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Perspectives on High Real Interest Rates in Turkey

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Abstract

The Turkish economy is typically characterized as having particularly high real interest rates. Fundamental considerations, such as high growth rates or high returns to capital, do not provide a satisfactory resolution of this puzzle. Instead, we find that two other factors—doubts about the sustainability of disinflation and the existence of a risk premium—have a significant impact on the level of real interest rates in Turkey. Importantly, fiscal policy variables are shown to affect both these factors, suggesting that a more credible and prudent fiscal policy can help reduce real interest rates in Turkey.

Keywords: Turkey; Real Interest Rates; Marginal Product of Capital; Risk Premium

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Contents Page

I. INTRODUCTION

The Turkish economy can be characterized as having particularly high real interest rates. Over the last decade, (ex-post) real interest rates have been around 20 percent on average, with a high degree of variability. While real rates have declined somewhat in recent years, they remain stubbornly high despite significant improvements in disinflation and fiscal consolidation. More tellingly, medium-term real interest rates, as implied by yields on inflation-indexed bonds, still hover around 10 to 11 percent.

The high level of real interest rates in Turkey is particularly evident in cross-country comparisons. Figure 1 shows real interest rates for a cross-section of countries measured as an average over the period January 2004 to June 2007.[2] The selection of countries, broadly determined by the availability of data, comprise both emerging markets and advanced economies covering a broad regional distribution.[3] From the figure, we can see that Turkey, along with Brazil, are clear outliers in the sample distribution. While these two countries have real interest rates on the order of 10-12 percent, the next highest country in the sample has a real interest rate that is only 3 ½ percent. The high real rates of these two countries are particularly puzzling given that the period over which the rates were averaged was one that featured low global interest rates.

This paper attempts to shed some light on the question of why Turkey's real interest rates are so high. From a general equilibrium perspective, this question is not a straightforward one as the real rate is influenced by multiple aspects of the economy. Productivity growth, the rate of return on capital, global interest rates, risk premia, as well as monetary and fiscal policies all weigh into the determination of real interest rates. In light of this, this paper adopts an eclectic approach to answer this question with the hope of arriving at a coherent synthesis at the end.

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[2] Real interest rates are difficult to measure as they involve inflation expectations. In constructing Figure 1, we first assume that rational expectations hold, such that $\pi_t = \pi_t^e + \varepsilon_t$, where π_t is the inflation rate, π_t^e is the expected inflation rate and ε_t is a mean-zero error term that is orthogonal to the real interest rate. Substituting this equation into the standard Fisher relationship, we have

$$r_t = \frac{i_t - \pi_{t+1}}{1+\pi_{t+1}} + (1+r_t)\varepsilon_{t+1}$$

where r_t and i_t are the real and nominal interest rate respectively.
Based on our assumptions, the last term should approach zero as we average over a large number of observations. The average $(1/T)\Sigma_t r_t = (1/T)\Sigma_t (i_t - \pi_{t+1})/(1+\pi_{t+1})$ is, therefore, our measure of the real interest rate.

[3] Cross-country interest rate comparisons have to be treated carefully given the differences in maturities and the nature of interest rates used. For most emerging market countries, bond markets are not well-developed and the securities traded typically have very short maturities. In the construction of Figure 1, we have used the 1-year interbank rate from *DataStream* to make the data as comparable as possible.

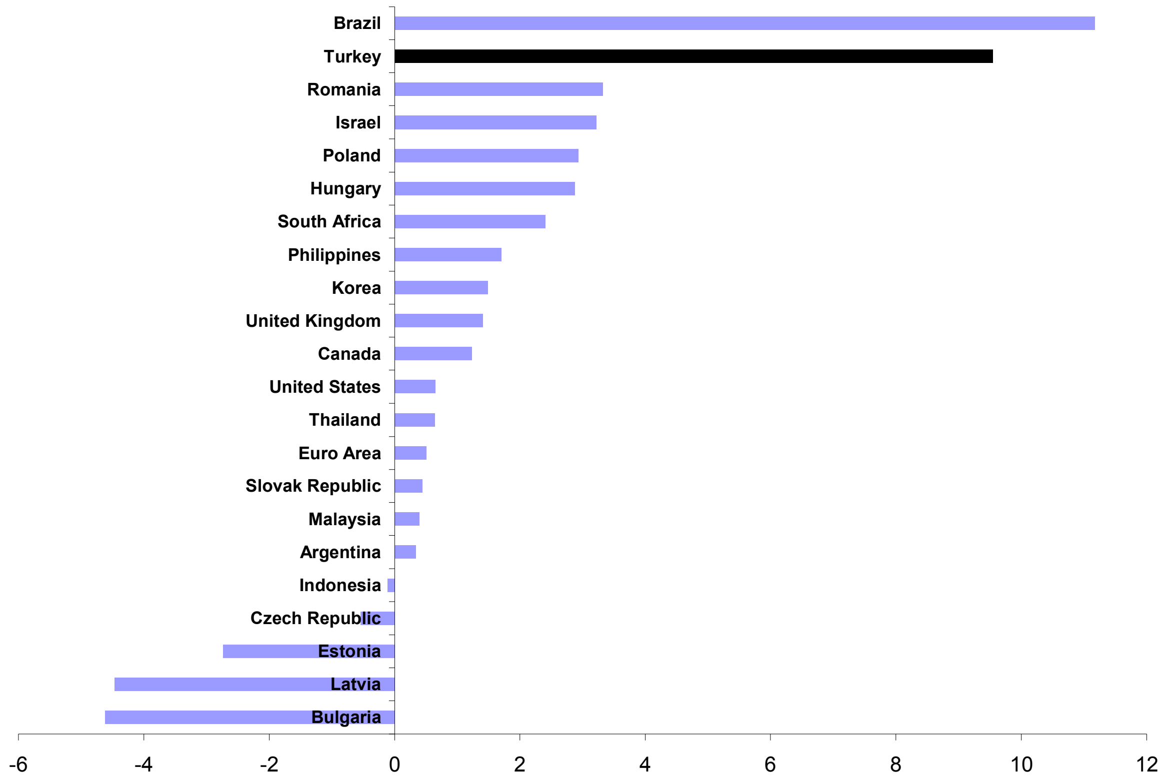

Figure 1: Estimated Real Interest Rates (average 2004-2007, percent)

The analysis in the paper can be generally divided into two parts. The first deals with what we call "fundamental" considerations. Essentially, these are the implications for real interest rates based on the standard neoclassical growth model. This benchmark model has two predictions for real interest rates. The first comes from the household's Euler equation along a balanced growth path, which states that real interest rates should be positively associated with the steady-state growth rate of output per capita. In a fast-growing economy, high real rates are necessary in order to incentivize households to save and thus increase investment. The second prediction of the standard growth model is based on the marginal product of capital. Countries that have lower capital-labor ratios should have higher rates of return on capital and thus higher real interest rates.

Taken at face value, these two predictions imply that it is perhaps not surprising that an economy with a high growth potential and a relatively low capital-labor ratio, such as Turkey, should have high real interest rates. Indeed, we find that the high level of real interest rates can be rationalized within this framework for not too implausible parameter values. This explanation, however, becomes less convincing once we look at the cross-country dimension. Countries with similar characteristics as Turkey have much lower real interest rates, reflecting the well-documented shortcoming of the neoclassical growth model in explaining international capital flows. We therefore conclude that explanations based on "fundamental" considerations are not a convincing explanation of the high real interest rate phenomenon in Turkey.

The second part of the paper looks at two other candidate explanations: (i) the lack of credibility regarding the sustainability of the recent disinflation, and (ii) risk premium considerations. Credibility issues are important for emerging markets in general, and Turkey specifically, given its history of macroeconomic volatility and failed attempts at stabilization. Doubts over the durability of disinflation programs will result in a positive bias in inflation expectations and, consequently, higher nominal interest rates. In the analysis carried out in this paper, we find that such a bias exists and is significant. As a result, especially in recent years, agents have been repeatedly over-estimating the real return to capital, and thereby keeping nominal rates at high levels. This finding serves as an explanation of why real rates continue to remain high despite the improvement in macroeconomic fundamentals over the last few years.

We next consider explanations based on the possible existence of a risk premium. In doing so, we take into account the open nature of Turkey's capital and financial account. In the open economy context, Turkey's high interest rates are even more puzzling given its relatively liberal exchange control regime. We find that a significant portion of the failure of uncovered interest rate parity for Turkey is due to the existence of a risk premium. The risk premium is estimated to be substantial, averaging around 5 percent in recent years. The risk premium draws a wedge between domestic and foreign real interest rates with the implication that the higher interest rates in Turkey are not necessarily yielding any excess returns for investors.

In both these explanations described above, we find that fiscal policy variables play an important role. Increases in the public sector's stock of debt relative to GDP, in particular, reduce policy credibility and increase the risk premium. The policy implications of the analysis presented here are therefore clear, though by no means novel. Credible, and prudent, fiscal policy has to be an important ingredient of any effort to reduce real interest rates in Turkey. Credibility, however, takes time to develop and, as such, there are no quick fixes to the phenomenon of high real rates in Turkey.

There have been several studies that have analyzed the level of interest rates specifically for the case of Turkey. In these papers, various forms of risk serve as the primary determinant of interest rates in Turkey. Berument and Malatyali (2001) find that inflation uncertainty (modeled using a GARCH process) positively affects nominal interest rates. Using a similar methodology to proxy for exchange rate risk, Berument and Günay (2003), find that the conditional volatility of exchange rates is also an important determinant of interest rates in Turkey. Basçi and Ekinci (2005), meanwhile, document the existence of a "bond premium" in Turkey, as returns on T-bills have historically exceeded equity returns. They explain this anomaly by both inflation and default risk.

This paper is organized as follows: Section II analyzes the implication of the standard growth model for interest rates in Turkey from both the perspective of the household's Euler equation (Section II.A) and the marginal product of capital (Section II.B). Section III then focuses on credibility concerns as an explanation during the recent disinflation period. Open economy considerations, in particular foreign exchange risk premia, are considered next in Section IV. Finally, Section V contains some concluding remarks.

II. Fundamental Considerations

We begin our analysis of the high real interest rate phenomenon in Turkey by looking at the deterministic version of the standard neoclassical growth model as in King, Plosser and Rebelo (1988). This benchmark model's implication for real interest rates, R_t, are given by two first-order conditions: the household's Euler equation and the firm's capital utilization decisions. The household's Euler equation is as follows:

$$R_{t+1} = \frac{U'(C_t)}{\beta U'(C_{t+1})} \tag{1}$$

where C_t is per-capita consumption at time t, β is the discount factor, and the function $U(\cdot)$ is the household's utility function. In the next two subsections, we consider the implication of this equation, as well as the marginal product of capital, in determining the level of real interest rates in Turkey.

A. Implications of the Euler Equation Along a Balanced Growth Path

Along a balanced growth path, the growth rate of consumption will be equal to the growth rate of labor-augmenting technical progress, which we shall denote as g. Together with the assumption that that the utility function has the constant relative risk aversion functional form, i.e. $U(C) = C^{1-\sigma} / 1-\sigma$, where σ is the coefficient of relative risk aversion, equation (1) can be approximated as

$$r \approx \sigma g + \rho \tag{2}$$

where r is the net real interest rate and ρ is the discount rate $\left(\frac{1-\beta}{\beta}\right)$.

What does equation (2) imply for real interest rates in Turkey? In order to answer this question, we need estimates of the parameters σ, g and ρ. As an estimate of the trend growth rate, g, we rely on the forecast of medium-term output per capita growth from the *World Economic Outlook* database, which suggests a value for g of about 3.8 percent. Estimates for the coefficient of relative risk aversion, σ, vary substantially in the literature. In their study of US business cycles, Kydland and Prescott (1982) and Cooley and Prescott (1995) use values ranging from 1 to 2. Higher values instead are used in the finance literature to explain asset pricing anomalies. Even with a value of 2 for σ, however, we can obtain our measure of Turkey's real interest rate for only small values of the discount rate, ρ, given Turkey's high

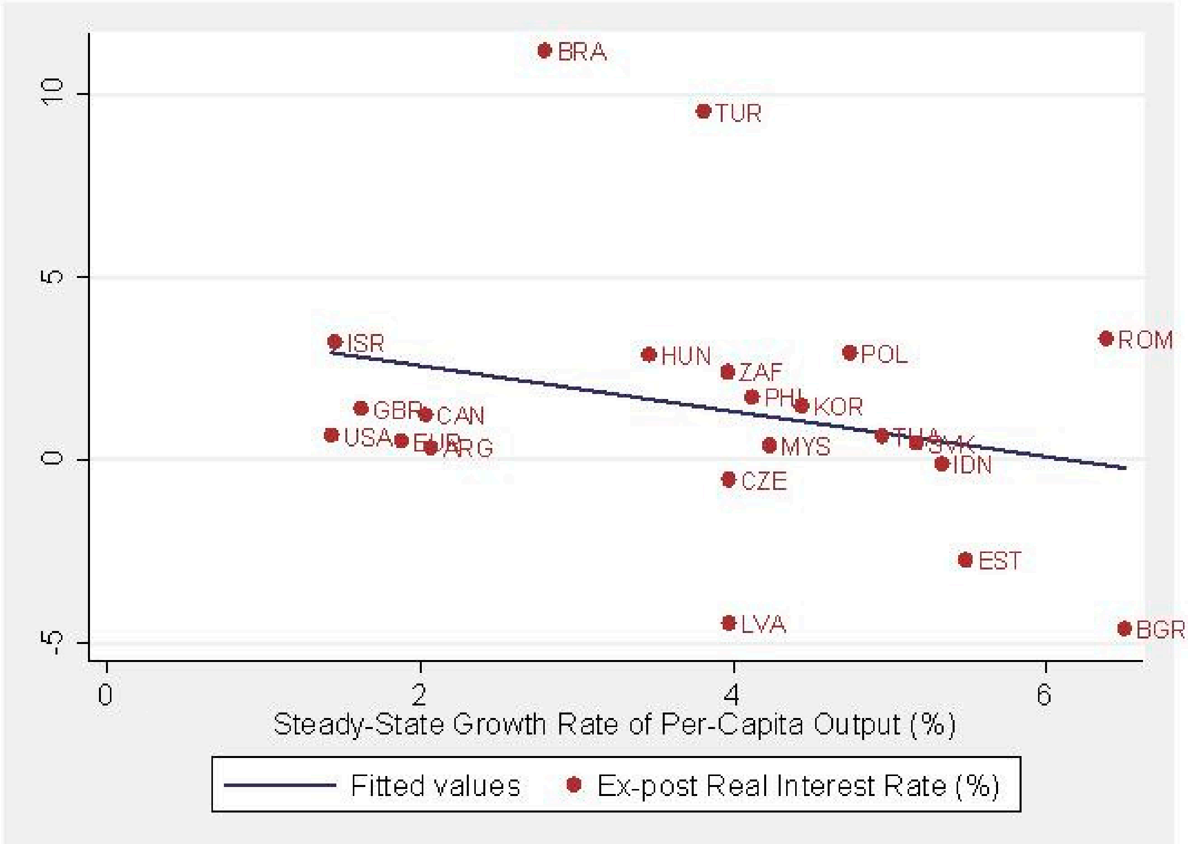

Figure 2: Cross-Country Comparison of Real Interest Rates and Steady-State Growth Rates

medium-term growth rate of per-capita output. The parameter values required to explain Turkey's high real interest rates are, therefore, not implausible and fall well within the range of estimates in the literature.

This explanation breaks down when we look at the cross-section of countries. Figure 2 shows a scatter plot of ex-post real interest rates against estimates of the steady-state growth rate of per-capita output, g, where, once again, the estimates of g are based on the medium-term forecasts in IMF's *World Economic Outlook*. Contrary to what equation (2) predicts, the empirical relationship between real interest rates and g is *negative* implying that countries that have higher medium-term growth rates actually have lower real interest rates. Relative to the fitted values, Turkey and Brazil are once again outliers. The inability of the Euler equation to explain the cross-country variation in real rates leads us to discount it as a serious explanation of high real rates in Turkey.

B. The Marginal Product of Capital for Turkey

We next take up the second implication of the standard growth model for real rates. Most textbook explanations of real interest rates would include a reference to the marginal product of capital. For production functions that feature diminishing returns to capital, economies with larger capital-labor ratios should have smaller real rates of return and vice-versa. Based on this reasoning, an emerging market country with a relatively low capital-labor ratio, such as Turkey, should be expected to have high real interest rates.

There are at least a couple of reasons why we should be sceptical of an explanation based on estimates of the marginal product of capital. Firstly, estimates of the rate of return to capital based on the standard neoclassical growth model are at odds with the data on international capital flows. While Lucas (1990a) shows that relative capital-output ratios imply massive return differentials between rich and poor countries, more recent research, such as Gourinchas and Jeanne (2007), show that capital instead tends to flow in the opposite direction. Secondly, Mulligan (2002) shows that in the presence of risk premia, interest rates on financial instruments may have very low correlations with the rental rate faced by firms. These caveats notwithstanding, it is still instructive to get a sense of what the return to capital in Turkey is and whether, at a cross-country level, it can explain the variation in real interest rates, if only to dismiss it as an explanation for high real interest rates in Turkey.

Framework

We follow the methodology used in Caselli and Feyrer (2007) (henceforth, CF) to estimate the aggregate marginal product of capital for Turkey as well as the cross-section of countries studied earlier, conditional on the availability of data. The CF framework imposes very little structure on the data and is relatively easy to compute. We do, however, encounter some difficulty in estimating the capital share of income, and we will describe later how these problems are addressed.

CF estimate four different measures of the marginal product of capital. The most basic measure, what the they term as the “naïve” measure, or *MPKN*, is given by

$$MPKN = \alpha \frac{Y}{K} \tag{3}$$

where α is the share of capital in GDP, Y is real GDP and K is the capital stock. Equation (3) can be obtained from a standard one-sector model that has a constant returns-to-scale production function. However, as noted in their paper, the share of capital, as typically measured from national accounts data, overestimates the marginal product of reproducible capital as it includes imputed rents to land and other non-reproducible capital. Their second estimate, therefore, corrects for this and uses instead an estimate of the reproducible-capital share of income, α_k. The estimate is thereby denoted as

$$MPKL = \alpha_k \frac{Y}{K} \tag{4}$$

where the letter “*L*” is used as a mnemonic for “land and natural-resource corrected”.

The next two estimates take into account the fact that the price of capital goods relative to consumption goods is higher in poor countries than in rich countries, as noted by several studies (see Hsieh and Klenow (2007) for a recent one). The return to capital, as measured for poorer countries, is thereby biased upwards as measures (3) and (4) do not take into account the fact that the relative price of capital is higher as compared to richer countries. Based on a multisector model, CF show that the marginal product of capital in a frictionless international environment that corrects for this bias is given by

$$PMPKN = \alpha \frac{P_y Y}{P_k K} \tag{5}$$

where P_y/P_k is a measure of the average price of final goods relative to the price of capital. The prefix "*P*" stands for "price-corrected" while the suffix "*N*" is used since we have the "naïve" estimate of capital share of income. If the share of reproducible capital is used, we will have

$$PMPKL = \alpha_k \frac{P_y Y}{P_k K} \tag{6}$$

Data sources

The data for output (Y), the relative price of capital (P_y/P_k) and our estimates of the capital stock come from version 6.2 of the Penn World Tables (PWT, Heston, Summers and Aten (2006)). Following Caselli (2005), we construct the capital stock, K, from real investment data from the PWT. We compute the initial capital stock, K_0, using the following formula

$$K_0 = \frac{I_0}{(\mu + \delta)} \tag{7}$$

I_0 is the value of the investment series in the first year it is available, and μ is the average geometric growth rate of investment between date 0 and date 1970.[4] As in CF, we assume a value for the depreciation rate, δ, of 6 percent.

We run into some difficulties in compiling estimates of the capital share of income. We first resort to Bernanke and Gürkaynak (2001), as do CF, who expand on the results of Gollin (2002). The overlap of countries between their sample and ours, however, is small. As our next resort, we refer to estimates in Gollin (2002) directly. After utilizing these two sources, we are still left with 9 countries, including Turkey, for which we do not have estimates of capital shares.[5] Estimates of labor compensation from the national accounts for this set of countries imply capital share estimates that are implausibly high, as noted by Gollin (2002). In the case of Turkey, for example, compensation of employees amount to only about 25-30 percent of GNP. Therefore, we assume a flat capital share of 0.35 as do Bosworth and

[4] The exceptions are the Czech Republic, Estonia, Hungary, Latvia, Poland and Slovakia for which we have shorter time series. For these countries, we compute μ as the average growth rate of the first 10 years of available data. We drop Bulgaria due to data limitations.

[5] For Brazil, we used an estimate of 0.45 as suggested by the IMF desk economist.

Table 1: Estimates of the Marginal Product of Capital

Country	*MPKN*	*PMPKN*	*MPKL*	*PMPKL*
Argentina	0.17	0.12	0.09	0.06
Brazil	0.22	0.15	0.11	0.07
Canada	0.12	0.15	0.06	0.08
Czech Republic	0.14	0.10	-	-
Estonia	0.22	0.12	0.13	0.07
Hungary	0.10	0.08	0.06	0.05
Indonesia	0.23	0.15	0.08	0.05
Israel	0.11	0.13	0.08	0.10
Korea	0.10	0.11	0.07	0.08
Latvia	0.55	0.36	0.31	0.20
Malaysia	0.17	0.13	0.08	0.06
Philippines	0.27	0.18	0.14	0.09
Poland	0.15	0.15	-	-
Romania	0.16	0.08	0.08	0.04
Slovak Republic	0.13	0.09	-	-
SouthAfrica	0.36	0.17	0.20	0.09
Thailand	0.12	0.11	0.06	0.06
Turkey	0.20	0.15	0.11	0.09
United Kingdom	0.12	0.14	0.08	0.10
USA	0.11	0.13	0.08	0.09

Collins (2003) for the remaining countries.[6] For estimates of the share of reproducible capital, we follow CF and refer to World Bank (2006), which has estimates of the breakdown of "national wealth" into land, natural resources, and reproducible capital.

Results

The various estimates of the marginal product of capital are presented in Table 1. We report the average measure over the years 2002-2004. Unlike CF, we find a bit more variation in their preferred measure of the marginal product of capital, the *PMPKL*. The distribution seems to be bimodal with a group of countries in the 4-7 percent range, and another in the 8-10 percent range.[7] Turkey lies in the group of countries that have the higher marginal product of capital, and has a rate of return on capital of around 9 percent.

[6] We could not replicate Gollin (2002)'s analysis for Turkey since the national accounts data does not provide the necessary breakdown of operating surplus.

[7] Latvia is an extreme case, which is a result of the short sample and a large capital share of income as measured by Gollin (2002).

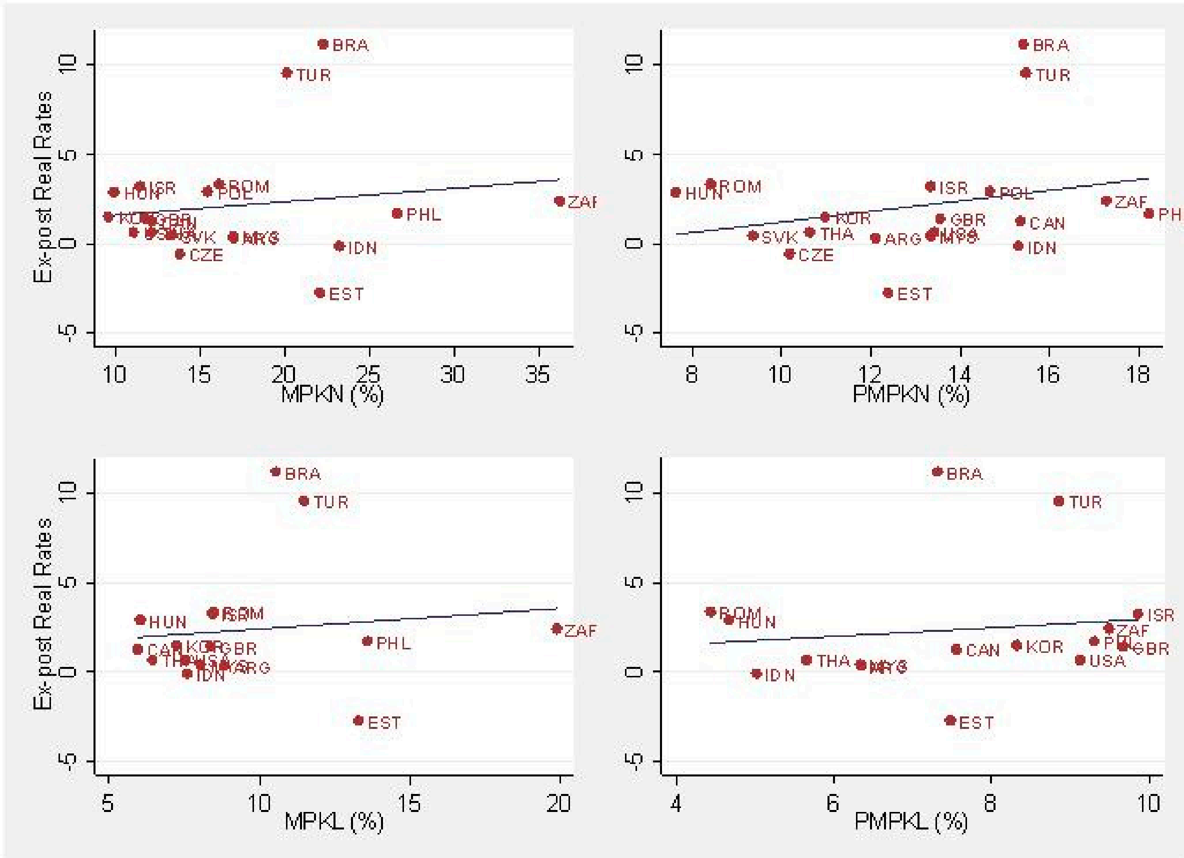

Figure 3: Cross-Country Comparisons of Marginal Product of Capital

Do countries that have higher rates of return on capital have higher real interest rates? Here, we once again look to the cross-country dimension for an answer. Unfortunately, we find that the estimates of the marginal product of capital do not correlate well with the estimates of real interest rates (see Figure 3). The fitted regression lines indicate relationships between real interest rates and the various measures of the marginal product of capital that are not statistically significant. In any event, Turkey, with its very high real interest rates, is far above all the fitted lines for the two variables. Countries that have similar, or even higher, rates of return to capital have much lower real interest rates.

C. What Does Explain the Cross-Section of Real Rates?

The previous sections have shown us that the benchmark neoclassical growth model's implications for real interest rates do not offer a satisfactory explanation for the high real interest rate phenomenon in Turkey. The failure becomes evident once we look at the implications for the cross-country variation in real interest rates. Fast growing economies are associated with *lower* real interest rates while there is no statistically significant relationship between various measures of the marginal product of capital and real rates.

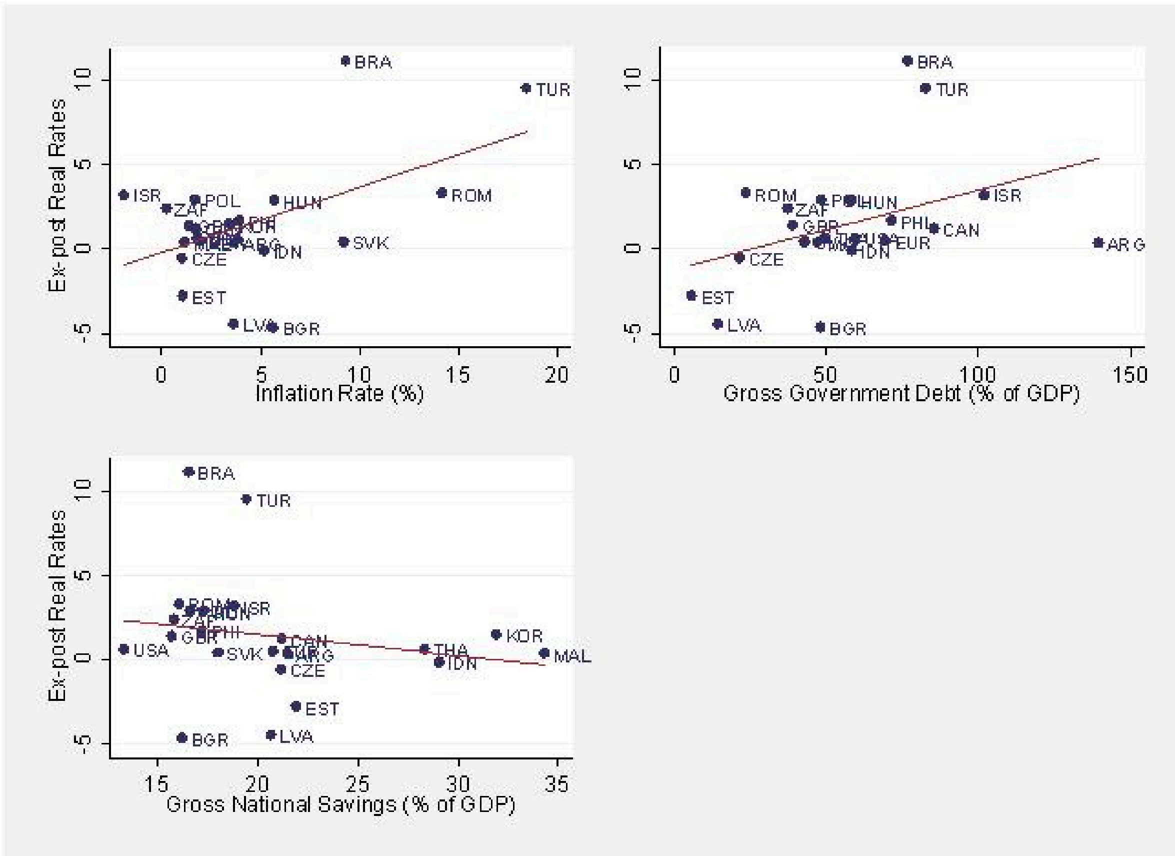

Figure 4: Cross-Country Scatter Plots

What then can explain the cross-country variance in real interest rates? To answer this question, we study the relationship between levels of real interest rates and several other standard macro variables. Due to the limited number of observations, we have to be parsimonious in the choice of variables. We consider three in particular that have received some attention in the literature. The first is the public sector's debt-to-GDP ratio. Higher debt ratios have been found to be associated with higher risk premiums both in the term structure of interest rates (Favero and Giavazzi (2002)) and in the foreign exchange market (Giorgianni (1997)). The second variable we consider is the inflation rate. Note that in the standard neoclassical growth model, there is a real-monetary dichotomy in the sense that real variables are determined by real factors while nominal variables are determined by nominal factors. The real interest rate, therefore, is not affected by any nominal variable. However, the models presented in Mundell (1963), Tobin (1965) and Feldstein (1976) show that the inflation rate can have a negative effect on the real interest rate due to either increases in the capital stock (Mundell (1963) and Tobin (1965)), or because of the way in which gains due to inflation are taxed (Feldstein (1976)). On the other hand, Evans (1998) and Buraschi and Jiltsov (2005) find evidence of time-varying inflation risk premia in interest rates for the US and UK respectively. The existence of inflation risk premia imply that investors require compensation in the form of higher yields for fixed-income securities for bearing inflation risk. If the inflation risk premium is positively correlated with the level of inflation, then we

Table 2: Cross-Section Estimation of Determinants of Real Interest Rates[a]

	(1)	(2)	(3)	(4)
Gross domestic debt (% of GDP)	0.047*			0.045*
	(0.025)			(0.022)
Inflation rate		0.388**		0.358**
		(0.146)		(0.143)
Gross national savings (% of GDP)			-0.126	-0.095
			(0.141)	(0.136)
Constant	-1.199	-0.211	4.046	-0.716
	(1.610)	(0.920)	(3.005)	(3.216)
N	21	22	22	21
R -square	0.15	0.26	0.04	0.42

[a] Notes: Dependent variable is ex-post real interest rates. Standard errors in parentheses. *, ** and *** represent significance at the 10, 5 and 1 percent respectively.

will get a positive association between inflation and real rates, unlike the predictions of Mundell (1963) and Tobin (1965). Finally, we also consider the gross national savings rate. In a closed-economy setting, the savings rate would be expected to have a significant negative impact on the real interest rate as it measures the supply of funds in the economy. Almost all the economies in the sample, however, are very open economies and so domestic savings and investment may not be as relevant in the determination of the real interest rate. Still, we include this variable for completeness.

Figure 4 shows bivariate scatter plots of the real interest rate against countries' inflation rates, public-sector debt ratios and savings rates. In constructing the plots, we have used the 2003 values for each variable from the IMF's *World Economic Outlook* database. Since the real interest rate series was computed as an average over the period 2004-2007, we use 2003 values for the explanatory variables such that these variables can be considered as "predetermined" to avoid any endogeneity issues. The solid line represents the least-squares fitted line for each bivariate regression. The coefficients are presented in Table 2, which also has estimates of a multivariate regression that incorporates all variables.

The bivariate regressions for the debt ratio and the savings rate yield slope coefficients that have the expected sign. The slope of the savings rate, however, is not statistically significant, which resonates with our earlier discussion on the importance of the savings rate in an open economy setting. Higher levels of government debt, however, are associated with higher real interest rates. Meanwhile, inflation rates are positively associated with real interest rates, and significantly so, implying that risk premium considerations are more important that the other elements at play in Mundell (1963) and Tobin (1965). These findings carry over to the multivariate regression.

The positive dependence of real interest rates on the level of government debt and the inflation rate points toward risk premium considerations in explaining the level of real interest rates. In order to gain a better understanding of what form these risk premiums manifest themselves in, we depart from the cross-country component of our analysis to focus solely on the case of Turkey. In particular, we focus our attention on two different explanations: the lack of credibility in achieving disinflation, which can be thought of as the risk of the economy reverting to a high-inflation state, and the existence of a foreign exchange risk premium. We take up these two explanations in the next two sections.

III. Credibility Concerns As An Explanation For High Real Rates

One of the puzzling aspects of high real interest rates in Turkey is the fact that they continue to remain high despite significant improvements in macroeconomic fundamentals. The inflation rate, in particular, has come down from an average of 45.1 percent in 2002 to 8.8 percent in 2007. Turkey, however, is not alone in this regard. Persistently high (ex-post) real interest rates have been documented in the literature around periods of significant disinflation. Kaminsky and Leiderman (1998) show that real interest rates in Argentina, Israel and Mexico continued to remain in the 20-40 percent range following stabilization programs, despite substantial inflation reduction. A similar phenomenon was also present within industrialized countries in the 1980s, where real interest rates were particularly high following disinflation in the early part of the decade (see Blanchard and Summers (1984)).

A strand of literature has emerged in recent years that focuses on issues related to credibility as a potential explanation of this phenomenon. The basic story goes as follows: In the early stages of a disinflation episode, agents are not confident of the durability of the new "low-inflation" regime. In forming their expectations of future inflation, therefore, agents attach a positive probability to the event that the economy switches back to the "high-inflation" regime. As a result, *ex-post*, if the economy continues to remain in the low-inflation state, the ex-ante inflation forecasts will appear to be positively biased. Only when (and if) the economy continues to stay in the low-inflation regime will the new regime gain credibility with the consequent reduction in the bias of inflation forecasts. Over the whole "learning" period, however, inflation expectations will be consistently higher than the realizations. Nominal rates, though, respond to inflation expectations and, as a result, *ex-post* measures of real interest rates will appear to be high. The basic intuition of the mechanism at work here is analogous to that of the well-discussed "peso problem" in foreign exchange markets, where forward rates can be biased predictors of future spot exchange rates due to issues related to credibility, as in Krasker (1980), or information asymmetry, as in Lewis (1989).

In the case of emerging markets, issues of credibility are important due to the costs associated with disinflation episodes, fragile political systems, and shorter institutional histories (see Beim and Calomiris (2001) and references therein). Credibility issues surrounding stabilization programs are emphasized in Kaminsky and Leiderman (1998) and Calvo and Végh (1993). Similar arguments have also been used to explain high real interest rates in industrialized countries, as alluded to earlier. In his discussion of Barro and Sala-i Martin (1990), Lucas attributed a large portion of the high real rates to errors in inflation expectations of agents, reflecting their belief that the economy would soon return to the high inflation state of the mid-1970s (see Lucas (1990b)).

In the case of Turkey, issues of credibility are of particular relevance given the long history of high inflation and failed attempts at inflation stabilization. Coalitional governments with slim majorities have historically not had sufficient political will to sustain difficult stabilization programs. The most recent attempt at stabilization, in late 1999, was an exchange rate-based stabilization program under the auspices of the IMF. Soon after, interest rates declined significantly, and inflation began to moderate. After slightly more than a year into the new regime, however, the economy entered into a sharp financial and currency crisis, which resulted in the abandonment of the crawling peg regime, soaring interest rates and a resumption of high inflation. While the economy has since recovered and some semblance of political and institutional stability has been achieved, credibility concerns are still of paramount importance in the Turkish economy.

A. Framework

To assess the importance of credibility issues for the level of real interest rates in Turkey, we employ the methodology used in Kaminsky and Leiderman (1998). The economy is assumed to evolve according to a two-state Markov-switching process with time-varying transition probabilities.[8] The two states, or regimes, refer to two different possibilities for the inflation process. We can think of one as a "high-inflation regime" and the other as a "low-inflation regime". At the end of each period, agents form priors as to which inflation regime the economy will be in the next period. The priors are based on observations regarding macroeconomic developments up to that point. Inflation expectations for the next period are then computed as the weighted average across the two possible inflation processes with the priors serving as weights.

Figure 5 shows the seasonally-adjusted monthly inflation rate for Turkey from 1995 to June 2008. The horizontal lines mark the average monthly inflation rate over the period 1995 to 2001 and mid-2003 to the latest observation. The average monthly inflation rate has reduced from around 5 percent in the late 1990s to about 1 percent now. Ignoring the turbulent period

[8] Time-varying transition probabilities also feature in Diebold, Lee and Weinbach (1994). In the current context, the model is an extension of Hamilton (1988), which features time-invariant transition probabilities.

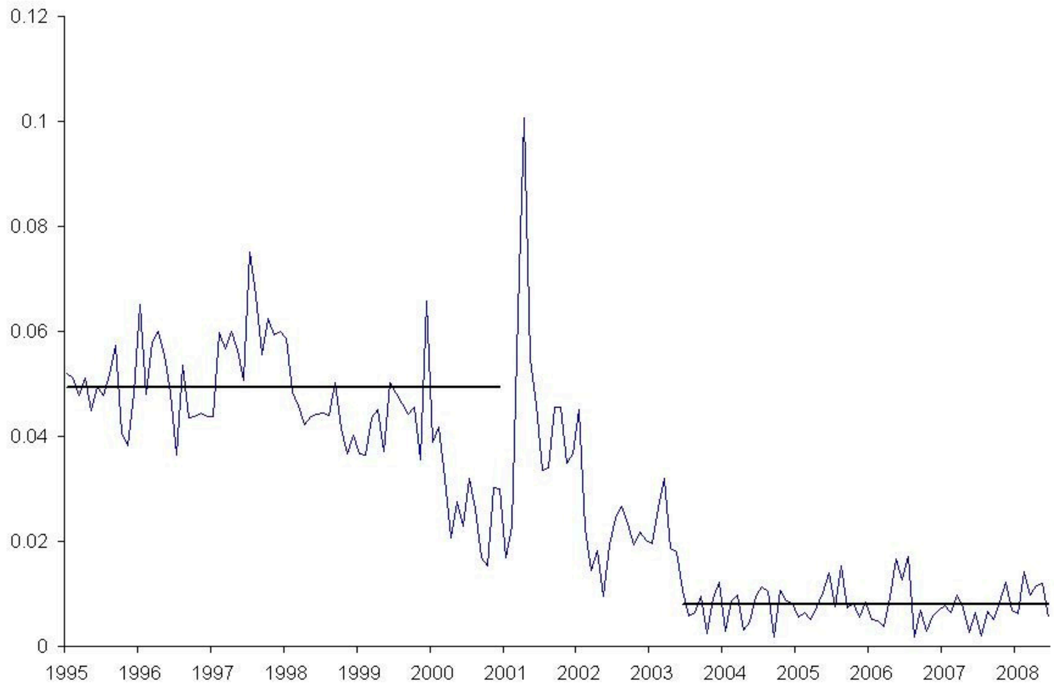

Figure 5: Seasonally-Adjusted Monthly Inflation Rates

surrounding the 2001 financial crisis, it appears that a two-state process adequately represents recent inflation developments in Turkey.

The model, as described above, consists of the following system of equations:

$$\Delta p_t = \alpha_i + \sum_{s=1}^{q} \beta_i^s \Delta p_{t-s} + \varepsilon_t\ , \qquad \varepsilon_t \sim N\left(0, \sigma_i^2\right),\ \ i \in \left(l, h\right)$$

$$\Pi_t = \begin{bmatrix} \left(1-\lambda_t^{lh}\right) & \lambda_t^{lh} \\ \lambda_t^{hl} & \left(1-\lambda_t^{hl}\right) \end{bmatrix}$$

$$\lambda_t^{lh} = \frac{\exp\left(\delta_0 + \delta_m M_t + \delta_d D_t\right)}{1+\exp\left(\delta_0 + \delta_m M_t + \delta_d D_t\right)}$$

$$\lambda_t^{hl} = \frac{\exp\left(\delta_0 - \delta_m M_t - \delta_d D_t\right)}{1+\exp\left(\delta_0 - \delta_m M_t - \delta_d D_t\right)}$$

The first equation describes the process for inflation (Δp_t, where p is the seasonally-adjusted consumer price index), which is modeled as an AR(q) process. The coefficients are indexed with a subscript i to indicate that they are allowed to take on different values in the different states. The states are labeled as l and h representing the low- and high-inflation regimes respectively. The error term is allowed to have a state-dependent distribution in that its variance can differ across states. The second equation is the matrix of transition probabilities,

Π_t. The *ij* element in the matrix, λ^{ij}_t, denotes the probability of transitioning from state *i* to state *j*. We have used the fact that $\Sigma_j \lambda^{ij}_t = 1$ in the notation above. The subscript *t* indicates that these transition probabilities are time varying. The last two equations show how the transition probabilities evolve over time. The probability of transiting from the low-inflation state to the high inflation state is assumed to depend on the real growth rate of credit to the private sector (M_t), which we use as a proxy for monetary conditions, and the real annual change in gross debt of the central government (D_t), which we use as a proxy for the budget balance.[9] Just as in Kaminsky and Leiderman (1998), we assume that these variables have the opposite effect (but the same magnitude) on the transition probability from the high-inflation state to the low-inflation state in order to economize on the number of parameters we need to estimate. The functional forms are chosen such as to ensure that λ remains bounded between 0 and 1.

The estimation procedure begins by first computing the density function for the inflation process, $f(\Delta p_t \mid I_{t-1})$, across the different states with the prior probabilities serving as weights.[10] The prior probability of being in state *i*, $\varphi^{pr}_{t,i}$, is computed as follows for the case of $i=h$,

$$\varphi^{pr}_{t,h} = \lambda^{hh}_{t-1}\varphi^{po}_{t,h} + \lambda^{lh}_{t-1}\varphi^{po}_{t,l} \tag{8}$$

where $\varphi^{po}_{t,i}$, the posterior probability that the economy is in state *i*, is computed using Bayes' Rule.

We then compute the sample log likelihood function

$$L(\Theta) = \sum_{t=1}^{T} \ln f\left(\Delta p_t \mid I_{t-1}\right) \tag{9}$$

which we then maximize numerically with respect to the unknown parameter set Θ. To compute the standard errors, we use the procedure proposed by White (1982), which combines two estimates of the information matrix, the *second-derivative estimate* and the *cross-product estimate*, to borrow terminology from Hamilton (1994).

We use monthly data from January 1995 to May 2008. The starting point was chosen so as to avoid the effects of the 1994 crisis. Data for CPI were obtained from the IMF's *International Financial Statistics* while data on credit to the private sector were obtained from the Central Bank of Turkey's Monetary Survey. For monthly data on the stock of gross outstanding debt of the central government, we used the series maintained on the website of the Treasury. In total, we have 161 observations for each variable.

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[9] We use changes in debt stocks, rather than the actual budget balance figures themselves, due to the availability of a longer time series for gross debt.

[10] I_{t-1} refers to the information set as of period *t-1*.

Table 3: Maximum-likelihood estimates of coefficients in regime-switching model

	α_l	α_h	$\beta^1{}_l$	$\beta^1{}_l$	σ_h	δ_m	δ_d
Coefficient	0.0039	0.0048	0.6047	0.9048	0.0087	1.1140	1.4811
z-ratios	(11.96)	(4.388)	(9.834)	(79.45)	(7.144)	(0.908)	(1.169)

Before we present the results, there are several technical issues that are relevant to highlight. Firstly, we adopted an agnostic view regarding the starting values for the coefficients used in the maximization procedure, choosing a value of 0.5 for all variables.[11] However, the procedure tended to give estimates of σ_l that were too close to zero such that the matrix inversion necessary to compute the Hessian for the information matrix could not be carried out. To overcome this problem, we fix the ratio of σ_h / σ_l to match the data (assuming the h and l states match the periods shown in Figure 5) and estimate σ_h as a free parameter. Finally, it was found that an AR(1) model is adequate to describe the monthly inflation process in the two regimes, and as such, q is set to 1.

B. Results

Table 3 shows the resulting coefficient estimates along with the estimated z-ratios. We first discuss the estimates of the coefficients related to the inflation process α_i and $\beta^1{}_i$. $\beta^1{}_i$ measures the persistence of the inflation process while (α_i /(1- $\beta^1{}_i$)) measures the unconditional mean (since the process is stationary). The results accord with our priors in that the process associated with the high-inflation regime features an inflation rate that is more persistent, and has a higher expected value than that of the low-inflation regime. The estimated unconditional mean for inflation is about 5 percent for the high-inflation regime and 0.9 percent for the low-inflation regime. The fact that these estimates match up almost perfectly with the sample averages shown in Figure 5 is remarkable.

The last two coefficients, δ_m and δ_d, capture the effect of monetary and fiscal variables on the transition probabilities. The estimates have a positive sign indicating that more rapid credit growth and larger changes in the debt stock increase the probability that agents place on the economy reverting to the high-inflation state. Admittedly, these two coefficients are estimated imprecisely, though the routines used to compute estimates of the information matrix are themselves subject to error.

We can also compute the time-varying probabilities that agents place on the event that the economy switches back to the high-inflation regime, $\varphi^{pr}{}_{t,h}$. This probability is shown in Figure 6. The solid line shows the six-month moving average of $\varphi^{pr}{}_{t,h}$ while the dashed line

[11] The function *fminval* in MATLAB was used.

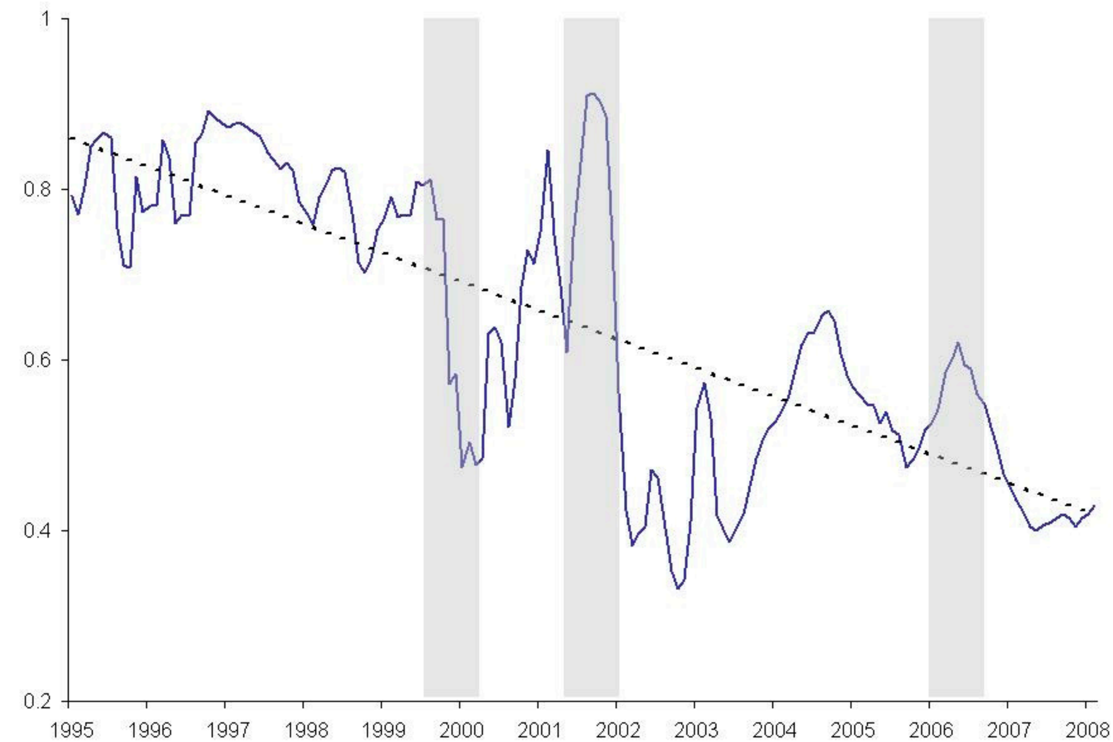

Figure 6: Estimated Probability of Being in High-Inflation Regime Next Period (six-month moving average of the estimated series. Dashed line shows linear trend while shaded areas are described in text.

shows the linear trend. The probability of transitioning to a high-inflation state has decreased over the years, though with considerable fluctuations around the trend. Three periods of interest are highlighted. The first is the introduction of the stabilization program in 1999. ${\varphi^{pr}}_{t,h}$ experienced a sharp drop during that period implying at least some initial credibility associated with the program. The drop was soon reversed at the onset of the crisis in 2001 where ${\varphi^{pr}}_{t,h}$ reverted back to its levels at the beginning of the sample. The most recent peak in ${\varphi^{pr}}_{t,h}$, which is the last column highlighted, occurred during the turbulence experienced in May-June 2006.

The implications of these results for real interest rates are shown in Figures 7 and 8. Figure 7 shows the forecast error for monthly inflation where the forecasts are based on the time-varying priors and the estimated coefficients of the two inflation processes, as shown in Table 3. Interestingly, we see that up to 2003, forecast errors in this model were close to zero. However, from 2003 onwards, agents were systematically overestimating inflation as we discussed in the beginning of the section. Essentially, agents were overly pessimistic regarding the durability of the low-inflation regime during this period. As a result, Figure 8 shows that *ex-post* real interest rates were consistently higher than *ex-ante* real interest rates. On average, the difference was around 3 percent over this period implying that agents in the economy were making consumption and investment decisions under the assumption that real interest rates were actually 3 percent lower than what they turned out to be. In other words,

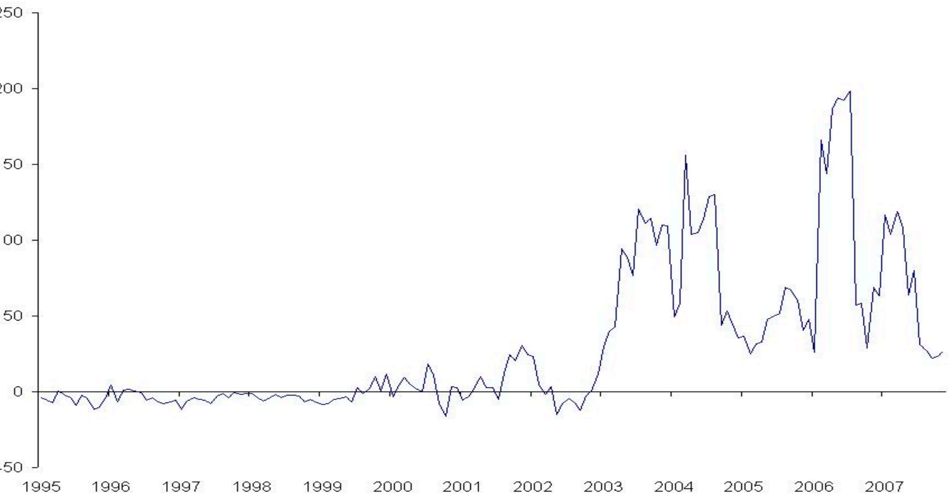

Figure 7: Forecast Error for Monthly Inflation (percent)

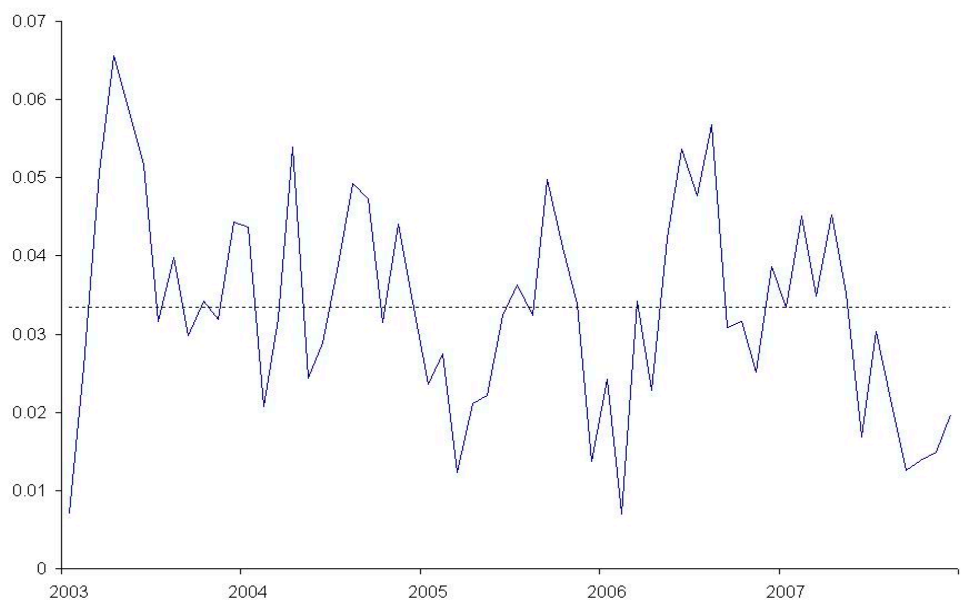

Figure 8: Estimated Difference Between Ex-Ante and Ex-Post Real Interest Rates (benchmark bond rates, annualized. Dashed line is the sample average over the period.

agents were over-estimating the real return to capital. The demand for capital, therefore, remained elevated providing support for the high level of interest rates.

IV. Open economy considerations

The analysis up to this point has not taken into account the fact that Turkey has a very liberal exchange control regime and a very open capital and financial account. The Turkish lira is a fully convertible currency, and there are almost no restrictions on non-residents' sales and purchases of domestic bonds and equities, or holdings of bank deposits (see International Monetary Fund (2007)).

In this section, therefore, we look at open economy considerations, and how they might affect the level of real interest rates in Turkey. The open economy dimension adds a dependency of domestic interest rates on foreign interest rates to the analysis. The uncovered interest rate parity condition (UIP) is often used to characterize international asset market equilibrium (mostly in the monetary model of exchange rates, see the collection in Frankel and Johnson (1976)). The condition states that domestic interest rates are equal to foreign interest rates plus the expected depreciation of the domestic currency. In log-approximation form, the UIP can be written as

$$i_t = i_t^* + E_t(s_{t+1}) - s_t \tag{10}$$

where i_t and i_t^* are domestic and foreign interest rates respectively while s_t is the (log) spot exchange rate defined such that an increase is a depreciation of the domestic currency. The relationship is a quasi-arbitrage relationship for risk-neutral traders who only care about the first moment of returns. The related concept of *covered* interest rate parity (CIP) equates the domestic interest rate to the foreign interest rate plus the forward discount, $fd_t = f_t - s_t$, where f_t is the (log) forward rate at time t:

$$i_t = i_t^* + fd_t \tag{11}$$

The two equations together show us that the UIP condition is equivalent to the unbiasedness of the forward rate as a predictor of the future spot exchange rate: $f_t = E_t(s_t+1)$.

Using the UIP together with the Fisher equation (again in log-approximation form),

$$i_t = r_t + \pi_{t+1}^e \tag{12}$$

we can derive a *real* UIP condition, which relates the domestic real interest rate to the foreign real interest rate plus the expected real depreciation. If, over the long run, purchasing power parity (PPP) is expected to hold, the real UIP condition tells us that domestic real interest rates will be pinned down by foreign real interest rates. As we saw in Figure 1, however, Turkey's real interest rates are significantly higher than a cross-section of countries. The open economy dimension, therefore, makes the high real interest rates in Turkey even more of a puzzle.

The standard UIP relationship, as shown in equation (10), however, assumes that agents are risk-neutral and that domestic and foreign instruments are perfect substitutes. The violation of these assumptions introduces a wedge between domestic nominal interest rates and the sum of foreign interest rates and the expected depreciation. This wedge carries over to the real UIP condition, such that domestic real rates can be higher than world rates even if PPP holds. In this section, we will focus our attention on this wedge, which some authors attribute to a risk premium term (Fama (1984) and Hodrick and Srivastava (1986)) while others attribute it to a failure of rational expectations (Bilson (1981) and Longworth (1981)).

A. The Foreign Exchange Risk Premium in Turkey

In order to understand the source of the wedge between domestic interest rates and foreign interest rates, we begin by running the standard regression that tests for the presence of a forward discount bias. As mentioned in the last section, the UIP condition is equivalent to the unbiasedness of the forward rate as a predictor of future spot rates. Thus, the presence of a forward discount bias implies failure of UIP. Using monthly exchange rate and forward rate data from Bloomberg, we run the following regression:

$$\Delta s_{t+12} = \alpha_1 + \beta_1 fd_t + \eta_{t+12} \tag{13}$$

where Δs_{t+12} is the one-year difference of the log value of exchange rates and fd_t is the forward discount (f_t - s_t) as noted earlier.[12] The null hypothesis of an unbiased forward rate implies a value of β_1 equal to one.

The results of the regression are reported in column (1) of Table 4.[13] The estimate of β_1 is significantly less than one, rejecting the unbiasedness hypotheses. This result is in accord with the large degree of evidence that find values of β that are significantly less than one and even negative (see Engel (1996) and Lewis (1994) and references therein). As mentioned earlier, the failure of UIP can be attributed to one, or both, of two sources: a time-varying risk premium, or departures from rational expectations.

Froot and Frankel (1989) employ survey data to decompose the forward discount bias found in a regression just like equation (13) into these two terms. In order to carry out the same exercise for Turkey, we use monthly forecasts of the Lira-US dollar exchange rate based on surveys of analysts from major investment banks, which have been compiled by Consensus Economics since 2001. In their publication *Foreign Exchange Consensus Forecasts*, the mean of the forecasts, the standard deviation, as well as the extreme points (min and max) are reported. In what follows, we use the mean 1-year ahead forecast from the various monthly issues of this publication.

[12] We only present the results using one-year maturities to match the survey data that we use later. Nevertheless, similar regressions were carried out for all maturities and theresults are available from the author upon request.
[13] As noted in Hansen and Hodrick (1980), the use of overlapping observations induces a moving-average process in the error-term. We adjust our estimates of the standard errors to account for this.

Table 4: Froot and Frankel (1989) regressions[a]

Coefficients[b]	Δs_{t+1} on fd_t (1)	Δs^e_{t+1} on fd_t (2)	Δs^e_{t+1} - Δs_{t+1} on fd_t (3)
β_i	0.250**	0.349***	0.077
	(0.099)	(0.046)	(0.116)
α_i	-0.070***	0.043***	0.124***
	(0.025)	(0.010)	(0.029)
N	75	88	75
R-square	0.09	0.49	0.51

[a] Notes: Robust standard errors in parentheses. *, ** and *** represent significance at the 10, 5 and 1 percent respectively.
[b] The subscript i refers to either 1,2 or 3 as appropriate

Using the definition of the risk premium,

$$rp_t \equiv fd_t - \Delta s^e_{t+12} \tag{14}$$

where Δs^e_{t+12} is the 1-year expected change in the exchange rate, one can write the coefficient β_1 in equation (13) as

$$\beta_1 = 1 - b_{re} - b_{rp} \tag{15}$$

where

$$b_{re} = \frac{-\operatorname{cov}(\eta_{t+12}, fd_t)}{\operatorname{var}(fd_t)}$$

$$b_{rp} = \frac{\operatorname{var}(rp_t) + \operatorname{cov}(\Delta s^e_{t+12}, rp_t)}{\operatorname{var}(fd_t)}$$

and η_{t+12} is the expectational error of market participants. With the use of the survey data as a proxy for expected changes in the spot exchange rate, the term b_{rp} can be independently measured.

Table 5 presents the results of the decomposition of β_1 as in equation (15). Contrary to the findings of Froot and Frankel (1989) for the case of industrialized countries, we find that the majority of the bias in forward rates for the case of Turkey is due to the existence of a risk premium. In order to verify if the point estimates in Table 5 are statistically significant, we follow Froot and Frankel (1989)'s suggestions for the following two tests:

$$\Delta \hat{s}^e_{t+12} = \alpha_2 + \beta_2 fd_t + \varepsilon_t \tag{16}$$

and

$$\Delta \hat{s}^e_{t+12} - \Delta s_{t+12} = \alpha_3 + \beta_3 fd_t + \upsilon_{t+12} \tag{17}$$

where $\Delta \hat{s}^e_{t+12}$ is the survey-based expectation.

Table 5: Components of the failure of the unbiasedness hypothesis[a]

Data set	N	Failure of rational expectations b_{re} (%)	Existence of risk premium b_{rp} (%)
Consensus Forecasts	88	13.4	86.6

[a] Elements in the table are presented as a percentage of the implied forward discount bias.

The first equation tests whether the estimates of the risk premium component is statistically different from zero. We can show that $\beta_2 = 1 - b_{rp}$, and so a rejection of the null hypothesis of $\beta_2 = 1$ would serve as evidence in favor of a statistically significant risk premium. Equation (17) instead is equivalent to the test in Fama (1984) where *ex-post* errors are regressed on information available at time t, namely the forward discount. If $\beta_3 \neq 0$, investors could have profited by employing a strategy of "betting against the forward discount", thus implying a failure of rational expectations.

Columns (2) and (3) of Table 4 present the results of these two regressions. In column (2), we find that β_2 is significantly less than 1, providing support that the risk premium does

indeed explain a significant portion of the forward discount bias. We also find further support based on the results in column (3), which shows that there exists no systematic expectational errors in exchange rate forecasts. Agents appear to be efficiently making use of information available at time t, at least in so far as the forward discount is concerned.

The analysis above presents strong evidence for the existence of foreign exchange risk premia for the Turkish lira. Figure 9 plots the behavior of the risk premium, as computed using equation (14). The risk premium has declined substantially since the 2001 financial crisis. While the risk premium during the period 2001-2003 fluctuated within the 20-40 percent range, it has since then moderated to the 0-10 percent range, with high points reached during the May-June 2006 turbulence and the early part of 2008.

The failure of the UIP due to the existence of a risk premium translates to a failure of the real UIP condition as well, such that, even if PPP holds, real rates in Turkey will be higher than real rates abroad. For the period 2004 to 2008, the risk premium averaged about 5 percent. As a benchmark, steady-state real interest rates for the US are typically estimated at about 4 percent (see Cooley and Prescott (1995) for estimates from the business cycle literature and Laubach and Williams (2003) for a Kalman filter approach), suggesting real interest rates in Turkey of about 9 percent.

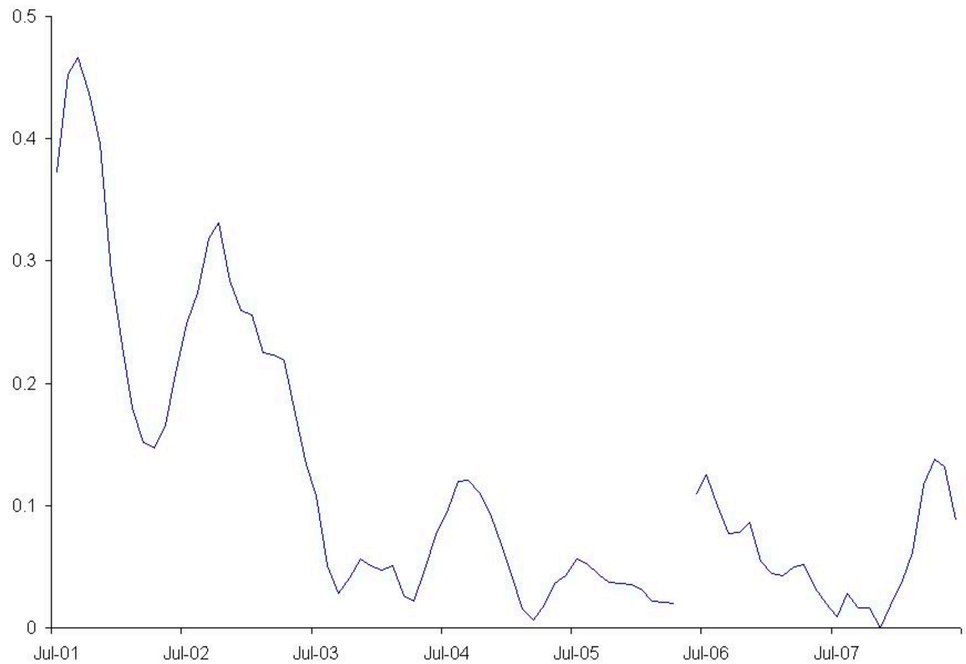

Figure 9: Foreign Exchange Risk Premium on 1-year Forwards (six-month moving average).

To further investigate the behavior of the risk premium, we study the implications of the portfolio balance model of exchange rate determination, just as in Giorgianni (1997). The portfolio balance model attributes the risk premium to the fact that domestic and foreign bonds are imperfect substitutes. In equilibrium, an increase in the relative supply of domestic bonds requires an increase in the expected excess return on the security. Following Giorgianni (1997), we estimate the following equation:

$$rp_t = \alpha_4 + \beta_4 DEF_t^e + \beta_5 DEF_t^{*e} + \omega_t \tag{18}$$

where DEF^e_t refers to the expected budget deficit of the central government (relative to GDP) and DEF^{*e}_t refers to the foreign equivalent, of which we use the US.[14]

Table 6 presents the results from estimating equation (18). The data source for the budget deficit for Turkey is the same used in the previous section. For the US, we use changes in the quarterly stock of gross public debt from the *FRED* database maintained by the St. Louis Federal Reserve, and interpolate the monthly observations. Standard OLS estimates of equation (18), however, result in residuals that are serially correlated. We account for this

[14] Just as in Giorgianni (1997), we compute the expected series based on an estimated autoregressive process for the respective series.

two ways. First, we use robust standard errors in an OLS framework, and second, we estimate the model using the FGLS procedure. The results in Table 6 confirm the implications of the portfolio balance model—higher domestic budget deficits result in a higher risk premium. The magnitude of the estimates suggest an almost one-for-one relationship between the budget deficit and the measure of the foreign exchange risk premium. However, foreign budget deficits, despite having the correct sign at least for the FGLS estimates, are all not significantly different from zero.

Table 6: Impact of budget deficits on the risk premium[a]

	OLS		FGLS
	(1)	(2)	(3)
Domestic budget deficit to GDP	1.091***	1.165***	1.171***
	(0.25)	(0.24)	(0.37)
Foreign (US) budget deficit to GDP		0.802	-0.15
		(2.09)	(2.08)
Constant	0.048***	0.022*	0.032
	(0.018)	(0.012)	(0.028)
ρ^b			0.637
N	84	79	79
R-square	0.15	0.32	0.17

[a] Notes: Robust standard errors in parentheses. *, ** and *** represent significance at the 10, 5 and 1 percent respectively.

[b] The first-order autoregressive coefficient for the estimated residuals

V. Conclusion

As mentioned in the introduction, the question of why real interest rates in Turkey are high is a multi-faceted one. This paper has approached this question in a variety of ways that hopefully capture some of the more important determinants of real interest rates in Turkey. Both the "negative" and "positive" results in this paper are of interest. With regards to the "negative" results, we have been able to dismiss the predictions for real interest rates based on the standard growth model primarily due to its failure along the cross-country dimension. Countries that are similar to Turkey, in terms of growth rates and the marginal product of capital, have much lower interest rates.

The "positive" results instead point towards two other explanations: credibility concerns and a high risk premium. These explanations are by no means novel. The financial press and analysts' reports constantly mention them in reference to the high real interest rates in

Turkey. This paper's contribution, however, is to provide a more systematic and rigorous analysis of these hypotheses. We conclude that they are indeed relevant explanations of high real interest rates in Turkey.

Both the credibility regarding disinflation and the foreign exchange risk premium show a favorable trend over the last few years that bode well for a gradual decline of real interest rates over time (see Figures 6 and 9). These favorable trends are due in no small part to the impressive fiscal consolidation that has taken place over the last 4 years. As we have shown repeatedly in this paper, fiscal policy variables play an important role in the determination of real interest rates. The challenge now is to lock in these hard-won gains, such that risk premiums decline and policy credibility improves, so that medium-term real interest rates can gradually decrease towards the world average rate.

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