distributed lag process and is related to a set of n economic fundamentals

$$\xi_t = \rho + \sum_{i=1}^{p} \alpha_i \xi_{t-i} + \sum_{j=1}^{n} \sum_{i=1}^{p} \beta_{ji} F_{t-i}^{(j)} + \mu_t, \tag{11}$$

where ρ is the constant degree of risk aversion (which would be related to the shape of institutions, rent seeking behavior and so on), $F^{(j)}$ is the j_{th} fundamental and the β_{ji} are parameters, p are the lags and μ_t is a white-noise error term. Equilibrium risk conditioned on the value of fundamentals is

$$\bar{\xi} = \frac{\rho + \sum_{j=1}^{n} \sum_{i=1}^{p} \beta_{ji} \bar{F}_{t-i}^{(j)}}{1 - \sum_{i=1}^{p} \alpha_i}, \tag{12}$$

where the upper bar stands for equilibrium values and stability conditions are assumed to hold. Equation (12) substituted in (10), solved for the equilibrium real interest rate differential and further substituted in (6) results

$$k_t = \left(\frac{1}{1 + \frac{\bar{\xi}}{1-\gamma_t} \frac{k_t^{*1-\alpha}}{\alpha}} \right)^{\frac{1}{1-\alpha}} k_t^*. \tag{13}$$

The effect of a constant risk aversion will be increased by the memory of both the risk and the interest rate process. Furthermore, the equilibrium risk will depend on the value of the fundamentals. A worsening in economic conditions, for example, an increase in the current account (or the public account) deficit as a proportion of the gross domestic product will enlarge risk which, in its turn, will be carried on across periods due to the inertia in agents behavior (investors, speculators and the Central Bank). The larger risk will increase the opportunity cost of investment generating a lower capital stock. The right-hand side of (13) can be defined as

$$\left(\frac{1}{1 + \frac{\xi_t}{1-\gamma_t} \frac{k_t^{*1-\alpha}}{\alpha}} \right)^{\frac{1}{1-\alpha}} = \theta_t, \tag{14}$$

where we now assume that the equilibrium risk $\bar{\xi}_t$ and γ_t are a function of time due to structural changes in the equilibrium value of fundamentals

$$k_t = \theta_t k_t^*. \tag{15}$$

By taking logarithms and differentiating with respect to time, we have

$$g_k = g_\theta. \tag{16}$$

If one supposes that both economies become similar after opening, except that one is riskier than another, the growth of capital per unit of effective labor (and thus, output per unit of effective labor) in the steady state will be different by a factor that corresponds to changes on equilibrium risk and on the conduct of monetary policy, steady state was assumed as $g_k^* = 0$. This is an analogous result found by Ferreira (2007) which is based on the combination of the real interest rate parity with demand constrained income growth models as in Roll (1979) and Thirlwall (1979), respectively. A deterioration of the macroeconomic fundamentals will negatively impact on domestic real returns, provoking capital outflows. Interestingly, when fundamentals deteriorate and risk increases, Central Banks could become more conservative and both γ_t and ξ_t could increase simultaneously. Hence, as the real interest rate increases in the face of a negative shock, for example an unexpected halt in world growth, it remains high for a long period of time impacting on the real side of the economy.

$$g_y - n = g_y^* - n^* + g_\theta. \tag{17}$$

Hence, whenever risk rises because of a current account deficit $g_\theta < 0$, the steady state and, maybe, *per capita* growth is impacted. Nevertheless, the main result is that standards of living will not increase to international levels as a response of a more liberalized economy if risk and the actions of Central Bankers imply a high real interest rate differential. The opportunity cost of investment rises, capital is curtailed, meaning less output.

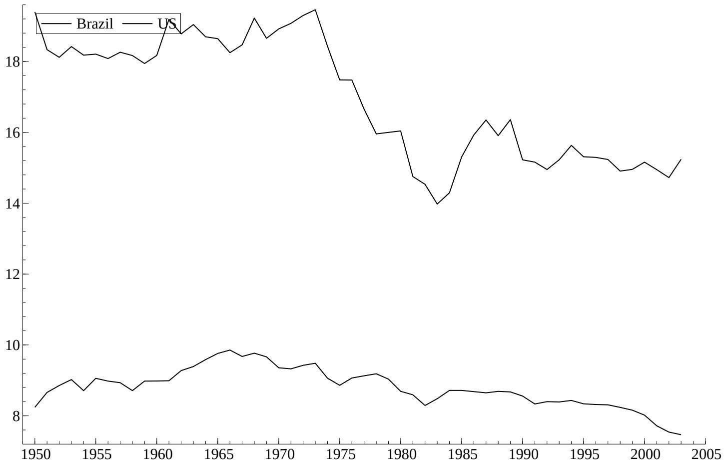
2 Results

We cannot test the model directly as θ would hardly be a measure of default risk. In addition, data of emerging market bonds index span from 1995 onwards which is quite a short sample. Nevertheless, in this section we present some evidence that lends support to equation (4) which underlies the whole analysis.[5]

In Graph (3) we present estimates of the marginal product of capital for Brazil and the US. Data on output was obtained from Heston et al. (2006) and the stock of capital series was constructed using data on investment from the same databse. The first observation for the stock of capital was obtained using the inventory method. The first step was the estimation of α for which we used the following formulae: $\alpha = \frac{\bar{r}+\delta}{n}\sum_{t=1}^{n}\frac{K_t}{Y_t}$ where n is the sample size and $\bar{r}$ was calculated as the static long run equilibrium of an autoregressive process with one lag, i.e. $\bar{r} = \hat{\beta}_0 / \left(1 - \hat{\beta}_1\right)$ and $\delta = 0.06$. The estimated regression using ordinary least squares is $r_t = \hat{\beta}_0 + \hat{\beta}_1 r_{t-1} + \varepsilon_t$ where ε_t is a white-noise error. The real interest rate series for both countries was calculated using annual data of the consumer price index for inflation and the treasury bill rate for nominal interest rates, available at Ipeadata (the Brazilian institute of applied research on economics). Using data from 1949 until 2006, our estimate of the American equilibrium real interest rate is 2.77% given $\hat{\beta}_0 = 0.56$ and $\hat{\beta}_1 = 0.525$. Both the constant and the autoregressive parameters are significant at the 5% level giving an average $\alpha^* = 0,18,$. The data used for Brazil corresponds to the period between 1995 until 2007, because of measurement errors during

[5] Evidence on the effect of current account and public account deficits can be seen in the empirical literature that emerged from the paper of Edwards (1984) and Edwards (1985). Empirical support for the view that monetary policy affects interest rate differentials is related to the literature based on McCallum (1994).

the high inflation period. We have also estimated an AR(1) that passed all tests. The estimated constant is 5,47 (not significant) and the root, 0,508, is significant at 10%, hence $\bar{r} = 10,76\%$ and $\alpha = 0,30$.



Graph 3: **Marginal Product of Capital** Author elaboration based on data from Heston et al. (2006)

Graph (3) shows significant differences between the marginal product of capital in Brazil and in the US and *a priori* failure of the predictions of the standard theory. According to our model, this result is due to the presence of risk which is enlarged by the actions of Central Bankers.

3 Concluding Remarks

The extensive literature on demand constrained models does not have much to say about **how** monetary problems (i.e., lack of foreign reserves) affect the real side of the economy in the long run. The reason is that researchers are mostly concerned with estimations of the benchmark export led growth model. Although the investigation regarding the structural character of income demand elasticities is nonetheless crucial, we believe that one should also worry about the modeling of the dynamic relationships between demand and supply. We attempted to contribute to this literature by taking a stand on this point. When searching for an answer on the question: "what is the transmission mechanism from BoP constraints to income levels or growth?", we turned our attention to the dynamics of the real interest rate. And the answer we gave in this paper connects the level of investment to a monetary problem. Furthermore, we provide a modern analysis since we considered the recent behavior of the Central Bank and its impact on real interest rates.

The story behind our model is the following. Current account imbalances would increase conditional risk affecting the interest rate. Investment would thus decrease and remain low as long as the actions of Central Bankers inputs inertia into the behavior of real interest rates. Hence, Brazilian real interest rates would be high in the present simply because they were higher "in the immediate past", which could be due, for instance, to a fundamental shock (current account or public account imbalances, political risk etc). Given some positive and constant degree of risk aversion, the slower action of Central Bankers would cause higher equilibrium real interest rates and persistent lower levels of investment and income.

We showed how the behavior of monetary authorities can explain differences in standards of living between Brazil and the rest of the world. We also explained that if the autoregressive root of real interest rate differentials (of Brazil with respect to the USA) is due to Central Bank smoothing, then the conduction of monetary policy will enlarge the effects of risk premium. At the time this paper is written, for illustration, Brazil risk, as measured by the emerging markets bond index, is in its lowest levels (around 1.8%). On the other hand, the difference between Brazil and USA *ex ante* real interest rates is much higher than what risk alone could explain. According to our model that would imply some degree of interest smoothing. Also, higher real interest rates and lower investment as a proportion to the gross domestic product had been recurrent issues in Brazil for the past two decades. Finally, income growth remained well below its pre-1980s levels. Our model is capable of explaining these facts.

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