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The Effects of Government Deficit on Equilibrium Real Exchange Rates and Stock Prices

Abstract

This paper studies the effect of government deficits on equilibrium real exchange rates and stock prices. The theoretical part modifies a two-country cash-in-advance model like used in Lucas(1982) and Sargent(1987) in order to accommodate an exchange rate market and a government that pursues fiscal and monetary policy targets. The implied result is that unanticipated shocks in government deficits raise expectations of both taxes and inflation and, therefore, are associated with real exchange rate devaluations and lower stock prices. This finding is strongly supported by empirical evidence for a group of 19 countries, representing 76% of world production.

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1 Introduction

Can persistent government budget deficits affect the exchange rate value? What are the possible links between fiscal and monetary policies and stock market performance? Given some recent currency crises and the increasing intensity of capital mobility since the early 70's, when almost only institutional funds were available, these questions represent an increasing concern among policymakers and academics.[1] Still, until recently economists made little effort to link government fiscal solvency to the exchange rate value and other asset prices. The present paper aims to contribute toward filling this gap.

This study is theoretical and empirical. The theoretical part, which constitutes the next section, develops a model where government deficits influence supply and demand, and therefore prices, for the national currency exchange rate and stocks. The empirical part, presented in section 3, uses post Bretton Woods data for 19 countries in order to study the empirical evidence relating asset price movements to fiscal fundamentals.

The sample is representative in terms of world production and includes both industrialized and emerging economies. The inclusion of developing economies in the sample is important because it allows one to test the usual claim that developing economies are more vulnerable than industrialized countries to currency and stock markets crises resulting from fiscal shocks.

The economic model's main contribution is to link a government policy, of pursuing specific targets for money expansion and taxes, to private agents ' expectations about future taxes and inflation. More specifically, given the government goals, what matters is how agents expect the government to finance an increase in the government budget deficit: by an increase in the public debt, and consequently higher taxes in the future, or by money creation.[2]

[1] To name a few up to the time this paper was written: Sweden 1992, see Obstfeld (1994); Mexico 1995, see Cole and Kehoe (1996); Southeast Asian economies 1997, see Burnside, Eichenbaum and Rebelo (1998); Russia 1998 and Brazil 1999, for data on the last two see IMF, International Financial Statistics CD-ROM.

[2] Another possibility would be government explicit default; for the sake of simplicity I will assume that government debt has no explicit default risk.

If agents expect that an increase in the government debt will finance the deficit, they anticipate higher taxes in the future and lower net dividends from taxable assets, which means lower stock prices today. On the other hand, when private agents expect that money creation will be used as the financing instrument, they anticipate future inflation, which in the model implies exchange rate devaluation. On a more general level, households attribute a positive probability to each possible event. Therefore, an unexpected increase in the deficit raises expectations for future taxes and future inflation, implying lower stock prices and exchange rate devaluation.

The model also introduces an exchange currency market at the end of the day. In this market, currency's demand and supply determines the equilibrium real exchange rate. This price determination reflects the relative inflation risk of each country, which depends on fiscal fundamentals. This results in a more general form of no-arbitrage conditions than the *Power Purchasing Parity* (*PPP*) theory. The *PPP* theory would be a specific case where there is no inflation risk, or the same relative risk, in carrying each currency overnight.

Section 3 explores the empirical data. Data is annual and represents 19 countries during the post Bretton-Woods period, 1974-98. The results give empirical support to the model developed in section 2. Pooled data regressions demonstrate a statistically significant correlation between real exchange rates and stock market prices, on the one hand, and the government budget deficit and other fiscal fundamentals on the other hand. The section also estimates the equilibrium exchange rate equation from the previous section. Using only data on government budget deficits and debt, the artificial time series approximates very closely the actual exchange rates.

Besides the conventional *PPP* definition for real exchange rates, section 3 also makes use of a more appropriate definition of real exchange rate, the *true* real exchange rate. As pointed by Sjaastad (1996, 1998a, 1998b and 1999) the *PPP* definition is just an empirical proxy of the *true* real exchange rate, which is defined as a ratio of a price index for traded goods to a price index for nontraded goods. It turns out that regressions using the true exchange rate definition delivers more significant coefficients and a better fit.

Section 4 gathers the results from the previous chapters and presents the paper's final conclusions and directions for future research.

2 Fiscal Fundamentals and Asset Pricing

The goal of this section is twofold: first, to review the literature concerning the effects of government budget deficits on the economy and to discuss the empirical evidence on the topic; and second, to develop an economic model that constructs a more direct link between fiscal policy and asset prices.

The next section presents the review of the literature. Section 2.2 explores some preliminary empirical evidence, which will be studied in more detail in section 3. Section 2.3 introduces some modifications on Lucas ' (1982) and Sargent's (1987) two-country cash-in-advance models, in order to link exchange rates and stock prices to fiscal fundamentals. Section 2.4 extends the model to a small economy where there is no aggregate risk.

2.1 Review of the Literature

Standard economic theory usually predicts that an increase in the government deficit will attract foreign capital and appreciate the equilibrium exchange rate, provided that the government has no problem rolling over its debt.

For instance, Ball and Mankiw (1995) claim that a higher government deficit increases the demand for loans, which drives interest rates up and attracts foreign capital. By equilibrium of the balance of payments, the counterpart to the foreign capital flow is a decrease in the commercial account surplus, which requires a real exchange rate appreciation.

Despite the simplicity and the logical appeal of this argument, it is in one sense just a manipulation of account identities. Namely, the gross domestic product, GDP, can be decomposed as:

$$Y_t = C_t + G_t + I_t + X_t - M_t \qquad (2.1.1)$$

where Y_t is the GDP, C_t is private consumption, G_t is the government consumption, I_t is investment and X_t and M_t are respectively exports and imports of goods and services. Subtracting taxes, T_t , from both sides and rearranging yields

$$(T_t - G_t) + (Y_t - T_t - C_t) + (M_t - X_t) = I_t \qquad (2.1.2)$$

Ball and Mankiw (1995) claim that an decrease in government surplus $(T_t - G_t)$, causes an decrease in private savings $(Y_t - T_t - C_t)$, and investment I_t which are altogether offset by an increase in external savings $(M_t - X_t)$ such that equation (2.1.2) is valid.

However, the opposite result can be obtained as well, everything depending crucially on the private agent's demand for government bonds. For instance, if the government cannot credibly guarantee higher surpluses in the future to repay debt, agents may be unwilling to acquire more bonds. The increase in the interest rate may be unable to increase the demand for bonds because it worsens the fiscal situation even more. Private agents will anticipate higher inflation, or a public default, or higher taxes in the future, which leads to capital flight, currency devaluation, and a fall in stock prices. Notice that, according to equation (2.1.2), investment level falls sufficiently to accommodate decreases in all of the three terms on the right hand side.

Sargent and Wallace (1981) show that demand for bonds has important fiscal and monetary policy effects. The authors assert that the real stock of bonds cannot indefinitely grow faster than the size of the economy. Thus, the demand for bonds will place an upper limit on the ratio of government debt to GDP and once this limit is reached, government deficits will have to be financed by either an increase in seignorage revenues, higher taxes, or a combination of both.

Many authors explore the possibility of fiscal fundamentals generating confidence crises. Ize and Ortiz (1987) show that, assuming price inertia, a fiscal shock (increase of the government debt) can induce capital flight and real exchange rate devaluation. Eaton (1987) illustrates that, because capital flight escapes taxation, the interdependence of investors can lead to the phenomenon of contagion. The investor who stays in the country pays higher taxes not only because of the higher

government deficit but also due to the tax base cut resulting from capital flight. In equilibrium, all investors will take their capital abroad. Obstfeld (1994) explores a self-fulfilling model of currency crises where government endogenous responses to market expectations and fiscal fundamentals play an active role in determining the equilibrium exchange rate.

Despite the possibility of fiscal shocks generating currency crises, the literature on speculative attacks of fixed exchange rate regimes gives little attention to those fundamentals. Garber and Svensson (1995) survey the literature and report that, although many of its models link the occurrence of speculative attacks to the increase of domestic credit, researchers give little attention to the relation between government financial needs and the creation of domestic credit.

In summary, the discussion above demonstrates that the government's ability to roll over its debt, and private agent's expectations about government's financing strategies, mediate the effects of budget deficits on the economy. However, the main theories of equilibrium exchange rates ignore the role of fiscal fundamentals. Subsection 2.2.1 reviews equilibrium exchange rate theories while subsection 2.2.2 discusses asset pricing equations and fiscal policies.

2.1.1 Equilibrium Exchange Rates

Most of the macroeconomic models that try to capture exchange rate movements assume that *Power Purchasing Theory* (*PPP*) theory of exchange rate determination holds. As stated by Dornbusch (1995, page 265): The *PPP* theory "asserts (in its most common form) that the exchange rate between two currencies over any period of time is determined by the change in the two countries relative prices levels." This is also known as the *weak form* of the *PPP* theory.

Despite the simplicity and no-arbitrage appeal of the *PPP* theory, empirical evidence shows that it does not hold on the short run. Froot and Rogoff (1995) survey the extensive literature testing the *PPP* hypothesis and report that half-life deviations from *PPP* are around 3-5 years for major industrialized countries.[3]

[3] Killian and Zha (1999) using a Bayesian approach find evidence of even higher half-lives for major industrialized countries. Edwards and Savastano (1999) report that supporting evidence for various forms

Sjaastad (1996, 1998, 1998b and 1999) provides one remarkable explanation for the empirical failure of the *PPP* theory. While one could argue that prices of traded goods are determined by world demand and supply, the price of a nontraded good does not have to be the same for different countries.

Therefore, a more appropriate definition of the real exchange rate consists of the ratio of a price index for traded goods to a price index for nontraded goods measured in a common numeraire, the true real exchange rate. Sjaastad's methodology also shows that the use of the conventional measure of *PPP*-real exchange rate as an empirical proxy of the *true*-real exchange rate is subject to very high measurement error and sheds doubt on the relevance of a plethora of papers testing the *PPP* hypothesis.

One example of the use of the *PPP* theory on economic models is the seminal paper of Lucas (1982), which integrates monetary theory with the apparatus of modern financial economics. In his model, provided symmetric allocation between agents, the real exchange rate is the ratio of the marginal utilities for foreign and domestic consumption goods. Consequently, an increase in government purchases implies change in the marginal utilities ratio and movements on the real exchange rate.

The Fiscal Theory of the Price Level (*FTP*) [see Cochrane (1998, 1999, 2000) and Woodford (1996)] inspires a different approach that tries to link fiscal fundamentals to the real equilibrium exchange rate. Dupor (2000) and Loyo (1998) extend the *FTP* to open economies and obtain an indeterminacy in the equilibrium exchange rate, similar to the classical result obtained by Kareken and Wallace (1981).

However, as Daniel (1999) points out, the exchange rate indeterminacy no longer holds if we assume that benevolent governments choose to eliminate Ponzi-Game schemes that benefit foreign agents. In this case, the exchange rate is determined by the relative ratio of each country's nominal

of PPP is even weaker for emerging economies. Furthermore, if one uses only data from the post Bretton-Woods period [see Rogoff (1996)], or control for cross-sectional correlation [see O'Connel (1998)] the assumption that real exchange rates follow a random-walk cannot be reject.

debt plus money supply to the discounted value of future surpluses.

2.1.2 Stock Prices

Consider an asset that produces a stochastic flow of dividends $\{D_{t+j}\}_{j=0}^{+\infty}$, which is taxed at the ad-valorem rate $\{\tau_{t+j}\}_{j=0}^{+\infty}$. Since the net flow of dividends is $\{(1-\tau_{t+j})D_{t+j}\}_{j=0}^{+\infty}$, this asset will be priced at

$$p_t^s = \sum_{j=0}^{+\infty} E_t\left[m_{t,t+j}(1-\tau_{t+j})D_{t+j}\right] \tag{2.1.3}$$

where $m_{t,t+j}$ is the stochastic discount factor from period t to $t+j$.

From this pricing equation it is trivial to see that the fiscal policy on government taxes will have direct effects on asset prices. If, for simplicity, we assume that there are no aggregate risks such that the discount factor does not depend on government variables, then it is easy to verify from equation (2.1.3) that higher taxation implies lower stock prices. There would be no effect only if taxes are not linked to stock ownership, as in the case of lump-sum taxes.

In the consumption-capital pricing model (*C-CAPM)*, pioneered by, among others, Lucas ' (1978) tree-model, we have $m_{t,t+j} = \beta^j[u'(C_{t+j})/u'(C_t)]$, where $\beta \in (0,1)$ is the intertemporal discount rate and $u'(C_s)$ denotes the representative agent one-period marginal utility of consuming C_s at time period s (by equilibrium of the goods market $Y_{t+j} = G_{t+j} + C_{t+j}$, where Y_{t+j} is the national income and G_{t+j} the government consumption). Thus, for the *C-CAPM* equation (2.1.3) specializes to

$$p_t^s = \sum_{j=0}^{+\infty} E_t\left[\frac{\beta^j u'(Y_{t+j}-G_{t+j})}{u'(Y_t-G_t)}(1-\tau_{t+j})D_{t+j}\right] \tag{2.1.4}$$

For the $C-CAPM$ model, not only the way that government finances its expenditures but also the government consumption stream, $\{G_{t+j}\}_{j=0}^{+\infty}$, influences stock prices. The model to be presented on section 2.3 also includes an additional feature on a stock pricing equation (2.1.4), which is the fact that inflationary revenues can inflate away part of the dividends flow $\{D_{t+j}\}_{j=0}^{+\infty}$.

2.2 Empirical Motivation

The review of the literature showed that the effects of budget deficits rely on the assumptions made about the government's ability to roll over its debt. If higher interest rates attract foreign capital to finance an increase in government deficit, the exchange rate should appreciate. On the other hand, if an increase in government deficit generates fears of higher future inflation, or higher taxes, or even explicit defaults, the expected result could be capital flights, currency devaluation, and lower stock prices.

Some can argue that confidence crises or "hard landing scenarios" are more relevant for developing economies but not really the case for industrialized countries. However, some industrialized countries can show even more volatility on exchange rates than emerging economies.[4]

Section 2.1.2 showed that stock prices depend on the expected level of future government purchases and future taxes. Therefore, since "hard landing scenarios" are usually associated with changes in fiscal policy, these confidence crises can also create substantial stock price movements.

This section sheds more light on the discussion introducing preliminary empirical evidence related to asset prices and government deficits.[5]

Figure 1 plots the government budget deficit, as a ratio of GDP, and the real exchange rate for a selected group of economies.[6] The plots present strong empirical evidence in support of a government deficit being positively correlated with real exchange rate devaluations.

[4] Indeed, exchange rates of developed economies can show even more volatility than exchange rates of developing economies. Edwards and Savastano (1999) report that during the period of January 1995 to November 1997, when the Mexican Peso floated against the dollar without explicit interventions of the Mexican Central Bank, the Mexican Peso/US dollar exchange rate was less volatile than the Yen, the Deutsche Mark, and the Pound/ Dollar exchange rates.

[5] A more complete analysis of the empirical evidence concerning fiscal policy and asset pricing, including a detailed descriptions of the data used, is discussed in section 3.

[6] The Real Exchange Rate is defined as $e_t P_t^{US}/P_t^{Nat.}$ where e_t is the nominal exchange rate in terms of national currency per US dollars at time t, P_t^{US} and is $P_t^{Nat.}$ are respectively the price level at time t of the United States and the national economy. Base price levels were obtained from the Penn World Tables for the year of 1990, other years ' price levels were calculated from the base year using the GDP-deflator. The true real exchange rate is defined as the ratio of an index price level for traded goods to an index price level for nontraded goods. Thus, for both definitions, an increase (decrease) in the real exchange rate value means a devaluation (appreciation) of the currency.

Figure 2 plots government surpluses, as a ratio of GDP, and stock prices.[7] The sample includes five industrialized economies: United States, Japan, Germany, Italy, and the United Kingdom, and four emerging economies: Mexico, South Korea, Malaysia, and the Philippines.

The data presented in Figures 1 and 2 indicate a positive correlation between government surpluses and stock prices values for all the countries analyzed. The empirical evidence of Figure 2 can be explained in light of the asset pricing equation (2.1.3) and the consumption-based (*C-CAPM)* model, equation (2.1.4). The intuition is that an unexpected higher government deficit (or surplus) can indicate expectations of higher (or lower) taxes and higher (or lower) inflation in the future and, consequently by (2.1.3) or (2.1.4), lower (or higher) stock prices.

Table 1 expands the sample used in Figures 1 and 2, reporting the sample correlations of government budget deficit as a ratio of GDP with the *true* and the *PPP* real exchange definitions and stock prices measured in 1995 national currency and 1995 U$ values.[8]

Data on Table 1 is annual and it is distributed in an unbalanced way for the post Bretton-Woods period, 1974-1998. The sample includes 10 high income economies and 9 middle income economies.[9] These countries responded for a total GDP of U$21,957 billions in 1998, which represents 76% of world total production.

Looking at table 1 we can verify that all high-income economies, excluding France, present evidence of a positive correlation of government financial requirements with exchange rate devaluation and lower stock prices.

The Latin America middle-income economies also demonstrate currency devaluations associated with higher deficits. However, the same evidence is not so clear for emerging Southeast Asian

[7] In Figure 1 annual stock prices are from DataStream Primark total market index, which is a price index for the most important stocks of each country. Stock prices are end of period values measured in national currency and deflated for 1995 values. The 1995 values are also normalized to 100.

[8] The methodology to compute the true real exchange rates is the same as described in Sjaastad (1996, 1998, 1998b and 1998), see appendix D. The PPP real exchange rate definition is the conventional one, nominal exchange rate times relative price levels. Stock prices are measured in constant currency values from 1995. A more detailed description of the data used in this section is presented in subsection 3.1.

[9] Definitions follow the World Bank classification as of 1998. High Income Economies correspond to those with a GDP per head in 1998 above U$9,361 while the range is from U$761 to U$9,360 for middle income economies.

economies.

For stock market correlations with government deficits, the only exception to a negative correlation between deficits and stock prices seems to be Argentina. In general, the empirical evidence for the selected sample of 19 countries is coherent with the intuition that increases in government deficit imply expectations of higher inflation and higher taxes in the future, devaluing the national currency value and depressing stock prices.

The model developed in the next section will explore this insight to match the empirical observations. Section 3 will investigate in more detail the empirical evidence controlling for known effects in the literature.

2.3 A Two-Country Cash-in-Advance Model

Consider a world economy that consists of two countries denoted by Home, H, and Foreign, F, each with its own currency, respectively denoted by $H\$$ and $F\$$. Private agents of these economies are characterized by one representative agent (Household) for each country. As in Lucas (1978), there is one good, which is produced by trees. Each country indexed by j, where $j = H$, F, has one tree that produces at time t a total amount of Y_t^j units of this consumption good. For the sake of simplicity, the endowment of country j is supposed to grow at a deterministic rate γ^j

$$Y_t^j = (1+\gamma^j)^t Y_0^j \tag{2.3.1}$$

Households in both countries have identical preferences represented by the utility function

$$E_0 \left[\sum_{t=0}^{+\infty} \beta^t \frac{(c_{it}^H + c_{it}^F)^{1-\sigma} - 1}{1-\sigma} \right] \tag{2.3.2}$$

where c_{it}^j denotes the consumption of goods produced in country j by the Household residing in country i.

Agents trade three kinds of assets: national currencies, $H\$$ and $F\$$; one-period inflation index bonds denominated in each country currency; and stock shares of the Home and the Foreign tree that give rights to the respective tree's endowment flow. Stock ownership is subject to taxation.

If the Household resident in country i held, at the end of period t, $s_{i,t}^{j}$ shares of stocks j, $j = H$, F, the amount of tax due in period t, measured in $j\$$, is $s_{it}^{j}\tau_t Y_t^j P_t^j$.

The government of country j issues government bonds, prints the national currency, and collects taxes from the ownership of their respective country's stock in order to finance expenditure levels of $g_t^j Y_t^j$ units of goods. We shall assume that the level of government purchases, $x_t = (g_t^H, g_t^F)$, is governed by a first-order Markov Process, in particular, assume for $j = H, F$:

$$g_t^j = (\bar{g}^j + \varepsilon_t^j + \varepsilon_{t-1}^j) \tag{2.3.3}$$

where the innovations are such that

$$\varepsilon_t^j \tilde{} U[-h^j, +h^j],\ h^j > 0,\ \bar{g}^j \pm 2h^j \in (0,1)\ \ \forall t, j \tag{2.3.4}$$

Equations (2.3.3) and (2.3.4) assume that government purchases have some persistence and do not exceed the level of national production. The argument for government expenditures following (2.3.3) is that a high deficit (or surplus) will more likely be followed by a high deficit (or surplus) again in the next period.

In order to simplify the argument, assume that the entire government debt consists of one-period inflation indexed bonds. Denote the price level, measured in *j\$* currency, for the consumption good in country j by P_t^j. Thus, at the beginning of period t, country $j's$ government spends $(1 + r_t)P_t^j B_t^j$ to repay debt acquired in period $t - 1$, and collects $P_t^j B_{t+1}^j$ by issuing new debt and by redeeming $\tau_t^j Y_t^j P_t^j$ from taxes. An extra source of revenue for the government of country j comes from seignorage revenues, which generates at time t an additional amount of $M_{t+1}^j - M_t^j$ in $j\$$.

In units of consumption goods, government $j's$ is subject to the budget constraint

$$B_{t+1}^j + \tau_t^j Y_t^j + \frac{M_{t+1}^j - M_t^j}{P_t^j} = (1 + r_t^j)B_t^j + g_t^j Y_t^j \tag{2.3.5}$$

For now, let the money demand equation be $M_{t+1}^j = P_t^j Y_t^j$, and this will be justified later. Thus, if one uses the requirement that the value of government debt as a fraction of national

output cannot have an explosive path, equation (2.3.5) can be written in an integrated form as

$$b_{t+1}^{j}=\sum_{k=1}^{+\infty}E_{t}\left[\prod_{l=1}^{k}\left(\frac{1+\gamma^{j}}{1+r_{t+l}}\right)\left(\tau_{t+k}^{j}-g_{t+k}^{j}+\frac{\mu_{t+k}^{j}}{1+\mu_{t+k}^{j}}\right)\right] \tag{2.3.6}$$

where $b_{t+1}^{j}\equiv B_{t+1}^{j}/Y_{t}^{j}$ is the end of period debt as a ratio of GDP and $\mu_{t}^{j}\equiv M_{t+1}^{j}/M_{t}^{j}-1$ is the growth rate of money supply.

As in Sargent (1987), governments have to set aside enough cash to buy consumption goods. Therefore, the amount of cash that government j holds, m_{t}^{j}, after collecting taxes and rolling over its debt has to satisfy[10]

$$m_{t}^{gj}\geq P_{t}^{j}g_{t}^{j}Y_{t}^{j} \tag{2.3.7}$$

Because government debt is inflation-indexed and there is no default risk, no-arbitrage implies that the real interest rate has to be the same in both countries, that is

$$r_{t}^{H}=r_{t}^{F}=r_{t} \tag{2.3.8}$$

A *fiscal policy* for the government j at time period t is defined as a choice of tax sequence $\{\tau_{t+k}^{j}\}_{k=0}^{+\infty}$. A *monetary policy* for the government j at time period t is defined by a sequence of money supplies $\{M_{t+1+k}^{j}\}_{k=0}^{+\infty}$. Given the stochastic sequences for interest rates, government expenditures, and national endowment $\{r_{t+k},g_{t+k}^{H},g_{t+k}^{F},Y_{t+k}^{H},Y_{t+k}^{F}\}_{k=0}^{+\infty}$, a *feasible policy* for government j at time period t is a sequence of fiscal and monetary policies, possibly contingent on the state of the economy $x_{t}=(g_{t}^{H},g_{t}^{F})$, such that equations (2.3.3) to (2.3.8) hold.

The structure of trading plays a very important role in the model.[11] At the beginning of each period, information is revealed and the values of the variables $g_{t}^{j},\tau_{t}^{j},M_{t+1}^{j},P_{t}^{j}$ for $j=H,F$ are announced, as well as the contingent future fiscal and monetary policies of both governments, $\{\tau_{t+k}^{j},M_{t+1+k}^{j}\}_{k=1}^{+\infty}$ for $j=H,F$. Afterward, the time period is subdivided in three distinct and consecutive trading sections: the *securities trading section*, the *shopping section*, and finally the *currency trading section*.

[10] This amount will be $m_{t}^{gj}=P_{t}^{j}\tau_{t}^{j}Y_{t}^{j}+P_{t}^{j}B_{t+1}^{j}-(1+r_{t}^{j})P_{t}^{j}B_{t}^{j}+M_{t+1}^{j}-M_{t}^{j}$.

[11] The timing protocol described here is a generalization of Sargent(1987), Chapter IV.

The securities trading section is divided into two distinct sections, one for each country. In country *j's* securities trading section, private agents of both countries trade only government's j bonds, *j\$* currency, and country j's stock shares. During these sections, the country j government repays old debt, issues new debt, and at the end of the section collects taxes in cash from stockholders.

During the trading section being held in country *j,* the Household residing in country i chooses the amount of currency to take to the shopping section, m_{it}^{pj}, the amount of government j bonds to take to the next period, $B_{i,t+1}^{j}$, and the number of stock shares from trees located on country j to be carried over to period *t+1.* The Household shall face the budget constraint

$$\frac{m_{it}^{pj}}{P_t^j} + B_{i,t+1}^j + s_{it}^j \tau_t^j Y_t^j + s_{it}^j q_t^j \leq \theta_{it}^j \tag{2.3.9}$$

where q_t^j is the spot price for country j stocks, $s_{it}^j \tau_t^j Y_t^j$ is the amount of taxes due at the end of the section and θ_{it}^j denotes the beginning of period real wealth in *j\$* of the Household residing in country *i,* everything measured in j consumption goods.

After the securities trading section, the shopping section takes place. In this section, each Household is constituted by a *shopper* and a *seller.* The shopper uses the cash set aside during the securities trading section to buy goods while the seller sells tree's endowments. A shopper who lives in country i can buy goods in either country, but can only use country *j's* currency to buy goods produced by country j's trees, that is

$$m_{it}^{pj} \geq P_t^j c_{it}^j \tag{2.3.10}$$

After all shopping is finished, each Household visits the tree locations and receives sales receipts (dividends) where it owns shares. Dividends are paid in the currency of the country that the trees are located.

In the currency trading section, households of both countries bring cash left over by the shopper and originating in dividends collection to the currency trading section in order to trade one currency for the other at the nominal exchange rate e_t, in terms of *H\$/F\$.* The constraint for the

currency trading section is that each Household residing in country i, will choose the amount of Home currency, $M^{pH}_{i,t+1}$, and Foreign currency, $M^{pF}_{i,t+1}$, to carry next period satisfying

$$M^{pH}_{i,t+1} + e_t M^{pF}_{i,t+1} = s^H_{i,t} P^H_t Y^H_t + e_t s^F_{i,t} P^F_t Y^F_t + m^{pH}_{it} - c^H_{it} + e_t(m^{pF}_{it} - c^{pF}_{it}) \tag{2.3.11}$$

The justification for the fact that the currency trading section takes place after the shopping section is market efficiency. Since private agents are forced to carry cash from one period to the other, trading currencies allows individuals to diversify the inflation risk of each currency.[12] In equilibrium, if one currency has a lower inflation risk than the other, this will be reflected in an appreciated exchange rate in favor of this currency. From constraint (2.3.11) we have that the real wealth of a Household that resides in country i in *j$* will evolve according to

$$\theta^j_{i,t+1} = \frac{M^{pj}_{i,t+1}}{P^j_{t+1}} + (1 + r_t) B^j_{i,t+1} + s^j_{it} q^j_{t+1} \tag{2.3.12}$$

Government's Problem

Government j's Objective Function at the beginning of each time period t is to choose a *feasible policy*, possibly contingent on the state of the economy $x_t = (g^H_t, g^F_t)$, in order to minimize deviations from exogenously specified *target policies* $\{\bar{\tau}^j_t, \bar{\pi}^j_k\}^{+\infty}_{k=t}$

$$Min_{\{\tau,\mu\}} \sum_{k=0}^{+\infty} \beta^k E_t \left[a \left| \tau^j_{t+k} - \bar{\tau}^j_t \right| + \left| \pi(\mu^j_t) - \bar{\pi}^j_t \right| \right] \tag{2.3.13}$$

where the sequence $\{\bar{\tau}^j_k\}^{+\infty}_{k=t}$ is the *target fiscal policy* and the sequence $\{\bar{\pi}^j_k\}^{+\infty}_{k=t}$ is the *target inflation rate.*[13] Because the inflation rate sequence is a direct function of the fiscal policy sequence, the target inflation rate will also be referred to as the *target monetary policy* $\{\bar{\mu}^j_k\}^{+\infty}_{k=t}$.[14] Therefore, I denote country j's *fiscal and monetary policy targets* as $\{\bar{\tau}^j_k, \bar{\mu}^j_k\}^{+\infty}_{k=t}$.

[12] Notice that because governments own no trees, governments will not carry cash from one period to the other.

[13] A more complex target sequence could be derived here, however it is not the objective of this thesis to investigate optimal taxation and optimal inflation schemes. Without loss of generality, we could assume that the policy targets are derived from optimal government policies that are not contingent on shocks.

[14] From the money demand equation $M^j_{t+1} = P^j_t Y^j_t = P^j_t (1 + \gamma_j)^t Y^j_0$. Thus, the inflation rate is given by $\pi^j_t = (\mu^j_t - \gamma_j)/(1 + \gamma_j)$, where $\mu^j_t \equiv M^j_{t+1}/M^j_t - 1$.

For the sake of simplicity, I assume that $\bar{\tau}_t^j = \bar{\tau}$ and $\bar{\pi}_t^j = 0$, $\forall t \geq 0$ and $j = H, F$. The solution for the government problem will consist in a government policy that is contingent on the shocks of government expenditures, $\{\varepsilon_t^j\}_{t=0}^{+\infty}$. The appendix shows that, for a sensible choice of parameters, there is a value $\varpi < h^j$ such that the specific form of the optimal feasible government policy will be to print money and use seignorage revenues to offset exactly the current deficit (or surplus) when the increase in government expenditures, $\varepsilon_t^j + \varepsilon_{t-1}^j$, belongs to an interval $[-\varpi, +\varpi]$, and increase taxes if $\varepsilon_t^j + \varepsilon_{t-1}^j \notin [-\varpi, +\varpi]$, or equivalently if $\varepsilon_t^j \notin [-\varepsilon_{t-1}^j - \varpi, -\varepsilon_{t-1}^j + \varpi]$.

Thus, optimal government *j's* policy will be characterized by

$$\begin{aligned}
\tau_{t+k}^j &= \bar{\tau}_t^j \; ; \; \mu_t^j = \frac{(\varepsilon_t^j + \varepsilon_{t-1}^j)(1+\gamma^j)^2}{1 - (\varepsilon_t^j + \varepsilon_{t-1}^j)(1+\gamma^j)} + \gamma^j, \; \mu_{t+1+k}^j = \gamma^j, \\
\forall k &\geq 0 \quad \text{if} \;\; \varepsilon_t^j \in [-\varepsilon_{t-1}^j - \varpi, -\varepsilon_{t-1}^j + \varpi] \\
\tau_t^j &= (\varepsilon_t^j + \varepsilon_{t-1}^j) + \bar{\tau}_t^j, \; \tau_{t+1+k}^j = \bar{\tau}_t^j \; ; \; \mu_{t+k}^j = \gamma^j, \\
\forall k &\geq 0 \quad \text{if} \;\; \varepsilon_t^j \notin [-\varepsilon_{t-1}^j - \varpi, -\varepsilon_{t-1}^j + \varpi]
\end{aligned} \tag{2.3.14}$$

Given the assumption that $\varpi < h^j$, the event $\varepsilon_t^j \in [-\varepsilon_{t-1}^j - \varpi, -\varepsilon_{t-1}^j + \varpi]$ has probability in the interval $(0, 1)$. Thus, tax changes will be less costly if $\varepsilon_t^j \in [-h^j, \max\{-\varepsilon_{t-1}^j - \varpi^j, -h^j\}] \cup [\min\{-\varepsilon_{t-1}^j + \varpi, h^j\}, h^j]$, which has a strictly positive probability.

The implication for the government policy described by (2.3.13) and (2.3.14) is that increases in taxes generate linear revenues while seignorage revenues are concave on the inflation rate. If the parameter a in (2.3.12) is high enough, and letting $\beta > (1+r)/(1+\gamma^j)$, an immediate increases in inflation revenues is less costly for small shocks on the deficit , $\varepsilon_t^j + \varepsilon_{t-1}^j \in [-\varpi, +\varpi]$, and immediate changes in taxes are the best choice for higher shocks if $\varepsilon_t^j + \varepsilon_{t-1}^j \notin [-2h^j, -\varpi^j] \cup [+\varpi, +2h^j]$.[15]

Also, due to the fact that a high(low) shock at time t, ε_t^j, raises(decreases) conditional expectations for the next period deficit, a high(low) government deficit at time t raises(decreases) expectations conditioned on time t information set about inflation and taxes for period $t + 1$.[16]

[15] In equilibrium, from the price formula for the real exchange rate, the condition $\beta > (1+r)/(1+\gamma^j)$ is naturally satisfied if the parameter σ on the utility function satisfies $\sigma > 1$.

This result will have a direct implication on the correlation of government budget deficits with real exchange rates and stock prices.

Household's Problem

Given the pattern of transactions described above, we can use a recursive formulation to write the problem of each Household $i = H, F$. I assume that households are identical in terms of initial endowments of stocks, bonds and trees. Since both consumers are identical, except in terms of citizenship, I drop the subscript i that identifies the consumer citizenship in the Household's problem and use the superscript $j = H, F$ to denote if the variable is with respect to the Home country or to the Foreign country. Letting primes denote next period values, the Household problem can be defined by the functional equation

$$v(x, \theta^H, \theta^F) = \max \left\{ \frac{(c^H + c^F)^{-\sigma} - 1}{1 - \sigma} + \beta E[v(x', \theta^{H\prime}, \theta^{F\prime}) \mid x_h, x_f] \right\} \tag{2.3.15}$$

subject to:

$$\frac{m^{pj}}{P^j(x)} + B^{j\prime} + s^j \tau^j Y^j + q^j s^j = \theta^j \quad \text{for } j = H, F \tag{2.3.16}$$

$$\frac{m^{pj}}{P^j(x)} \geq c^j \quad for j = H, F \tag{2.3.17}$$

$$M^{pH\prime} + eM^{pF\prime} \tag{2.3.18}$$

$$= \quad s^H P^H(x) Y^H + e s^F P^F(x) Y^F + m^{pH} - P^H(x) c^h + e \left(m^{pF} - P^F(x) c^F \right)$$

$$\theta^{j\prime} = \frac{M^{pj\prime}}{P^j(x')} + (1 + r) B^{j\prime} + q^{j\prime} s \quad \text{ for } j = H, F \tag{2.3.19}$$

$$c^j \geq 0, \; m^{pj} \geq 0, \; \tilde{M}^j \geq 0 \tag{2.3.20}$$

The state variables of this problem are the level of income carried from one period to another in each country's currency, θ^H and θ^F and the level of government expenditures for both countries, $x_t = (g_t^H, g_t^F)$. The distinction between the distribution of income in each currency is important,

[16] By the specification of the shocks and the optimal government policies (2.3.13) and (2.3.14), expected government expenditures conditioned on the time t information set are $E_t[g^j_{t+1} - \tau^j_{t+1}] = E_t[\bar{g}^j + \varepsilon^j_t + \varepsilon^j_{t+1} - \tau^j_{t+1}] = E_t[\bar{g}^j + \varepsilon^j_t - \tau^j_{t+1}] = (1 - p_j)(\bar{g}^j - \bar{\tau}^j) + p_j(\bar{g}^j + \varepsilon^j_t - \bar{\tau}^j) = \bar{g}^j - \bar{\tau}^j + p_j \varepsilon^j_t$, which is increasing in ε^j_t,where p_j is the probability of increasing taxes in the nest period.

since in the next period securities-trading Households can use only domestic currency to trade into each domestic market, see constraint (2.3.16).

Equation (2.3.17) represents the cash-in-advance constraint for the shopping section. Constraint (2.3.18) represents the currency trading section, where private agents use their cash holdings of each currency to trade one currency for the other at the exchange rate e, in terms of $(H\$/F\$)$. Condition (2.3.19) states the law of movement for the state variables θ^H and θ^F. The last constraint, (2.3.20), dictates that the instruments of choice, except possibly $B^{h\prime}$ and $B^{f\prime}$, should be non-negative.

A *competitive equilibrium* in this model is a set of initial conditions $\{M_0^j, \tau_0^j, B_0^j, Y_0^j, \gamma_j, s_{i0}^j, B_{i0}^j, \tilde{M}_{io}^j\}_{j=H,F}$, a set of target policy functions $\{\bar{\tau}_k^j, \bar{\mu}_k^j\}_{k=t}^{+\infty}{}_{,j=H,F}$ a set of stochastic process for $\{g_t^j, \tau_{t+1}^j, B_{t+1}^j, M_{t+1}^j, P_t^j, c_{it}^j, m_{it}^j, s_{i,t+1}^j, M_{i,t+1}^{pj}, B_{i,t+1}^j\}_{t=0;\ i,j=H,F}^{+\infty}$, and pricing functions$\{q_t^j, r_t^j\}_{t=0;\ ,j=H,F}^{+\infty}$, such that

i) The stochastic process $\{\tau_{t+1}^j, B_t^j, M_t^j, \}_{t=0;\ i,j=H,F}^{+\infty}$ is a feasible government policy for country $j = H,\ F$ and solves (2.3.12), and $\{\bar{\tau}_k^j, \bar{\mu}_k^j\}_{k=0}^{+\infty}{}_{,j=H,F}$ solves (2.3.6) for $b_0^j = B_0^j/Y_0^j$;

ii) Given the pricing functions $\{q_t^j, r_t^j\}_{t=0;\ ,j=H,F}^{+\infty}$, the stochastic process $\{c_{it}^j, m_{it}^j, s_{i,t+1}^j, M_{i,t+1}^{pj}, B_{i,t+1}^j\}_{t=0;\ i,j=H,F}^{+\infty}$ solves the Household's problem.

iii) All markets clear, that is, for all t and $i, j = H, F$:

- Currency markets: $m_{Ft}^{pj} + m_{Ht}^{pj} + m_t^{gj} = M_{t+1}^j$.
- Public Debt Market : $B_{t+1}^i = B_{i,t+1}^{pH} + B_{i,t+1}^{pF}$.
- Stock markets: $s_{H,t}^j + s_{F,t}^j = 1$
- Goods market: $c_{Ft}^j + c_{Ht}^j = (1 - g_t^j)Y_t^j$.
- At the exchange rate $e_t(H\$/F\$) : M_{H,t+1}^{pj} + M_{F,t+1}^{pj} = M_{t+1}^j$

This completes the definition of equilibrium.

Equilibrium and price formulas

Now I compute equilibrium allocations and the pricing formulas for interest rates, stock prices,

and the exchange rate. Since individuals of both countries have the same endowment and the same wealth, the equilibrium of this model is the symmetric allocation where in agents of each country keep identical portfolios and consume the same amount of goods each period

$$C_t = c_{Ht}^H + c_{Ht}^F = c_{Ft}^H + c_{Ft}^F = \frac{1}{2}\left[(1-g_t^H)Y_t^H + (1-g_t^F)Y_t^F\right],\ \forall t \geq 0 \tag{2.3.21}$$

In order to have a role for unbacked fiat currency we shall assume that nominal interest rates are always positive, that is $(1+r_t)(P_t^j/P_{t-1}^j) > 0\ \forall t$ and j. Given this assumption, the cash-in-advance constraints bind agents and governments of both countries, implying

$$Y_t^j = c_{Ft}^j + c_{Ht}^j + g_t^j Y_t^j = \frac{m_{Ht}^{pj} + m_{Ft}^{pj} + m_t^{gj}}{P_t^j} = \frac{M_{t+1}^j}{P_t^j} \quad \text{for} \quad j = H, F$$

which implies the money demand equation

$$M_{t+1}^j = P_t^j Y_t^j \quad \text{for} \quad j = H, F \tag{2.3.22}$$

The first-order necessary conditions for the Household problem, which are computed in the appendix, are

$$1 + r_t = \beta^{-1} E_t \left[\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\right]^{-1} \tag{2.3.23}$$

The equilibrium equation for the stock prices is

$$q_t^j = Y_t^j E_t \left[\sum_{k=1}^{+\infty} \beta^k \left(\frac{C_{t+k}}{C_t}\right)^{-\sigma} (1+\gamma^j)^{k-1} \left(\frac{1+\gamma^j}{1+\mu_{t+k}^j} - \tau_{t-1+k}^j\right)\right] \tag{2.3.24}$$

From equation (2.3.24) we can see that stock prices depend on expectations of taxes and seignorage revenues in the future. The stock prices decrease with expectations of higher monetary expansions or higher taxes in the future. The condition that prices the equilibrium exchange rate is

$$e_t E_t \left[\frac{(C_{t+1})^{-\sigma}}{P_{t+1}^H}\right] = E_t \left[\frac{(C_{t+1})^{-\sigma}}{P_{t+1}^F}\right] \tag{2.3.25}$$

Equation (2.3.25) is a generalization of the *PPP theory* of exchange rates. For the special case where there is no inflation risk associated with trading one currency for the other and no aggregate

risk on the next period consumption, we would recover $e_t = P^H_{t+1}/P^F_{t+1} = P^H_t/P^F_t$, which is the *PPP* no-arbitrage formula. However, since private agents are constrained to carry both currencies from one period to another, they are subject to idiosyncratic inflation risks in each country. The pricing equation in (2.3.25) is obtained by allowing private agents to diversify these two inflation risks.

The intuition behind pricing equations (2.3.23)-(2.3.25) is better described using a benchmark economy where there is no aggregate risk. This is the task of section 2.4.

2.4 A Small Economy with no Aggregate Risk

Consider the case where the *Home* country is relatively small compared to the rest of the world economy, which is represented by the *Foreign* country. Thus, as an approximation we will assume

$$(1 - g^H_t)Y^H_t + (1 - g^F_t)Y^F_t \cong (1 - g^W_t)Y^W_t \tag{A1}$$

We shall also assume that there is no aggregate risk in the sense that

$$(1 - g^W_t)Y^W_t = (1 - \bar{g}^W)(1 + \gamma^W)^t Y^W_0 \tag{A2}$$

Since there are no aggregate shocks on the world economy, the monetary and fiscal policy of the rest of the world will be set such that there is no Foreign inflation, which means

$$P^F_{t+1} = \bar{P}^W_0 \quad \forall t \geq 0 \tag{A3}$$

In this case, the pricing equations (2.3.23) to (2.3.25) from section 2.3 simplify to

$$1 + r_t = 1 + r^W = \beta^{-1}(1 + \gamma^W)^\sigma \tag{2.4.1}$$

Theorem 2 in the appendix shows that for this small economy the real exchange rate at the end of period t will be a nondecreasing function of shocks on government expenditures incurred

at the beginning of period t. More specifically, this function takes the form

$$\begin{aligned}
e_t(\varepsilon_t)\frac{P_t^W}{P_t^H} &= \left[1+\frac{1}{4h}\left((h-\varepsilon_t)^2-\varpi^2\right)\right]^{-1} > 1,\ \text{for } h > \varepsilon_t > h-\varpi \\
e_t(\varepsilon_t)\frac{P_t^W}{P_t^H} &= 1,\ \text{for } -(h-\varpi) < \varepsilon_t < h-\varpi \qquad (2.4.2) \\
e_t(\varepsilon_t)\frac{P_t^W}{P_t^H} &= \left[1+\frac{1}{4h}\left(\varpi^2-(h+\varepsilon_t)^2\right)\right]^{-1} < 1,\ \text{for } -h < \varepsilon_t < -(h-\varpi)
\end{aligned}$$

Notice that this function is strictly decreasing for $\varepsilon_t \in [h, h-\varpi] \cup [-h, -(h-\varpi)]$ and constant for ε_t values close to zero, $\varepsilon_t \in [-(h-\varpi), h-\varpi]$.

If the current shock is on the higher interval, $\varepsilon_t \in [h, h-\varpi]$, the deficit is usually high and there is a higher probability of inflation than deflation on period *t+1.* Therefore, real exchange is depreciated relative to its *PPP* parity. If the shock ε_t is close to zero, $\varepsilon_t \in [-(h-\varpi), h-\varpi]$, inflation and deflation are equally likely and the real exchange rate obeys the *PPP* rule. Finally, if the shock on government expenditures is too low at time *t*, $\varepsilon_t \in [-h, -(h-\varpi)]$, deflation will be more likely than inflation in the next period and the real exchange rate appreciates relative to the *PPP* parity.

The equation for the real exchange rate (2.4.2), has a nice interpretation since only high absolute value shocks will deviate the economy from its *PPP* value. The results also match the empirical data where real exchange rates tend to depreciate (appreciate) in response to government deficits (surpluses).

Theorem 2 in the appendix also shows that for this small economy, given the value for ε_{t-1}, stock prices are strictly decreasing in ε_t for all the possible shocks, that is for $\varepsilon_t \in [-h, +h]$. This result stems from the fact that any disturbance of government deficits will be compensated for either by a change in seignorage revenues or a change in taxes, which negatively affect stock prices. The results also match the empirical evidence from section 2.3 and section 3 where stock prices are negatively correlated to government budget deficits.

As a final note to this section, it is important to say that the results of the model depend on the imposed symmetry among the households of both countries. As in Lucas (1982) and Sargent

(1987), the exchange rate is determined assuming that consumption goods in each country can be acquired only with the respective country's currency. If, instead, either currency could be used to purchase goods in any country, the result would be an indeterminate exchange rate as in Kareken and Wallace (1981).

The equilibrium exchange rate determination relies on the assumption made here that currencies Households can trade one currency for the other only at the end of the day and inflation risk can be diversified. In Lucas(1982) and Sargent (1987), the exchange rate market takes place together with securities trading, instead of being exchanged at the end of the day. Therefore, in their models, no-arbitrage implies the PPP rate $e_t = P_t^H / P_t^F$.

3 Empirical Analysis

Recent currency crises have also raised some evidence that high budget deficits lead to a real exchange rate devaluation. Obstfeld (1994) reports that Sweden's Krona strong devaluation in 1992 was contemporaneous with economic recession and a jump in the government deficit from an average budget surplus of 2.5% of GDP to a deficit of 7.1% of GDP in 1992.

The Mexican Peso crisis in January 1995 was preceded by capital flight and a drastic decrease in international reserves in 1994, and accompanied by a strong increase in net domestic credit due to the Mexican central bank's strategy of sterilization, see Mancera(1995). Cole and Kehoe (1996) allege that the currency crisis in Mexico was caused by the inability of the Mexican government to rollover its debt during December 1994 and January 1995, even though a large part of the debt was indexed to the exchange rate, the so called *Tesobonos*.

Burnside, Eichenbaum, and Rebelo (1998) claim that the speculative attack on southeast Asian currencies in July 1997 was related with expectations of high future deficits caused by government guarantees to bailout the failing Asina financial system. Data from the International Monetary Fund (1999, 2000) shows that the Russian currency crisis in August 1998 was accompanied by a Russian government default; in 1998 the real exchange rate devalued 176% and the government

total debt to GDP ratio increased by 167%.

In Brazil, the January 1999 devaluation of 66% of the Real was preceded by an increase in the public debt from 24% of GDP in June 1994 to 44% at the crisis time, see Banco Central do Brazil (1996-2000). Finally, up to the time this paper was written, the recent slide of the Euro against the Dollar also is matched by the fiscal strength of the American government relative to the Euro economies, the former running budget surpluses and a decreasing debt relative to the latter.

The goal of this section is to investigate the empirical evidence introduced in subsection 2.3 in more detail. Section 3.1 describes the database used and its sources. Section 3.2 presents panel-data regressions for real exchange rates. Stock market prices regressed on fiscal fundamentals are presented in section 3.3. Section 3.4 investigates how well the panel data estimates of the previous sections fit to each country individually. Section 3.5 uses the model developed in section 2 to estimate artificial time-series for the equilibrium real exchange rates using parameters picked by non-linear least squares estimates.

3.1 Data Description

The selected sample consists of annual data from 1975 to 1998 for 19 countries. Following the definition of the world Bank, see footnote 9, ten of this group are characterized as high-income economies: Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, the United Kingdom and the United States. Nine countries are considered middle-income economies: Argentina, Brazil, Korea, Indonesia, Malaysia, Mexico, the Philippines, Thailand, and Uruguay.

The sample is representative in terms of world production and in terms of diversity of development stages. The 19 countries accounted for a Gross national Product in 1998 of US$21,957 billions, which represents 76% of the world production. The high-income economies selected, the United States excluded, total US$11,890 billions of production and the middle-income economies US$2,146 billions, which are respectively 53% and 52% of their respective group's total output.[17]

The choice of the time span, 1975-98, was intended to include only the post Bretton-Woods period.[18] For the country fundamentals, the sources of data were the *International Financial Statistics CD-ROM* from the International Monetary Fund (*IFS-IMF)*, the *Penn world Tables* (*PWT*). For Brazilian data, an additional source was the Central Bank of Brazil. For stock market returns, the data source was the total stock markets price indices calculated by *DataStream, Primark.*

I use two definitions of real exchange rate, the *PPP* real exchange rate and the *true* real exchange rate. The first definition is computed as the nominal exchange rate, national currency per U.S. dollar, multiplied by the price levels ratio, the U.S. prices divided by national prices. The nominal exchange used was the annual rate for the end of the period, reported by the *IFS-IMF.* Relative consumption price levels were obtained from the *Penn World Tables* for the year 1990.[19] Price levels other than 1990 values were computed recursively from the 1990 value using the *GDP* deflators.

The true real exchange rate is defined as the ratio of a price index for traded goods to a price index for nontraded goods. I computed this rate using the methodology developed by Sjaastad (1998b), which is described in the appendix. The methodology constructs a index price for traded goods from a weighted average of export and import prices. The weights are estimated by non-linear regressions using quarterly data from 1974 to 1998.[20]

[17] Source: World Bank Development Report, 1998.

[18] During the Bretton-Woods period, 1946-71, other countries pegged their exchange rate against the US dollar. After a turbulent period from 1971 to 1973, the Bretton-Woods system collapsed and the world economy initiated a much less structured exchange rate system, see Obstfeld and Rogoff (1996).

[19] Both real exchange rate definitions were rebased in order to match in 1990 the value of the relative consumption price levels (US prices / National Prices) from the *Penn-World Tables.* However, since regressions were taken in logs and a dummy was included for all countries but one, this normalization had no effect on the results.

[20] For some of the middle-income economies, Argentina, Uruguay, Indonesia, Malaysia and the Philippines, Sjaastad's methodology could not be used due to data absence for export and import prices. For these countries, I used instead the ratio of Wholesale Price Index to Consumption Price Index , obtained from the IFS-IMF. The justification for this empirical proxy is the fact that WPI are heavily weighted toward traded goods while CPI tend to reflect nontraded goods.

In order to obtain elasticities for fiscal variables, I used a definition of government deficit that could not take negative values. Instead of using the conventional definition, *Deficit = Expenditures - Revenues*, a more appropriate definition for our purposes was the ratio *Expenditures / Revenues.*[21] Other fiscal variables used included the total government *Debt* as a ratio of the *GDP.*[22] As a measure of inflationary effects on government debt, I made use of the ratio *(Debt without Inflation/Debt)* $=(Debt_t+\pi_t Debt_{t-1})/Debt_t$, where π_t = inflation rate at time t. This variable estimates how much higher the real debt would be if there were no inflation during the period.[23]

For the stock markets price index there was the methodological problem of choosing for each country a stock markets index that was representative and uniform. Some indices include the 500 most traded stocks, others just the first 100's, others only technology companies, etc. The option selected was for the broadest representation and a uniform methodology of index, which was captured for the *Total Market Index* reported by *DataStream*, *Primark.*[24] Their index included all the stocks traded on each market where data is available. Stock prices are measured in 1995 national currency and also in 1995 U$, using the GDP deflator as the inflation index.

A set of control variables were included to control for some effects characterized in related literature. The *Government Consumption variable* is defined as the ratio of government consumption as a ratio of GDP. The *Real Interest Rate* is the Lending Interest Rates reported by the *IMF* deflated by the CPI. Total *GDP* is the total gross domestic product measured in constant 1995

[21] Following the IMF definitions: Government Expenditures includes Expenditures and Lending minus Repayments. Respectively "all nonrepayable payments by the government, whether requited or unrequited, and whether for current or capital purposes", "government acquisitions of claims on others - both loans and equities - for public policy purposes; and net of repayment to the sales of equities previously purchased". Government Revenues were defined as Revenues plus Grants Received, which means "all nonrepayable government receipts, whether requited or unrequited". The definitions are from the International Financial Statistics Yearbook - IMF, 1999.

[22] By the definition of the IMF International Financial Statistics - IFS: "Debt relates to the direct and assumed debt of the central government and excludes loans guaranteed by the government. The variable debt is the sum of Domestic and Foreign debts. The distinction between Domestic and Foreign Debt is based on residence of the lender, where possible, but otherwise on the currency in which the debt instruments are denominated" - International Financial Statistics Yearbook 1999.

[23] Assuming also that absence of inflation would have no effect on the nominal interest rate on the government debt.

[24] Exception made for Argentina where the Merval stock price index was used.

U$. *GDP Per Capita* for 1990 is from *PWT*, values for other years are deflated form this base value using *IMF* data for growth rates for total GDP at constant prices and population. The *Growth Rate* variable makes reference to the GDP per capita.

Inflation rate is described by the change on the GDP deflator. *Expenditure / GNI* is characterized as Current Account Deficit divided by Gross National Income plus one. *Openness* is the sum of exports and imports of goods and services divided by the GDP. Finally, *Terms of Trade* are defined as the ratio of an Export Price Index and Import Price Index. The source for all controls is the *IFS-IMF* except for the 1990 *GDP Per Capita, PWT,* and some observations for Brazil, "Banco Central do Brasil".

3.2 Real Exchange Rate Regressions

In order to verify the impact of fiscal variables on real exchange rates, I specify two regression equations.[25] The first, called *Basic specification*, uses no controls and no dummies, and serves as a benchmark case for the fiscal policy effects on the real exchange rates:

$$rer_{it}^{x} = \alpha + \delta_{RE}(R/E)_{it} + \delta_D D_{it} + \delta_I DI_{it} + u_i + \varepsilon_{it} \tag{3.2.1}$$

where the subscript i denotes the country and t denotes the time period, rer_{it}^{x} = log of the real exchange rate (x denotes the definition of real exchange rate, *True* or *PPP),* (R/E) = log of government *Revenues/Expenditures*, D_{it} = log of total government *Debt / GDP*, and DI_{it} = log of the variable *Debt without Inflation / Debt.* Since all variables are in logs, the coefficients $\delta's$ are all elasticities of the real exchange rate with respect to the variables. An alternative basic specification excludes the variable DI_{it}.

A second specification, named *Control and Dummies*, assumes different slopes for $(R/E)_{it}$, D_{it}, and DI_{it}, for the group of high-income and two middle-income subgroups Latin American economies (Argentina, Brazil, Mexico, Uruguay), and Southeast Asian emerging economies (Indonesia, Korea, Malaysia, the Philippines, and Thailand). Different slopes for these groups are

[25] The sample excludes the United States, which is the numeraire country for the *PPP* real exchange rate definition, and Indonesia for the Controls and Dummies specification.

intended to account for different patterns presented in the different groups, as can be seen in Table 1, section 2.3. A set of controls for common effects in the literature is also included in this specification[26]

$$\begin{aligned} rer^x_{it} &= \alpha + \sum_{g=hi,la,as} [\delta^g_{RE}(R/E)^g_{it} + \delta^g_D D^g_{it} + \delta^g_I DI^g_{it}] \\ &\quad + \Psi \cdot (controls_{it}) + u_i + \varepsilon_{it} \end{aligned} \tag{3.2.2}$$

where the superscript g denotes the group hi = high-income, la = Latin America, as = Southeast Asia; $x^g_{it} = x_{it}$ if $i \in g$ and $x^g_{it} = 0$ if $i \notin g$; $\Psi \cdot (controls_{it}) \equiv \delta^{hi}_R R^{hi}_{it} + \delta^{la}_R R^{la}_{it} + \delta^{as}_R R^{as}_{it} + \delta_G GRO_{it} + \delta_g gov_{it} + \delta_y y_{it} + \delta_e (ex/y)_{it} + \delta_{op} ope_{it} + \delta_{tt} tt_{it}$. Notation for the controls variable is R_{it} = *Real Interest Rate*, GRO_{it} = *Growth Rate*, gov_{it} = log of *Government Consumption*, y_{it} = log of *GDP per Capita*, $(ex/y)_{it}$ = log of *Expenditures/GNI*, ope_{it} = log of *Openness*, and tt_{it} = log of *terms of trade* (ratio of export price index to the import price index).

In both regressions, u_i is the individual effect and ε_{it} is the independent effect. Including the u_i term takes into consideration the panel structure of the data. This is a simple way to model the fact that two observations of the same country are more like each other than observations from two different countries, see Johnston and DiNardo (1997). The individual effect u_i was directly estimated by including $n-1$ dummies one for each country but one. Table 2 presents estimates of (3.2.1) and (3.2.2), using *OLS* with robust (White) standard errors; Table 3 shows *Prais-Winsten*

[26] A very famous effect is the Balassa-Samuelson effect, see Obstfeld and Rogoff (1996). The prediction of the Balassa-Samuelson effect is that price levels tend to rise with income and fast growing economies, which will tend to see their real exchange rate appreciate. The controls used for this effect are per capita *GDP*, y_{it}, and rate of growth of per capita GDP, GRO_{it}.

It is also reported that government purchases level, which is measured by gov_{it}, affects the real exchange rate. This stems from the fact that government spending is concentrated on nontraded goods. As described in Rogoff (1996), an increase in government spending raises the demand for nontraded goods, which will increase the nontraded sector price level. Capital immobility in the short run increases wages in the nontraded goods sector, which causes the overall price level to rise and makes the real exchange rate appreciate. In the long run capital is perfectly mobile and these results tend to disappear.

The variable $(ex/y)_{it}$ is used to control for the Salter effect. In a very clever exposition, Salter (1959) argues that if a country keeps receiving capital inflow and, consequently, incurring a deficit on the current account, the total expenditure exceeds the national production. Therefore, the real exchange rate has to appreciate to deviate this excess demand towards traded goods.

Additional controls are the real interest rate, R_{it}, and the level of openness, ope_{it}. In particular, the real interest rates constitute an interesting control since their effect can be thought of as twofold: on the one hand, an increase in the real interest rate reflects expectation of currency devaluation and increases the debt burden of the government. In this case, high interest rates can imply self-fulfilling currency crises since they decrease the government's ability to roll-over its debt. On the other hand, an increase in the domestic real interest rate attracts foreign capital and eases the government's financing constraints.

estimates corrected for panel-specific autocorrelation of residuals.[27]

The estimated coefficients confirm the preliminary empirical evidence of section 2.3 and the model predictions from sections 2.4 and 2.5, where government budget deficits are associated with real exchange rate devaluations and lower stock prices. In general, the *true real exchange rate* definition gives a better fit (R^2) and higher t-values than the *PPP* definition. The government budget surplus elasticity, here specified in terms of government *Revenues/Expenditures,* is statistically significant and negative, for high-income economies and Latin Americam middle-income economiesand also does not differ significantly across these economies.

The computed elasticities allow us to generate some quantitative estimations. Government expenditures averages for high-income and Latin American middle-income economies are respectively 30% and 21% of GDP and the elasticities estimated averages are $\delta_{RE}^{hi} \cong -.44$ and $\delta_{RE}^{la} \cong -.42$. Thus, an increase of the surplus of 1% of the GDP will induce an approximate appreciation of the real exchange rate of $(1/.3).(-.44) = 1.5\%$ for high-income economies and $(1/.21).(-.42) = 2\%$ for Latin American middle-income economies.

Looking at the other fiscal variables we observe that *Debt/GDP* has a strong and positive impact on Latin America economies. One of the possible reasons is that government debt in foreign currency accounts for around 50% of total debt of these countries. For high-income and Asian economies the *Debt/GDP* elasticity tends to be negative and significant, but only for the *true real exchange rate* definition. One of the possible reasons is that for these economies, we could expect real interest rates close to or even lower than the growth rate of the economy; thus, keeping a constant *Debt/GDP* ratio indicates positive revenues for these countries.

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[27] For the robust regression estimators, White routine, robust estimates of the standard errors are obtained from the variance matrix: $(X'X)^{-1}X'(\sum_i \sum_j x_{ij}\epsilon_{ij}\epsilon_{ij}x_{ij})X(X'X)^{-1}$where ϵ_{ij} are the regression residuals.

The Prais-Winsten regressions estimates assume that the error component follows a country specific AR(1) process:$\varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + \eta_{it} \quad$ w/ $\eta_{it} \sim N(0, \sigma^2)$and regress

$y_{it} - \rho_i y_{i,t-1} = c(1-\rho_i) + a(x_{it} - \rho_i x_{i,t-1}) + \eta_{it}$ for $t > 1$ and for $t = 1$ $\sqrt{1-\rho_i^2}y_{i1} = c\sqrt{1-\rho_i^2} + a\sqrt{1-\rho_i^2}x_{i1} + \sqrt{1-\rho_i^2}\eta_{i1}.$ The last equation is the only difference between Prais-Winsten estimation and the Cochrane-Orcutt method.

The last fiscal variable, (*Debt without Inflation)/Debt*, which measures revenues from part of the debt being inflated away, seems to be a relevant factor only for high-income economies for the *true real exchange rate* definition. This result could suggest that middle income economies, which present higher inflation rates, are not able to inflate away part of their debt, perhaps because of strong debt indexation.

The controls elasticities and semi-elasticities coefficients also present interesting results. For the *GDP Per Capita*, the negative and significant estimated elasticity is consistent with the *Balassa-Samuelson* effect, see footnote 10. The *Expenditure/GNI* coefficient confirms the Salter Effect: an excess of internal absorption relative to internal production is expected to appreciate the real exchange rate driving the excess of demand toward traded goods. The estimated coefficients also predict that more *Openness* and a fall on *Terms of Trade* are highly significant and tend to be positively correlated with real exchange rate devaluations.

Real Interest Rate, *Growth Rate,* and *Government Consumption* elasticities tend not to be statistically significantly different from zero at a 10% level. The exception is *Real Interest Rate* elasticities with respect to the *true real exchange rate* for Latin America economies, negative, and high-income economies, positive.

The inclusion of the variable $DI_{it} = \ln($ *Debt without Inflation / Debt)* measures the impact of inflationary revenues on debt. An alternative way to measure this impact is to use a different definition of *Government Revenues / Expenditures,* one that takes into account the devaluation of government debt due to inflation as a source of government revenues. This alternative definition of *Government Revenues/ Expenditures* starts from the fact that

$$\frac{\textit{Gov. Rev.}}{\textit{Gov. Exp.}} = \frac{\textit{Gov. Exp.-(Gov. Rev.-Gov. Exp.)}}{\textit{Gov. Exp.}} = 1 - \frac{\Delta \textit{Real Debt}}{\textit{Gov. Exp.}}$$

If we define the real value of debt for $t \geq 1$ as

$$RD_t = \frac{D_{t-1} + (\textit{Expenditures} - \textit{Revenues})_t}{P_t}$$

where D_{t-1} = nominal debt at the beginning of time t and P_t = price level at the end of time

t, and the real value of debt at $t = 0$ is defined as $RD_0 = \frac{D_0}{P_0}$. Then, a definition of the ratio of Government revenues to expenditures that takes into account the devaluation of the government debt due to inflation is given by

$$\frac{Gov.\ Rev.'}{Gov.\ Exp.} = 1 - \frac{RD_t - RD_{t-1}}{Gov.\ Exp.} \tag{3.2.3}$$

Although this definition takes into account inflationary revenues as a source of Government revenues, it does not present satisfactory results. Panel regressions using (3.2.3) as the definition of *Government Revenues/Expenditures*, which are not presented here, implied no statistically significant coefficients at a 5% level and lower R^2 values for almost all regression specifications. The exception was the dummy for high income economies, which was negative and significantly different from zero at a 1% level.

3.3 Stock Price Regressions

The asset price formulas demonstrated in section 2 showed that government deficit has direct implications for stock prices. The intuition for this result relies on the fact that higher government deficits are in general persistent and a higher deficit today induces expectations of higher taxes and or higher inflation in the future, which decreases the discounted flow of expected future dividends. [28] Preliminary empirical evidence, which was discussed on section 2.3, also corroborates this observation.

This section intends to present even stronger evidence that stock prices are negatively correlated with higher government deficits. For this purpose I used two regression specifications, a benchmark *Basic Specification* and a more complete *Controls and Dummies Specification.*[29] The *Basic Specification* runs the regression

$$q^x_{it} = \alpha + \varphi_{RE}(R/E)_{it} + \varphi_D D_{it} + \varphi_I DI_{it} + \varphi_\pi \pi_{it} + u_i + \varepsilon_{it} \tag{3.3.1}$$

[28] Lower dividends due to high taxes are evident if dividends are taxed. The loss due to higher inflation, however, relies on the assumption that dividends revenues have to be carried in cash from one period to the other.

[29] The sample excludes Uruguay, which has data for stock prices for the Total Market price index from Data Stream.

where the subscript i denotes the country and t denotes the time period, q^x_{it} = log of the stock price index (x denotes the numeraire used, *National Currency* or *US dollar)*, and as before (R/E) = log of government *Revenues/Expenditures*, D_{it} = log of total government *Debt / GDP*, and DI_{it} = log of the variable *Debt without Inflation / Debt* and π_{it} = inflation rate at time t *obtained form the CPI* index. Alternatively, I also run specification (3.3.1) without the variable DI_{it}, since it tends to be highly correlated with the inflation rate.

The *Control and Dummies Specification*, assumes that slopes for $(R/E)_{it}$, D_{it}, π_{it}, and DI_{it}, for the group of high-income and middle income countries. Controls are used for *Growth Rate, GDP Per Capita* and total *GDP.*

$$
\begin{aligned}
rer^x_{it} &= \alpha + \sum_{g=hi,md} [\varphi^g_{RE}(R/E)^g_{it} + \varphi^g_D D^g_{it} + \varphi^g_{DI} DI^g_{it} + \varphi^g_\pi \pi^g_{it}] \\
&\quad + \Psi \cdot (controls_{it}) + u_i + \varepsilon_{it} \qquad (3.3.2)
\end{aligned}
$$

Table 4 presents the regression results for *OLS* estimates using the White routine while Table 5 presents Prais-Winsten regressions estimates. The results present strong evidence that higher deficits associated with lower stock prices. The average implied elasticity for $\varphi^{hi}_{RE} \cong .84$ and $\varphi^{md}_{RE} \cong 2.14$ implies that an increase of 1% of GDP in the government budget deficit would be associated with a fall in stock prices in national currency on the order of 2.8% for the high-income economies and of 10.2% for middle-income economies.[30] As opposed to the real exchange rates elasticities case, the government deficit has a quantitatively different impact on stock prices among industrialized and emerging economies.

For the *Control and Dummies Specification*, the impact of government debt to GDP ratio is statistically different from zero at a 1% level for the two groups of economies. However, while an increase in debt for high-income economies is associated with higher stock prices, the opposite is true for middle-income economies.

[30] For the high-income economies, government revenues average 30% of GDP, so the impact is computed by $(1/.3)\varphi^{hi}_{RE}$. For middle-income economies, average revenues are 21% of GDP, which implies an elasticity surplus to stock prices of $(1/.21)\varphi^{md}_{RE}$. For the values φ^{hi}_{RE} and φ^{md}_{RE}, I used the average of the coefficients estimated in tables 4 and 5 for stock prices measured in national currency.

The impact of the inflation rate, φ_π, is statistically significant at reasonable confidence intervals and negative only when the variable *(Debt w/o inflation)/ Inflation,* which measures debt devaluation due to inflation, is not included. This is a natural result, since (*Debt w/o Inflation) /Debt*) $\equiv (Debt_t + \pi_t Debt_{t-1})/Debt_t \cong 1 + \pi_t$, for small variations on nominal debt.

3.4 Country-Specific Regressions

An alternative to the panel data regressions of Tables 2-5 would be to run a specific regression for each country. However, although this would allow less restricted estimates of countries ' exchange rate and stock prices sensibilities, this choice would involve a sensible loss of observations in each regression specification. Since the panel-data used was unbalanced with at most 25 observations for each country, specific regressions would involve a much lower number of observations.

In order to verify the goodness of fit of the pooled data regressions of sections 3.2 and 3.3 for specific countries, I computed R^2 values for each country when the coefficients are restricted to be the estimated panel data coefficients. The estimated country i specific $R_i^{2\prime}s$ are computed by the formula

$$R_i^2 = 1 - \frac{\sum_{t=1}^{ni}(e_{it} - \bar{e}_i)^2}{\sum_{t=1}^{ni}(y_{it} - \bar{y}_i)^2} \tag{3.4.1}$$

where ni = the number of observations for country i, y_{it} = the value of the independent variable for country i, $\bar{y}_i$ = sample mean for country i independent variable, e_{it} = regression residual for country i at time period t, $\bar{e}_i$ = sample mean for country's i regression residual. Notice that although $R_i^2 \leq 1$, we cannot guarantee that they are positive.

Computed R_i^2 for the *OLS* real exchange regressions with robust standard errors (Table 2) are presented on table 6, while the values for the *OLS* stock price regressions with robust standard errors (Table 4) are presented in Table 7.

Table 6 shows that the R_i^2 values are in general better when the *true* real exchange rate definition is the independent variable and the specification used includes dummies and controls. In general, the fit is good for high-income and Latin American economies, while the results are

not particularly good for the Asian economies.

Table 7 reports that the R_i^2 values for the stock price OLS regressions is close to or even higher than the panel regression R^2 for the majority of countries.[31] The exceptions are Canada, Indonesia, Thailand, and Argentina. The computation of country specific R^2 as in (3.4.1) allows us to see how well the panel regressors fit for each country. However, a more rigorous test for imposing same regressors' coefficients across countries is an F-test of the constrained model (panel data coefficients) against the unrestricted model (country-specific regressions). This test is done for the *OLS* regressions presented on Table 2 and 4.

Table 8 reports the F-test results for the real exchange rate regressions. For the high income economies - excluding France, Italy, and Spain - the null hypothesis of the restricted model is not rejected at the 1% level for the Basic Specification and the *PPP* real exchange rate definition. However, the null is frequently not accepted for the *Controls and Dummies Specifications.* For the middle-income economies the results is the opposite, the null is frequently not rejected when the controls and dummies specification is assumed.

Table 9 computes the F-test for the stock price *OLS* regressions. The constrained model cannot be rejected at a 1% level in at least 4 regressions specifications for Japan, Germany, Italy, Spain, Indonesia, the Philippines, and Mexico. However, the constrained model is rejected at a 1% level in all cases for the United States, the United Kingdom, the Netherlands, and Thailand. In conclusion, using the R_i^2 values of Tables 6 and 7 and the F-tests on Tables 8 and 9, we can see that the panel regressions do not impose very strong restrictions on the estimated coefficients in most of the cases. Idiosyncratic elasticities are present, but due to the low number of observations in annual terms the panel data specification is more appealing than country-specific regressions. Finally, the use of pooled regressions is justified by reinforcing the intuition developed in section 2 that a better fiscal solvency, meaning higher government surpluses, is associated with a stronger currency and higher stock prices.

[31] Notice that R_i^2 was not computed for Brazil due to the small number of observations for this country.

3.5 Model Estimation

This section estimates an artificial time-series for the real exchange rates based on the model from section 2.3. From the equilibrium equation for the exchange rate, equation (E5), we have:

$$e_t = E_t\left[\frac{u'(Y_{t+1}-G_{t+1})}{P^F_{t+1}}\right] E_t\left[\frac{u'(Y_{t+1}-G_{t+1})}{P^H_{t+1}}\right]^{-1}$$

I assume that the government policy for country $j = H, F$, will be such that with probability $1 - p^j$ the government will change only the taxes stream and changes in debt will accommodate the current deficit. With probability p^j the government budget will be balanced by changes only on seigniorage revenues and debt will be kept constant.

$$\begin{aligned}\frac{P^j_t u'(Y^j_{t+1}-G^j_{t+1})}{P^j_{t+1}} &= \frac{u'(c^j_1)}{1+\phi(b^j_t, s^j_t, \gamma^j_t)} \qquad \text{with prob. } p^j \\ &= u'(c^j_2) \qquad \text{with prob. } 1-p^j\end{aligned}$$

Therefore, using the model expectations for next period prices lead us to:

$$\begin{aligned}\frac{e_t P^F_t}{P^H_t} &= \frac{E_t\left[\frac{P^F_t u'(Y^F_{t+1}-G^F_{t+1})}{P^F_{t+1}}\right]}{E_t\left[\frac{P^H_t u'(Y^H_{t+1}-G^H_{t+1})}{P^H_{t+1}}\right]} = \frac{p^F \frac{u'(c^F_1)}{1+\phi(b^F_t, s^F_t, \gamma^F_t)} + (1-p^F)u'(c^F_2)}{p^H \frac{u'(c^H_1)}{1+\phi(b^H_t, s^H_t, \gamma^H_t)} + (1-p^H)u'(c^H_2)} \\ &= \frac{(1-p^F)u'(c^F_2) \ + u'(c^F_1)p^F(1+\gamma^F)[1-(r-\gamma^F)b^F_t + s^F_t]}{(1-p^H)u'(c^H_2) \ + u'(c^H_1)p^H(1+\gamma^H)[1-(r-\gamma^H)b^H_t + s^H_t]}\end{aligned}$$

where $\phi(b^j_t, s^j_t)$ = inflation contingent on the government using seignorage revenues to keep the debt level constant, b^j_t is the government debt to GDP ratio and s^j_t = is the government primary deficit to GDP ratio. The last equation can be parameterized as:

$$\frac{e_t P^F_t}{P^H_t} = \frac{\alpha^F + \beta^F_s s^F_t + \beta^F_b b^F_t}{\alpha^H + \beta^H_s s^H_t + \beta^H_b b^H_t} \tag{3.5.1}$$

where $\alpha^j = u'(c^j_2) + p^j[u'(c^j_1)(1+\gamma^j) - u'(c^j_2)]$; $\beta^j_s = p^j u'(c^j_1)(1+\gamma^j)$; $\beta^j_b = p^j u'(c^j_1)(1+\gamma^j)(\gamma^H - r)$ for $j = H, F$. Figures 3 and 4 present the plots of the artificial time series for the real exchange rates, estimated by non-linear least squares in equation (3.5.1).

The fit shows a fairly strong correlation among the two series. All the countries presented correlations above .58, and 11 out of 18 presented correlations above .80. This estimation furhter reinforces even more the link of the model with empirical evidence.

4 Conclusion

This paper's goal was to investigate the effects of government budget deficits on equilibrium real exchange rates and stock prices. Section 2 presented preliminary empirical evidence and a theoretical model. Section 3 investigated the empirical evidence and estimated the model for equilibrium real exchange rates.

The theoretical results give support to two main theoretical conclusions. First, in a two-country cash-in-advance model as in Lucas(1982) and Sargent(1987), the introduction of government targets for monetary and fiscal policies and an exchange rate market at the end of the day results in a more general form of no-arbitrage condition than the *PPP* theory of equilibrium exchange rates. In this more general form of exchange rate determination, the relative inflation risk of both countries is the main concern and it is directly linked with fiscal fundamentals. The *PPP* theory would be recovered in special cases like that of no inflation risk or a similar inflation risk in both currencies.

For small economies, studied in section 2.4, we can assume that government expenditure shocks do not affect the world's real interest rates. In this case, the generalization of the *PPP* theory gives even more intuitive results. For shock values close to zero, the *PPP* theory is still valid for determinating real exchange rates. However, for large positive (or negative) shocks on government expenditures, the real exchange rate depreciates (or appreciates) relative to the *PPP* parity.

Second, since dividends are subject to taxation and inflation can depreciate the real value of dividends received in cash, stock prices will be affected by future expectations of high inflation or high taxes. In the case of small economies, stock prices will be strictly decreasing on contemporaneous government expenditures innovations.

Empirical results form section 2.3 and section 3 supports the theoretical model. Empirical results can be summarized into three main findings. First, empirical evidence for a representative sample of countries suggests that government deficits tend to be positively correlated with real

exchange rate devaluations and lower stock prices. Second, these results are even more robust with the use of a more appropriate definition of real exchange rate, the *true real exchange rate* defined in Sjaastad (1996, 1998a, 1998b and 1999).

Finally, the empirical findings allow us to derive some quantitative results. For the real exchange rates, an increase of the surplus by 1% of the *GDP* is associated with an approximate devaluation of the real exchange rate of 1.5% for high-income economies and of 2% for Latin American economies. For stock prices, an increase in the government budget deficit by 1% of the GDP would be contemporaneous with a fall in stock prices, measured in national currency, on the order of 2.8% for high-income economies and of 10.2% for middle-income economies.

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APPENDIX

A. HOUSEHOLD'S PROBLEM

This subsection finds the optimality conditions for the Household's problem described in section 2.3, equations (2.3.15) - (2.3.20). Assuming interior solutions and using the Lagrange multipliers, λ_H, λ_F, ϕ, μ_H and μ_F respectively for constraints (2.3.16)-(2.3.20). Optimality conditions for the Household's problem are:

$$u'(C^H + C^F) = -\phi P^H(x_H) + \mu_H \tag{Ap1}$$

$$u'(C^H + C^F) = -\phi e P^F(x_F) + \mu_F \tag{Ap2}$$

$$\beta E[v_{\theta^H}(\theta^{H\prime}, \theta^{F\prime}; x'_H, x'_F) q^{H\prime} \mid x_H, x_F] = \lambda_H(\tau Y^H + qH^H) - \phi P^H Y^H \tag{Ap3}$$

$$\beta E[v_{\theta^F}(\theta^{H\prime}, \theta^{F\prime}; x'_H, x'_F) q^{F\prime} \mid x_H, x_F] = \lambda_F(\tau Y^F + q^F) - \phi e P^F Y^F \tag{Ap4}$$

$$\beta E[v_{\theta^H}(\theta^{H\prime}, \theta^{F\prime}; x'_H, x'_F)(1+r) \mid x_H, x_F] = \lambda_H \tag{Ap5}$$

$$\beta E[v_{\theta^F}(\theta^{H\prime}, \theta^{F\prime}; x'_H, x'_F)(1+r) \mid x_H, x_F] = \lambda_F \tag{Ap6}$$

$$\beta E\left[\frac{v_{\theta^H}(\theta^{H\prime}, \theta^{F\prime}; x'_H, x'_F)}{P^H(x'_H)} \mid x_H, x_F\right] = -\phi \tag{Ap7}$$

$$\beta E\left[\frac{v_{\theta^F}(\theta^{H\prime}, \theta^{F\prime}; x'_H, x'_F)}{P^F(x'_F)} \mid x_H, x_F\right] = -e\phi \tag{Ap8}$$

$$\lambda_H = -\phi P^H(x_H) + \mu_H \tag{Ap9}$$

$$\lambda_F = -e\phi P^F(x_F) + \mu_F \tag{Ap10}$$

And the envelope conditions:

$$v_{\theta^H}(\theta^H, \theta^F; x_H, x_F) = \lambda_H \tag{Ap11}$$

$$v_{\theta^F}(\theta^H, \theta^F; x_H, x_F) = \lambda_F \tag{Ap12}$$

Substituting equations (Ap9) and (Ap10) into (Ap1) and (Ap2) yields:

$$u'(C^H + C^F) = \lambda_H$$

$$u'(C^H + C^F) = \lambda_F$$

Forwarding one period the envelope conditions, (Ap11), and (Ap12) and using both equations above, gives us the Euler equation:

$$\beta E[u'(C^{H\prime} + C^{F\prime})(1+r) \mid x_H, x_F] = u'(C^H + C^F) \tag{Ap13}$$

From equations (Ap7) and (Ap8):

$$\varepsilon E\left[\frac{u'(C^{h\prime} + C^{f\prime})}{P^h(x_h')} \mid x_h, x_f\right] = E\left[\frac{u'(C^{h\prime} + C^{f\prime})}{P^f(x_f')} \mid x_h, x_f\right] \tag{Ap14}$$

Equation (Ap14) just equalizes the return of investing overnight in each of the two currencies. The right-hand side is the marginal utility in the next period of buying ε units of home currency and the left-hand side is the marginal utility of using ε units of $H\$$ to buy one unit of $F\$$. In the exchange rate of equilibrium, these returns have to be the same.

Inserting (Ap7), (Ap8), (Ap11), and (Ap12) into equations (Ap3) and (Ap4), after some recursive algebra we find

$$q^j = E_t\left[\sum_{k=0}^{\infty} \beta^{t+k} \frac{u'(C^j_{t+k} + C^j_{t+k})}{u'(C^j_t + C^j_t)} \left(\frac{P^j_{t+k}}{P^j_{t+k+1}} Y^H_{t+k} - \tau^H_{t+k} Y^H_{t+k}\right)\right] \tag{Ap15}$$

B. GOVERNMENT'S PROBLEM

Theorem 1 *Assume that* $\bar{\tau}^j_t = \bar{\tau}$ *and* $\bar{\pi}^j_t = 0$, $\forall t \geq 0$ *and* $j = H, F$, *also assume that the parameters satisfy* $h > \varpi, a > (1+\gamma^j)$, $2h(1+\gamma^j) \in (0,1)$ *and* $\beta > (1+\gamma^j)/(1+r_t)$, *for* $j = H, F$. *Then, the solution for the problem facint government of country j:*

$$Min_{\{\tau,\mu\}} \sum_{k=0}^{+\infty} \beta^k E_t\left[a\left|\tau^j_{t+k} - \bar{\tau}^j_t\right| + \left|\pi(\mu^j_{t+k}) - \bar{\pi}^j_t\right|\right]$$

such that $\{\tau^j_{t+k}, \mu^j_{t+k}\}^{+\infty}_{k=0}$ *is feasible is characterized by*

$$\begin{aligned} \tau^j_{t+k} &= \bar{\tau}^j_t \ ; \ \mu^j_t = \frac{(\varepsilon^j_t + \varepsilon^j_{t-1})(1+\gamma^j)^2}{1 - (\varepsilon^j_t + \varepsilon^j_{t-1})(1+\gamma^j)} + \gamma^j, \ \mu^j_{t+1+k} = \gamma^j, \ \forall k \geq 0 \\ \text{if } \varepsilon^j_t &\in [-\varepsilon^j_{t-1} - \varpi, -\varepsilon^j_{t-1} + \varpi] \end{aligned}$$

, which occurs with probability $p_j \equiv \varpi^j/h^j \in (0,1)$

$$\begin{aligned} \tau^j_t &= (\varepsilon^j_t + \varepsilon^j_{t-1}) + \bar{\tau}^j_t, \ \tau^j_{t+1+k} = \bar{\tau}^j_t \ ; \ \mu^j_{t+k} = \gamma^j, \forall k \geq 0 \\ \text{if } \varepsilon^j_t &\notin [-\varepsilon^j_{t-1} - \varpi, -\varepsilon^j_{t-1} + \varpi] \end{aligned}$$

, which occurs with probability $1 - p_j = 1 - \varpi^j/h^j \in (0,1)$.

Proof. The amount collected with tax changes is linear while the revenues collected with seignorage revenues are concave on the inflation rate. In order to finance the extra deficit with an immediate increase in taxes, the associated cost in terms of government utility is:

$$\tau_t^j - \bar{\tau} = a(\varepsilon_t^j + \varepsilon_{t-1}^j) \qquad \text{and} \qquad \frac{\partial(\tau_t^j - \bar{\tau})}{\partial(\varepsilon_t^j + \varepsilon_{t-1}^j)} = a \ > 0$$

If it is financed with an immediate increase in seignorage revenues, the associated cost will be

$$\begin{aligned} \pi(\mu_t^j) - \bar{\pi}_t^j &= \frac{(\varepsilon_t^j + \varepsilon_{t-1}^j)(1+\gamma^j)}{1-(\varepsilon_t^j + \varepsilon_{t-1}^j)(1+\gamma^j)} \\ \text{and} \qquad \frac{\partial(\pi(\mu_t^j) - \bar{\pi}_t^j)}{\partial(\varepsilon_t^j + \varepsilon_{t-1}^j)} &= \frac{(1+\gamma^j)}{\left[1-(\varepsilon_t^j + \varepsilon_{t-1}^j)(1+\gamma^j)\right]^2} > 0 \end{aligned}$$

At $\varepsilon_t^j + \varepsilon_{t-1}^j = 0$, the marginal cost of increasing taxes is greater than the marginal cost of increasing seignorage revenues since by assumption $a > (1+\gamma^j)$. But, by the assumption of $2h(1+\gamma^j) \in (0,1)$,

$$\frac{\partial^2(\pi(\mu_t^j) - \bar{\pi}_t^j)}{\partial(\varepsilon_t^j + \varepsilon_{t-1}^j)^2} = 2(1+\gamma^j)^2 \left[1-(\varepsilon_t^j + \varepsilon_{t-1}^j)(1+\gamma^j)\right]^3 > 0$$

while

$$\frac{\partial^2(\tau_t^j - \bar{\tau})}{\partial(\varepsilon_t^j + \varepsilon_{t-1}^j)^2} = 0$$

So, there is a value ϖ^j where the cost of using inflationary revenues will be less costly than changing taxes if $\varepsilon_t^j \in [-\varepsilon_{t-1}^j - \varpi, -\varepsilon_{t-1}^j + \varpi]$ and more costly otherwise. By assumption, $h > \varpi$, so there is a strictly positive probability for each event. To complete the proof we just need to show that since the government policy has to be feasible, equation (2.3.6) holds for all t and postponing by one period the increases in taxes or seignorage revenues costs $(1+r_t)/(1+\gamma^j)$, which is greater than β^{-1} by assumption. So it is optimal to adjust to the changes in deficit at time t by increasing taxes or revenues by the same amount at the same period t, and since (2.3.6) holds for $\{\bar{\tau}_t^j, \bar{\pi}_t^j\}$, this policy is feasible. ■

C. THE SMALL ECONOMY PRICE FORMULAS

Theorem 2 *Assume the small-country model described by conditions (A1), (A2), and (A3) and the pricing equation (2.4.1). Also, let the government expenditures follow the stochastic process described by (2.3.3) and (2.3.4) and let the assumptions for theorem 1 to hold. Then:*

(I) The real exchange rate for the small country will be a nondecreasing function of expenditures shocks at time t, ε_t, meaning that higher shocks at time t depreciate the real exchange rate. Specifically, the real exchange rate is described by the function:

$$
\begin{aligned}
e_t(\varepsilon_t)\frac{P_t^W}{P_t^H} &= \left[1+\frac{1}{4h}\left((h-\varepsilon_t)^2-\varpi^2\right)\right]^{-1} > 1,\ \textit{for } h>\varepsilon_t>h-\varpi \\
e_t(\varepsilon_t)\frac{P_t^W}{P_t^H} &= 1,\ \textit{for } -(h-\varpi)<\varepsilon_t<h-\varpi \\
e_t(\varepsilon_t)\frac{P_t^W}{P_t^H} &= \left[1+\frac{1}{4h}\left(\varpi^2-(h+\varepsilon_t)^2\right)\right]^{-1} < 1,\ \textit{for } -h<\varepsilon_t<-(h-\varpi)
\end{aligned}
$$

(II) Given the value for ε_{t-1}, stock prices are strictly decreasing in ε_t for all the possible shocks, that is for $\varepsilon_t \in [-h,+h]$, and also a continuous function in $\varepsilon_t$except on the points $\varepsilon_t = -\varpi - \varepsilon_{t-1}$ and $\varepsilon_t = \varpi - \varepsilon_{t-1}$.

Proof. (I) Real Exchange rates:

Notice first that $\varepsilon_{t+1}+\varepsilon_t \in (-h+\varepsilon, h+\varepsilon)$. Thus, since $h>\varpi$, by assumption, we have three possible cases:

i) (High shock at t) Assume $h>\varepsilon_t>h-\varpi$,

then since $\varepsilon_{t+1} \in (-h,h)$ we have $\varepsilon_{t+1}+\varepsilon_t \in (-\varpi, h+\varepsilon)$, with $h+\varepsilon>\varpi$, since, by assumption; $\varepsilon_t > h-\varpi > 0 > \varpi - h$. Given the government policy described by Theorem 1, if $\varepsilon_{t+1} \in (-h, \varpi-\varepsilon_t) \Rightarrow \varepsilon_{t+1}+\varepsilon_t \subset (-\varpi,\varpi)$ and there will be inflation (or deflation) at *t+1*, if instead $\varepsilon_{t+1} \in (\varpi-\varepsilon_t, h) \Rightarrow \varepsilon_{t+1}+\varepsilon_t \in (\varpi, h+\varepsilon_t)$, there will be no inflation. Notice that $h+\varepsilon_t>\varpi$, since by assumption, $\varepsilon_t>h-\varpi>0>\varpi-h$. Thus, the real exchange rate value will

be:

$$\begin{aligned} e_t(\varepsilon_t) &= E_t\left[\frac{1}{P^H_{t+1}}\right]^{-1}\frac{1}{P^W_t} \\ &= \frac{P^H_t}{P^W_t}E_t\left[\frac{1}{1+\pi(\varepsilon^H_t,\varepsilon^H_{t+1})}\right] \\ &= \frac{P^H_t}{P^W_t}\left[\int_{\varpi-\varepsilon}^{h}\frac{1}{2h}ds+\int_{-h}^{\varpi-\varepsilon}\frac{1-(s+\varepsilon)}{2h}ds\right]^{-1} \\ &= \frac{P^H_t}{P^W_t}\left[1+\frac{1}{4h}\left((h-\varepsilon)^2-\varpi^2\right)\right]^{-1} \\ &\geq \frac{P^H_t}{P^W_t} \end{aligned}$$

Since $\varepsilon_t > h-\varpi$ and $h-\varepsilon>0$, we have $(h-\varepsilon)^2-\varpi^2<0$, and $e_t(h-\varpi)=P^H_t/P^W_t$, $\partial e_t/\partial\varepsilon_t>0$ for $h>\varepsilon_t>h-\varpi$.

ii) (Middle shock at t) Assume $-h+\varpi<\varepsilon_t<h-\varpi$, then since $\varepsilon_{t+1}\in(-h,h)$, we have $\varepsilon_{t+1}+\varepsilon_t\in(-h+\varepsilon,h+\varepsilon)$, with $(-\varpi,\varpi)\subset(-h+\varepsilon,h+\varepsilon)$. Thus, given the government policy described by Theorem 1 the real exchange rate value will be:

$$\begin{aligned} e_t(\varepsilon_t) &= E_t\left[\frac{1}{P^H_{t+1}}\right]^{-1}\frac{1}{P^W_t} \\ &= \frac{P^H_t}{P^W_t}E_t\left[\frac{1}{1+\pi(\varepsilon^H_t,\varepsilon^H_{t+1})}\right]^{-1} \\ &= \frac{P^H_t}{P^W_t}\left[\int_{-h}^{-\varpi-\varepsilon}\frac{1}{2h}ds+\int_{-\varpi-\varepsilon}^{\varpi-\varepsilon}\frac{1-(s+\varepsilon)}{2h}ds+\int_{\varpi-\varepsilon}^{h}\frac{1}{2h}ds\right]^{-1} \\ &= \frac{P^H_t}{P^W_t} \end{aligned}$$

For this range of shocks PPP holds. The explanation is that all possible level of inflations are feasible and agents expect on average zero inflation.

iii) (Low shock at t) Assume $-h+\varpi>\varepsilon_t>-h$, $-h+\varepsilon>-\varpi \Leftrightarrow \varepsilon\in(h-\varpi,h)$, then since $\varepsilon_t<-h+\varpi$ and $h+\varepsilon>0$, we have $\varpi^2-(h+\varepsilon)^2>0$,and $e_t(-h+\varpi)=P^H_t/P^W_t$, $\partial e_t/\partial\varepsilon_t>0$ for $-h+\varpi>\varepsilon_t>-h$.

(II) By the pricing formula from section 2.3, given (A1)-(A3) and (2.4.1), stock prices are

determined by the equation

$$q_t^H = Y_{t-1}^j E_t \left[\sum_{k=1}^{+\infty} \beta^k \left(1+\gamma^W\right)^{-k\sigma} (1+\gamma^j)^k \left(\frac{1+\gamma^j}{1+\mu_{t+k}^j} - \tau_{t-1+k}^j \right) \right]$$

Given the government policy described by Theorem 1, and the definition of $\tilde{\beta} \equiv \beta \left(1+\gamma^j\right) / \left(1+\gamma^W\right)^{\sigma}$, this formula simplifies to

$$\begin{aligned} q_t^H &= Y_{t-1}^j \frac{\tilde{\beta}^2}{1-\tilde{\beta}}(1-\bar{\tau}) - Y_0^j \tilde{\beta} \tau_t^j + Y_0^j \tilde{\beta} E_t \left[\frac{1+\gamma^j}{1+\mu_{t+1}^j} - \tau_{t+1}^j \right] \\ &= Y_{t-1}^j \tilde{\beta} \left\{ \frac{\tilde{\beta}^2}{1-\tilde{\beta}}(1-\bar{\tau}) + E_t \left[\frac{1}{1+\pi(\varepsilon_{t+1},\varepsilon_t)} - \tau_t^j + 1 - \tau_{t+1}^j \right] \right\} \end{aligned}$$

We shall prove that q_t^H is strictly decreasing for all values of ε_t, that is, for $\varepsilon_t \in [-h,+h]$ and continuous except on $\varepsilon_t = -\varpi - \varepsilon_{t-1}$ and $\varepsilon_t = \varpi - \varepsilon_{t-1}$.

From part (I) of the proof, this is exactly the case for $E_t \left[\left(1+\pi(\varepsilon_{t+1},\varepsilon_t)\right)^{-1} \right]$, which is continuous and nonincreasing on ε_t.

Also, taxes at time t influence the stock price at t since agents pay the taxes after buying stock, so

$$\begin{aligned} \tau_t^j = \upsilon(\varepsilon_t, \varepsilon_{t-1}) &= \bar{\tau} + \varepsilon_t + \varepsilon_{t-1} \text{ if } \varepsilon_t + \varepsilon_{t-1} \notin (-\varpi, \varpi), \\ &= \bar{\tau} \text{ if } \varepsilon_t + \varepsilon_{t-1} \in (-\varpi, \varpi) \end{aligned}$$

, which is nondecreasing in ε_t and discontinuous on $\varepsilon_t = -\varpi - \varepsilon_{t-1}$ and $\varepsilon_t = \varpi - \varepsilon_{t-1}$.

For the last term, $E_t \left[1 - \tau_{t+1}^j \right]$, we have that

i) For $h > \varepsilon_t > h - \varpi$

$$\begin{aligned} E_t \left[1 - \tau_{t+1}^j \right] &= \int_{-h}^{\varpi-\varepsilon} \left(\frac{1-\bar{\tau}}{2h}\right) ds + \int_{\varpi-\varepsilon}^{h} \left(\frac{1-\bar{\tau}-\varepsilon-s}{2h}\right) ds \\ &= \int_{-h}^{h} (1-\bar{\tau}) + \int_{\varpi-\varepsilon}^{h} (-\varepsilon - s) ds \\ &= 1 - \bar{\tau} + \frac{1}{4h} \left[\varpi^2 - (h+\varepsilon)^2 \right] \end{aligned}$$

, which is strictly decreasing on ε_t.

ii) For $-h+\varpi<\varepsilon_t<h-\varpi$,

$$
\begin{aligned}
E_t\left[1-\tau_{t+1}^j\right] &= \int_{-h}^{-\varpi-\varepsilon}(\frac{1-\bar{\tau}-\varepsilon-s}{2h})ds+\int_{-\varpi-\varepsilon}^{\varpi-\varepsilon}(\frac{1-\bar{\tau}}{2h})ds \\
&\quad +\int_{\varpi-\varepsilon}^{h}(\frac{1-\bar{\tau}-\varepsilon-s}{2h})ds \\
&= \int_{-h}^{h}(\frac{1-\bar{\tau}}{2h})ds+\int_{-h}^{-\varpi-\varepsilon}(\frac{-\varepsilon-s}{2h})ds+\int_{\varpi-\varepsilon}^{h}(\frac{-\varepsilon-s}{2h})ds \\
&= 1-\bar{\tau}-\varepsilon
\end{aligned}
$$

, which is strictly decreasing on ε_t.

iii) For $-h+\varpi>\varepsilon_t>-h$,

$$
\begin{aligned}
E_t\left[1-\tau_{t+1}^j\right] &= \int_{-h}^{-\varpi-\varepsilon}(\frac{1-\bar{\tau}-\varepsilon-s}{2h})ds+\int_{-\varpi-\varepsilon}^{h}(1-\bar{\tau})ds \\
&= \int_{-h}^{h}(1-\bar{\tau})+\int_{-h}^{-\varpi-\varepsilon}(-\varepsilon-s)ds \\
&= 1-\bar{\tau}+\frac{1}{4h}\left[(h-\varepsilon_t)^2-\varpi^2\right]
\end{aligned}
$$

, which is strictly decreasing on ε_t.

Also, for $\varepsilon_t=h-\varpi\Rightarrow\varpi^2-(h+\varepsilon)^2=\varpi^2-(2h-\varpi)^2$

$=-4h^2+4h\varpi=-4h(h-\varpi)=-4h\varepsilon_t$

and for $\varepsilon_t=-h+\varpi\Rightarrow(h-\varepsilon_t)^2-\varpi^2=(2h-\varpi)^2-\varpi^2$

$=-4h^2+4h\varpi=-4h(h-\varpi)=-4h\varepsilon_t$

so, $E_t\left[1-\tau_{t+1}^j\right]$ is continuous for all possible values of ε_t. ■

D. TRUE REAL EXCHANGE RATES

This section follows very closely Sjaastad (1999). The *Basic Notation* is the same as in Sjaastad (1999) where capital letters means log. We shall define

EX_x^y : the price of currency Y in terms of currency X,

PX_x (PM_x) : a price index of country X's exports (imports),

PT_x (PH_x) : a price index of country X's traded (nontraded) goods,

$P_x=w_xPH_x+(1-w_x)PT_x$: an overall price index of country X,

$PRER_x$: the *PPP* RER of country X vis à vis country Y,

$TRER_x$: the true RER of country X, and

$TT_x = PX_x - PM_x$, the terms of trade

An F appended to a variable means that this variable is being measured in foreign currency; $\delta Z/\delta W$ means final form multipliers.

A True RER is measured by $PT_x - PH_x$, but because PH_x is hard to measure a convenient working definition is:

$$TRER_x \equiv PT_x - P_x = w_x(PT_x - PH_x) \tag{Ap16}$$

The *PPP RER* is an empirical proxy of the *true RER* where PH_x is replaced with the domestic price level, P_x, and PT_x is replaced with $P_y + EX_y$. The most common definition can be written as

$$PRER_x \equiv P_y + EX_y - P_x = PF_y - P_x \tag{AP17}$$

Although there is a link between PT_x and PF_y, this link is not constant across reference countries. This link is shown in Sjaastad (1999) to be

$$PT_x = \sum_j^M \theta_x^j PF_j^x + G(Z_x) \tag{Ap18}$$

The coefficients θ_x^j , which sum to one by construction, measure the *relative market power* possessed by country j over the prices of country X's traded goods ($\theta_x^j = 0 \Rightarrow$country j is a 3 *price taker,* $\theta_x^j = 1 \Rightarrow$country j is a *price maker)*; they have no logical relation to international trade patterns. Neglecting $G(Z_x)$, we can use equation (Ap17) and (Ap18) to write:

$$TRER_x \equiv PT_x - P_x = \sum_j^M \theta_x^j \left(PF_j^x - P_x\right) = \sum_{j \neq x}^M \theta_x^j PRER_x^j \tag{Ap19}$$

Thus, the *true RER* is a linear combination of country X's vis à vis all other relevant countries. As $PRER_x^x = 0$, the coefficients on equation (Ap19) sum to $1-$ θ_x^x . To construct PT_x, Sjasstad makes use of an weighted average of import price indices, PM_x, and export price indices, PX_x,

and the assumptions that imports and domestically produced import-competing goods are perfect substitutes.

$$PT_x = \varpi_x PM_x + (1-\varpi_x)PX_x = PX_x - \varpi_x TT_x = PM_x + (1-\varpi_x)TT_x \tag{Ap20}$$

Defining $PT_x = PM_x + (1-\varpi_x)TT_x$, and with lags added on all variables, the parameter ϖ_x can be estimated using equation (3) which is parameterized as:

$$A_x(L)PM_{x,t} = \sum_j^M \theta_x^j(L)PF_{j,t}^x - (1-\varpi_x)[A_x(L)TT_{x,t}] \tag{Ap21}$$

Equation (Ap18) was based on only three price levels; those of Germany, Japan, and the United States. The estimates of ϖ_x were then used to construct the PT_x variables according to equation (Ap20), which in turn was used to construct the $TRER_x$ as defined in (Ap16).

Notice that we can estimate equation (Ap21) by transforming everything in prices of country Y. To see this just add EX_y^x (price of currency X in terms of currency Y, $Y\$/X\$$) on both sides of equation (Ap18) and get:

$$PTF_x^y = \sum_j^M \theta_x^j PF_j^y + G(Z_x)$$

Also, (Ap20) can be rewritten as:

$$PTF_x^y = PMF_x^y + (1-\varpi_x)TT_x$$

Then, from the last two equations:

$$A_x(L)PMF_{x,t}^y = \sum_j^M \theta_x^j(L)PF_{j,t}^y - (1-\varpi_x)[A_x(L)TT_{x,t}] \tag{Ap22}$$

Equation (Ap22) was estimated by non-linear least squares using quarterly data from 1974 to 1998. On the right-hand side, the PPP parities, $PF_{j,t}^y$, used were the ones for the United States, Japan, Germany, and the country of reference.

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Figure 1: Government Budget Deficit and Real Exchange Rates

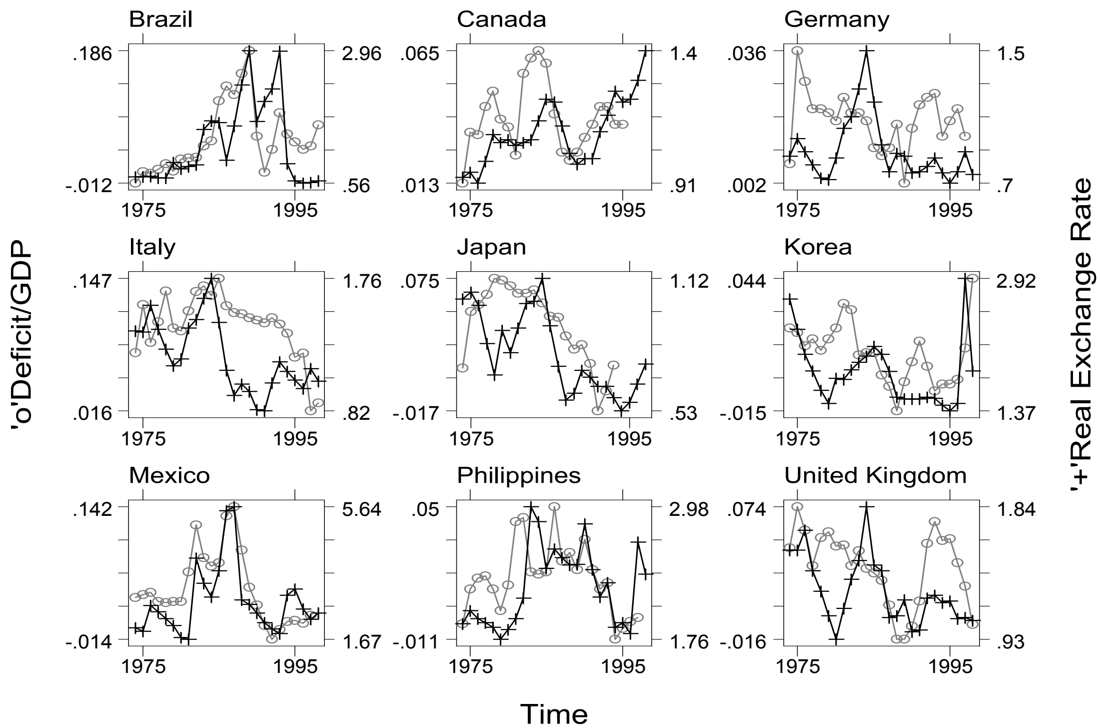

Figure 2: Government Budget Surplus and Stock Prices

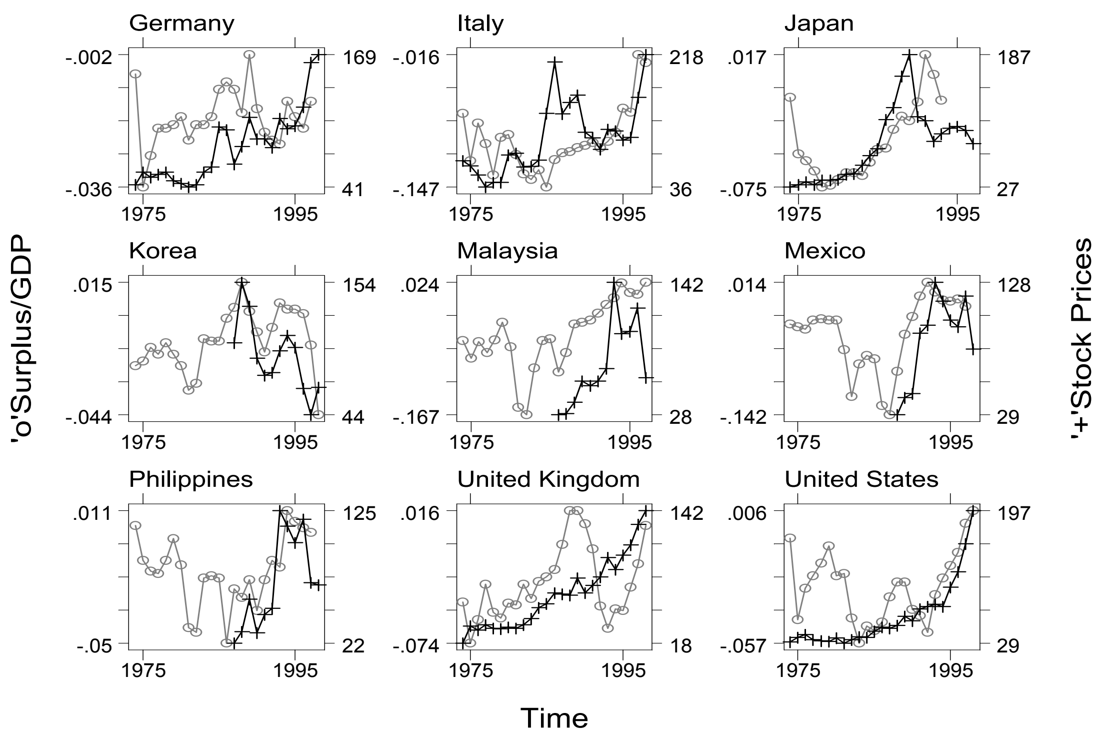

Figure 3: Simulated and Actual *PPP Real Exchang Rates* - High-Income Economies

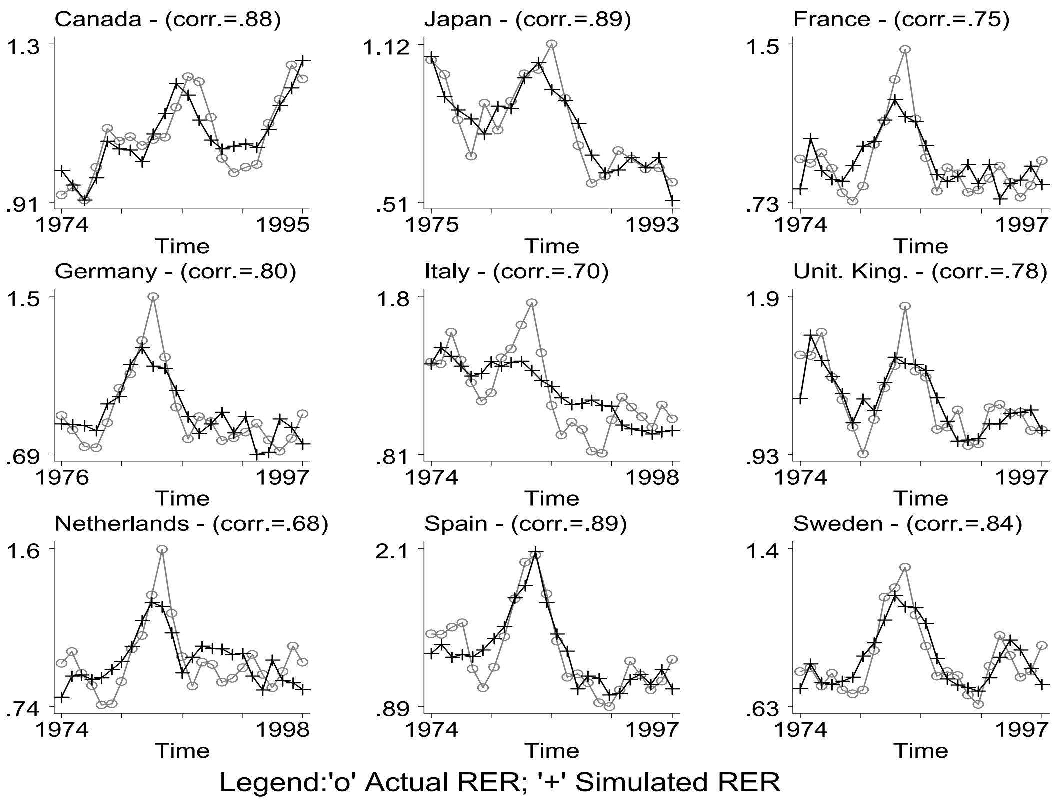

Figure 4: Simulated and Actual *PPP Real Exchange Rates* - Middle-Income Economies

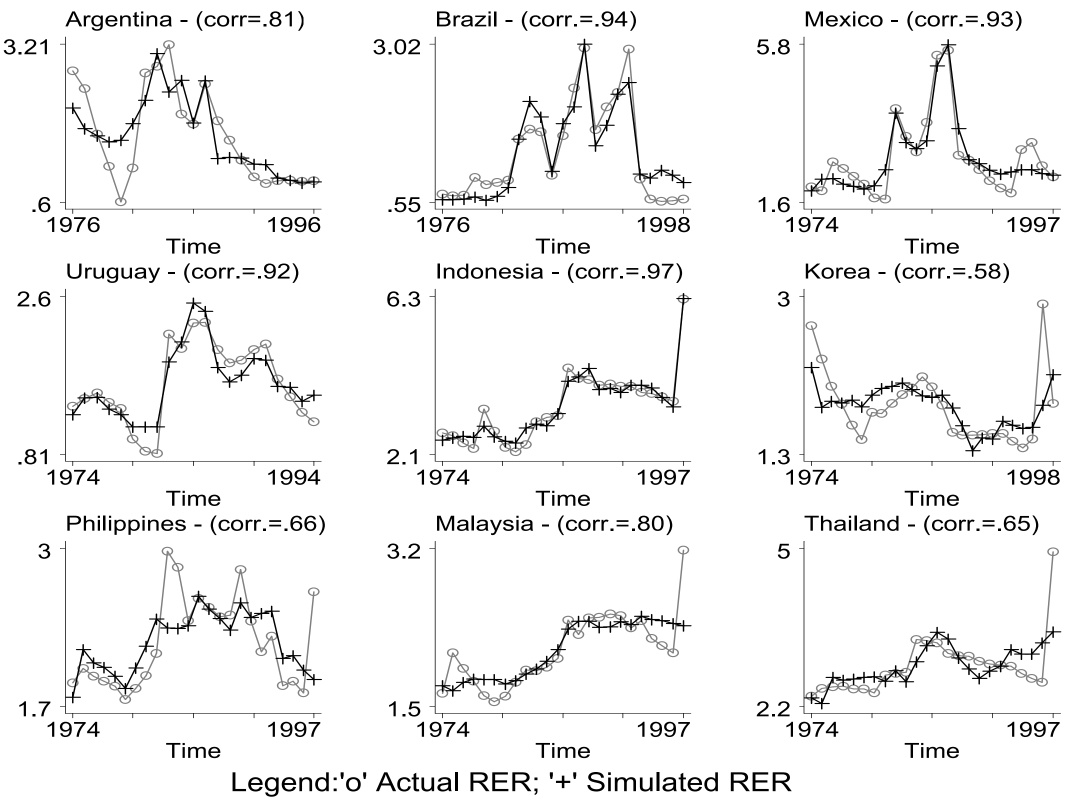

Table 1: Correlations of Government Budget Deficits as a GDP Proportion with the Real Exchange Rates and Stock Prices 1974-1998

Country	Real Exchange Rate (Nat$/U$)	True Real Exchange Rate	Stock Prices Nat. Currency	Stock Prices U$
High-Income				
Canada	.46	.35	-.03	-.28
France	.04	-.59	.58	.55
Germany	.03	.16	-.32	-.28
Japan	.52	.58	-.55	-.59
Italy	.37	.30	-.37	-.40
Netherlands	.55	.65	-.49	-.55
Spain	.58	.19	-.33	-.39
Sweden	.45	.25	-.31	-.42
Un. Kingdom	.39	.52	-.37	-.43
United States	…	.12	-.54	…
Middle-Income:	Latin America			
Argentina	.43	.45	.03	.06
Brazil	.61	.66	-.15	-.72
Mexico	.79	.82	-.82	-.78
Uruguay	.42	.13	…	…
Middle-Income:	Southeast Asia			
Indonesia	-.47	-.49	-.49	-.35
Korea	.35	.40	-.64	-.66
Malaysia	-.50	.34	-.72	-.67
Philippines	.43	.44	-.78	-.81
Thailand	-.10	-.13	-.16	-.20

Source: International Financial Statistics – IMF, DataStream – Primark.

Table 2: Real Exchange Rate and Fiscal Fundamentals: OLS Regressions with Robust (White) Standard Errors

Panel A: Basic Specification

	True Real Exchange Rate		***PPP Real Exchange Rate***	
Revenues / Expenditures	-.618	-.740	-.518	-.619
	[-7.39]	[-8.67]	[-5.28]	[-6.09]
Debt / GDP	-.055	-.076	.197	.177
	[-2.54]	[-3.23]	[6.03]	[5.29]
(Debt w/o Inflation) / Debt	.609	…	.594	…
	[3.50]	…	[3.43]	…
R^2	.91	.90	.83	.81

Panel B: Controls and Dummies Specification

	True Real Exchange Rate		***PPP Real Exchange Rate***	
Revenues / Expenditures- High-Income	-.425	-.394	-.532	-.504
	[-3.75]	[-3.69]	[-4.29]	[-4.38]
Revenues / Expenditures.- Latin America	-.469	-.482	-.347	-.417
	[-3.14]	[-2.97]	[-1.50]	[-1.83]
Revenues / Expenditures- Southeast Asia	-.193	-.180	-.081 †	-.075 †
	[-1.01]	[-.952]	[-.395]	[-.374]
Debt / GDP - High-Income	-.112	-.135	.066	.045
	[-4.20]	[-4.91]	[1.61]	[1.24]
Debt / GDP - Latin America	.287 †‡	.281 †‡	.725 †‡	.686 †‡
	[3.64]	[3.82]	[5.46]	[5.70]
Debt / GDP - Southeast Asia	-.163	-.169	-.077	-.087
	[-2.76]	[-3.23]	[-1.07]	[-1.27]
(Debt w/o Inflation)/Debt - High-Income	1.32	…	.817	…
	[3.45]	…	[1.17]	…
(Debt w/o Inflat.)/Debt - Latin America	.017 †	…	.158	…
	[.130]	…	[.822]	…
(Debt w/o Inflat.)/Debt - Southeast Asia	.356	…	-.328	…
	[.533]	…	[-.462]	…
Real Interest Rate - High-Income	.528	-.344	.901	.337
	[1.55]	[-1.51]	[1.76]	[.913]
Real Interest Rate - Latin America	-.235 †	-.247	.184	.090
	[-1.90]	[-1.74]	[.956]	[516]
Real Interest Rate - Southeast Asia	.318	.081	.371	.563
	[.585]	[.289]	[.449]	[.956]
Growth Rate	.222	.174	-.390	-.328
	[.821]	[.708]	[-1.19]	[-1.10]
Government Consumption	-.007	-.014	.060	.107
	[-.081]	[-.220]	[.430]	[.960]
GDP Per Capita	-.423	-.445	-.151	-.152
	[-4.52]	[-5.11]	[-1.45]	[-1.54]
Expenditure/GNI	-.590	-.550	-1.36	-1.52
	[-1.89]	[-1.94]	[-3.31]	[-4.17]
Openness	.241	.243	.168	.162
	[3.00]	[3.08]	[2.01]	[1.98]
Terms of Trade	-.445	-.482	-.690	-.742
	[-5.07]	[-5.48]	[-6.01]	[-6.82]
R^2	.96	.96	.92	.91

Notes: Between square brackets are the t-statistics for robust standard errors.
† Dummy is significantly different from the dummy for high-income economies at a 5% level.
‡ Dummy is significantly different from the dummy for Asian economies at a 5% level.

Table 3: Real Exchange Rate and Fiscal Fundamentals: Prais-Winsten Regressions, Correlated Panels, Corrected Standard Errors

Panel A: Basic Specification

	True Real Exchange Rate		***PPP Real Exchange Rate***	
Revenues /Expenditures	-.381	-.335	-.545	-.508
	[-4.35]	[-3.49]	[-4.98]	[-4.21]
Debt / GDP	.124	.066	.426	.393
	[3.38]	[1.70]	[9.24]	[7.63]
(Debt w/o Inflation)/Debt	.497	…	.301	…
	[5.30]	…	[2.28]	…
R^2	.89	.84	.80	.75

Panel B: Controls and Dummies Specification

	True Real Exchange Rate		***PPP Real Exchange Rate***	
Revenues / Expenditures – High-Income	-.403	-.362	-.445	-.471
	[-4.51]	[-3.83]	[-3.40]	[-3.59]
Revenues / Expenditures - Latin America	-.447	-.494	-.326	-.360
	[-2.61]	[-2.91]	[-1.76]	[-1.87]
Revenues /Expenditures - Southeast Asia	-.113	-.117	-.015	-.070
	[-.773]	[-.814]	[-.077]	[-.364]
Debt / GDP - High-Income	-.124	-.160	.044	.043
	[-3.58]	[-4.22]	[.715]	[.749]
Debt / GDP - Latin America	.313 †‡	.286 †‡	.823 †‡	.822 †‡
	[3.57]	[3.83]	[7.24]	[7.82]
Debt / GDP - Southeast Asia	-.094	-.084	-.011	.008
	[-2.09]	[-1.91]	[-.215]	[.173]
(Debt w/o Inflation)/ Debt - High-Income	1.19	…	-.048	…
	[2.48]	…	[-.053]	…
(Debt w/o Inflat.) / Debt - Latin America	.082 †	…	.045	…
	[.799]	…	[.273]	…
(Debt w/o Inflat.) / Debt - Southeast Asia	-.410 †	…	-1.05	…
	[-.808]	…	[-1.19]	…
Real Interest Rate - High-Income	.663	.045	.341	.343
	[1.82]	[.157]	[.516]	[.656]
Real Interest Rate - Latin America	-.176 †	-.227	.117	.079
	[-1.75]	[-2.13]	[.760]	[.602]
Real Interest Rate - Southeast Asia	-.225	.057	-.018	.739
	[-.578]	[.212]	[-.026]	[1.64]
Growth Rate	.054	.066	-.384	-.323
	[.260]	[.329]	[1.28]	[-1.11]
Government Consumption	-.083	-.054	.150	.096
	[-.898]	[-.655]	[1.17]	[.780]
GDP Per Capita	-.397	-.380	-.114	-.080
	[7.92]	[-8.28]	[-1.57]	[-1.18]
Expenditure / GNI	-.019	-.046	-.661	-.692
	[-.066]	[-.175]	[-1.48]	[-1.65]
Openness	.302	.311	.222	.216
	[4.54]	[4.60]	[2.30]	[2.24]
Terms of Trade	-.421	-.442	-.542	-.559
	[-3.98]	[-4.15]	[-4.09]	[-4.28]
R^2	.96	.96	.92	.92

Notes: Between square brackets are the t-statistics for robust standard errors.
[†] Dummy is significantly different from the dummy for high-income economies at a 5% level.
[‡] Dummy is significantly different from the dummy for Asian economies at a 5% level.

Table 4: Stock Market Price Index and Fiscal Fundamentals: OLS Regressions with Robust (White) Standard Errors

Panel A: Basic Specification

	Real Market Index (In U$)		***Real Market Index (In National Currency)***	
Gov. Reven./Expendit.	2.81	2.77	2.19	2.14
	[9.32]	[9.11]	[7.82]	[7.44]
Debt / GDP	.378	.459	.383	.463
	[3.23]	[4.12]	[3.51]	[4.57]
(Debt w/o Inflation) / Debt	-3.40	…	-3.68	…
	[-1.74]	…	[-2.19]	…
Inflation level (CPI)	.016	-1.69	.282	-1.57
	[.012]	[-1.91]	[.243]	[-2.10]
R^2	.54	.54	.54	.53

Panel B: Controls and Dummies Specification

	Real Market Index (In U$)		***Real Market Index (In National Currency)***	
Revenues / Expenditures – High-Income	1.30	1.14	1.05	.902
	[5.06]	[4.68]	[3.83]	[3.41]
Revenues/Expenditures – Middle-Income	1.98	1.89	2.05 †	1.97 †
	[5.01]	[4.71]	[4.93]	[4.64]
Debt / GDP - High Income	.139	.172	.420	.438
	[1.71]	[1.99]	[4.76]	[4.79]
Debt / GDP - Middle Income	-.541 †	-.496†	-.398†	-.353 †
	[-4.57]	[-4.64]	[-3.19]	[-3.14]
(Debt w/o Inflation)/ Debt – High-Income	-6.53	…	-5.72	…
	[-3.43]	…	[-3.01]	…
(Debt w/o Inflat.)/ Debt – Middle-Income	-1.47 †	…	-1.51	…
	[-1.05]	…	[-.949]	…
Inflation Rate (GDP Def.) – High-Income	3.64	-.930	2.11	-1.93
	[2.35]	[-1.09]	[1.35]	[-2.25]
Inflat. Rate (GDP Def.) – Middle-Income	.678	-.023	.701	-.014 †
	[1.05]	[-.122]	[.962]	[-.074]
Growth Rate	1.17	1.47	.625	.848
	[1.40]	[1.72]	[.852]	[1.13]
GDP Per Capita	-2.08	-2.00	-.576	-.503
	[-6.40]	[-6.19]	[-1.69]	[-1.48]
GDP - U$millions of 1995	1.18	1.17	.490	.480
	[13.3]	[12.9]	[5.66]	[5.38]
R^2	.81	.80	.73	.72

Notes: Between square brackets are the t-statistics.
† Dummy is significantly different from the dummy for high-income economies at a 5% level.

Table 5: Stock Market Price Index and Fiscal Fundamentals: Prais-Winsten Regressions, Correlated Panels, Corrected Standard Errors

Panel A: Basic Specification

	Real Market Index (In U$)		***Real Market Index (In National Currency)***	
Revenues / Expenditures	2.26	2.22	1.68	1.60
	[6.95]	[6.68]	[5.95]	[5.55]
Debt / GDP	.100	.143	.240	.280
	[.607]	[.903]	[1.92]	[2.31]
(Debt w/o Inflation) / Debt	-.882	…	-1.11	…
	[-.638]	…	[-.922]	…
Inflation level (CPI)	-.292	-.734	-.028	-.763
	[-4.22]	[-2.12]	[-.338]	[-2.28]
R^2	.99	.99	.99	.99

Panel B: Controls and Dummies Specification

	Real Market Index (In U$)		***Real Market Index (In National Currency)***	
Revenues / Expenditures – High-Income	.852	.697	.776	.631
	[2.61]	[2.08]	[2.50]	[1.97]
Revenues / Expenditures – Middle-Income	2.36 †	2.32 †	2.29 †	2.26 †
	[6.36]	[6.29]	[5.60]	[5.56]
Debt / GDP - High Income	.200	.242	.475	.494
	[1.43]	[1.73]	[3.80]	[3.86]
Debt / GDP - Middle Income	-.497 †	-.460 †	-.303 †	-.271 †
	[-3.77]	[-3.81]	[-2.12]	[-2.08]
(Debt w/o Inflation) / Debt – High-Income	-4.01	…	-3.62	…
	[-2.41]	…	[-2.28]	…
(Debt w/o Inflation)/ Debt – Middle-Income	-.854	…	-.784	…
	[-.612]	…	[-.565]	…
Inflation Rate (CPI) – High-Income	1.63	-.801	.584	-1.68
	[1.52]	[-1.05]	[.542]	[-2.23]
Inflation Rate (CPI) – Middle-Income	.471	.066	.377	.002 †
	[.702]	[.261]	[.543]	[.007]
Growth Rate	-.146	-.006	-.657	-.579
	[-.209]	[-.009]	[-.920]	[-.842]
GDP Per Capita	-2.20	-2.14	-.428	-.371
	[-7.40]	[-7.58]	[-1.22]	[-1.11]
GDP (U$millions of 1995)	1.15	1.14	.361	.349
	[8.34]	[8.21]	[2.67]	[2.55]
R^2	.99	.99	.99	.99

Notes: Between square brackets are the t-statistics.
† Dummy is significantly different from the dummy for high-income economies at a 5% level.

Table 6: R^2 Values for the OLS/White Real Exchange Rate Regressions Restricted by Country

Country	Basic Specification				Controls and Dummies			
	True-RER		*PPP-RER*		*True-RER*		*PPP-RER*	
	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
All Countries	.91	.90	.83	.81	.96	.96	.92	.91
High-income								
Japan	.56	.55	.34	.24	.91	.90	.76	.76
Germany	.18	.18	-.20	-.18	.88	.86	.58	.59
United Kingdom	.28	.11	.17	.20	.74	.74	.23	.31
France	.31	.18	-.41	-.52	.89	.88	.36	.34
Italy	.66	.55	.04	-.03	.32	.50	.63	.59
Canada	.41	.35	.45	.49	.76	.61	.27	.33
Spain	.47	.43	-.06	-.12	.92	.92	.86	.87
Sweden	.28	.20	.29	.26	.73	.66	.53	.50
Netherlands	.45	.48	.21	.21	.76	.76	.43	.43
Middle-Income:	Latin America							
Argentina	.76	.38	.63	.51	.76	.77	.57	.40
Brazil	.20	.15	.54	.46	.80	.79	.81	.82
Mexico	.50	.44	.57	.52	.40	.38	.47	.48
Uruguay	.07	-.23	.50	.51	.68	.66	.79	.80
Middle-Income:	Southeast Asia							
Indonesia	-1.01	-1.01	.16	.17	-	-	-	-
Korea	.13	.06	.19	.26	.65	.66	.21	.18
Malaysia	-.83	-1.86	-.84	-1.02	.20	.15	-.03	-.07
Philippines	-.23	-.48	.34	.38	-.28	-.34	-.54	-.60
Thailand	-.93	1.23	1.99	2.03	.04	.04	.42	.39

Note: R(2)'s computed from Table 5 regression and restricted for each country as in equation (3.4.1)
(I) Includes the independent variable (Debt w/o Inflation)/Debt in the regression, (II) does not.

Table 7: R^2 Values for the OLS/White Stock Price Regressions Restricted by Country

Country	Basic Specification				Controls and Dummies			
	True-RER		*PPP-RER*		*True-RER*		*PPP-RER*	
	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
All Countries	.54	.54	.54	.53	.81	.80	.73	.72
High-income								
United States	.65	.62	.63	.60	.78	.77	.77	.76
Japan	.78	.76	.78	.79	.88	.87	.84	.82
Germany	.45	.44	.58	.58	.74	.72	.64	.62
United Kingdom	.33	.23	.39	.24	.82	.81	.67	.66
France	.53	.51	.66	.65	.86	.83	.86	.83
Italy	.61	.61	.51	.52	.69	.69	.40	.40
Canada	-.20	-.10	.35	.38	-2.31	-1.89	-.41	-.21
Spain	.49	.52	.52	.52	-.16	-.03	.32	.36
Sweden	.43	.39	.46	.39	.80	.74	.70	.63
Netherlands	.59	.60	.54	.56	.76	.76	.68	.69
Middle-Income								
Indonesia	-.88	-.50	-.95	-.43	.72	.71	.28	.20
Korea	.17	.20	.23	.29	.78	.75	.36	.29
Malaysia	.38	.35	.30	.24	.73	.75	.72	.74
Philippines	.47	.53	.42	.49	.73	.74	.57	.58
Thailand	-.72	-.86	-1.05	-1.21	.76	.75	.66	.64
Argentina	-1.96	-.58	-2.03	-.34	-.64	-.26	-1.06	-.65
Mexico	.35	.39	.26	.28	.93	.89	.85	.81

Note: R(2)'s computed from Table 5 regression and restricted for each country as in equation (3.4.1)
(I) Includes the independent variable (Debt w/o Inflation)/Debt in the regression, (II) does not.

Table 8: F-tests for the OLS/White Real Exchange Rate Regressions Restricted by Country (Prob. > F)

Country	Basic Specification				Controls and Dummies			
	True-RER		*PPP-RER*		*True-RER*		*PPP-RER*	
	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
High-income								
Japan	.003	.025	.253	.042	.001	.000	.001	.000
Germany	.017	.066	.019	.015	.050	.013	.039	.014
United Kingdom	.000	.000	.130	.104	.000	.000	.000	.011
France	.000	.000	.000	.000	.002	.000	.003	.007
Italy	.000	.000	.001	.000	.000	.000	.001	.000
Canada	.245	.296	.742	.974	.000	.000	.000	.000
Spain	.000	.000	.001	.000	.000	.000	.001	.002
Sweden	.000	.000	.973	.801	.001	.000	.070	.006
Netherlands	.000	.000	.086	.085	.000	.000	.000	.000
Middle-Income:	Latin America							
Argentina	.001	.013	.005	.005	-	-	-	-
Brazil	.000	.000	.000	.000	.117	.026	.029	.083
Mexico	.001	.000	.020	.001	.001	.030	.075	.039
Uruguay	.209	.028	.000	.000	.035	.003	.005	.001
Middle-Income:	Southeast Asia							
Indonesia	.000	.000	.000	.000	-	-	-	-
Korea	.001	.000	.012	.302	.118	.137	.044	.025
Malaysia	.013	.003	.000	.000	.004	.002	.007	.026
Philippines	.000	.000	.556	.657	.001	.002	.004	.000
Thailand	.000	.000	.000	.000	.028	.031	.012	.010

Note: H(0): coefficients of the country regression = coefficients of the panel data regression
(I) Includes the independent variable (Debt w/o Inflation)/Debt in the regression, (II) does not.

Table 9: F-tests for the OLS/White Stock Price Regressions Restricted by Country (Prob. > F)

Country	Basic Specification				Controls and Dummies			
	True-RER		*PPP-RER*		*True-RER*		*PPP-RER*	
	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
High-income								
United States	.000	.000	.000	.000	.004	.003	.002	.001
Japan	.013	.238	.002	.301	.004	.085	.018	.003
Germany	.051	.141	.164	.236	.002	.006	.026	.004
United Kingdom	.000	.000	.000	.000	.000	.000	.000	.000
France	.004	.003	.002	.000	.366	.164	.539	.002
Italy	.324	.270	.189	.259	.032	.020	.006	.033
Canada	.000	.000	.001	.001	.000	.000	.000	.000
Spain	.134	.099	.014	.009	.123	.022	.084	.169
Sweden	.022	.016	.005	.001	.007	.001	.030	.001
Netherlands	.000	.001	.000	.000	.000	.000	.000	.000
Middle Income								
Indonesia	.009	.007	.024	.014	-	.004	-	.365
Korea	.077	.058	.003	.001	.005	.000	.013	.000
Malaysia	.017	.002	.001	.000	.000	.001	.001	.000
Philippines	.001	.072	.000	.062	.071	.250	.029	.041
Thailand	.001	.000	.001	.000	.000	.009	.001	.002
Mexico	.000	.000	.001	.000	.079	.030	.075	.021

Note: H(0): coefficients of the country regression = coefficients of the panel data regression
(I) Includes the independent variable (Debt w/o Inflation)/Debt in the regression, (II) does not.