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DEVIATIONS FROM INTEREST RATE PARITY IN SMALL OPEN ECONOMIES: A QUANTITATIVE-THEORETICAL INVESTIGATION

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BALÁZS VILÁGI
JÁNOS VINCZE

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Authors: Loránd AMBRUS-LAKATOS (Central European University)

Balázs VILÁGI (Budapest University of Economic Sciences and Public Administration)

János VINCZE (Budapest University of Economic Sciences and Public Administration and Institute of Economics of HAS)

Please address corresponcence to: János Vincze, BUESPA, Fővám tér 8., Budapest, H–1093. E-mail: janos.vincze@bkae.hu

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DEVIATIONS FROM INTEREST RATE PARITY IN SMALL OPEN ECONOMIES: A QUANTITATIVE-THEORETICAL INVESTIGATION

BY LORÁND AMBRUS-LAKATOS, BALÁZS VILÁGI AND JÁNOS VINCZE

Abstract

It is frequently claimed that the expected yield on emerging market bonds commands a premium. Here we investigate the sources of this phe-nomenon. A stochastic general equilibrium model of a small open economy is analyzed numerically to derive conditions for interest rate premia. The novelty of our approach is to attack the problem form the point of view of state dependent policy mixes. The main lessons include: if positive premia were universal, then 1. nominal rigidity should be important, 2. monetary authorities might have a current account stabilization motive, and 3. taste shocks possibly play some role in emerging markets.

AMBRUS-LAKATOS LORÁND – VILÁGI BALÁZS – VINCZE JÁNOS

ELTÉRÉSEK A KAMATLÁBPARITÁSTÓL KIS NYITOTT GAZDASÁGOKBAN EGY KVANTITATÍV-ELMÉLETI MEGKÖZELÍTÉS

Összefoglalás

Általában úgy tartják, hogy a feltörekvő piacok valutáinak hozamprémiuma van a tőkepiacokon. Ez a tanulmány ennek a jelenségnek az eredetét vizsgálja. Egy kis nyitott gazdaság sztochasztikus dinamikus általános egyensúlyi modelljét elemezzük numerikusan, célunk olyan feltételek meghatározása, amelyek hozamprémiumhoz vezetnek. Módszerünk újdonsága az, hogy a problémát állapotfüggő gazdaságpolitikai keverékek oldaláról közelítjük meg. A legfontosabb tanulságok: nominális merevségek, a fizetési mérleg stabilizálásának célja, és ízléssokkok szerepet kell, hogy játsszanak abban, hogy léteznek hozamprémiumok.

1 Introduction

Apparent deviations from uncovered interest parity have interested researchers for a long time. One particular puzzling instance came under the heading of the peso problem, another one has come to be known as the forward premium puzzle. Though it has not been formalized there is a general feeling that emerging market currencies command a premium over dollar, yen and the euro because of exchange rate risk. To translate this proposition into more formal language one would say that the expected yield on default free emerging market currencies is higher than that of developed country currencies. In fact it has been argued that enhanced exchange rate flexibility increases this premium, and that it is in fact advantageous since monetary policy makers can achieve higher real interest rates in this way in emerging countries. The later is thought to be important because of the needs of disinflation, and the possible real exchange rate appreciation. Though obviously the latter question has the important policy relevance in this paper we try to achieve a more modest goal, namely we would like to derive conditions for the existence of a positive premium as such, without investigating the possible consequences on inflation or the current account.

This claim of the existence of a premium is rather vague, and it admits of multiple interpretations. The first possible interpretation invokes a peso problem, that is the possibility that ex post average yields are not good measures of average yields since there is a small probability of a large devaluation of the developing country currency, which might not have realized during the period of observation. A second way out of the dilemma is referring to default risk. This argument says that developing country bonds bear the risk of outright default, and should have a risk premium on this account. Of course this opinion loses much of its strength if we observe that the "premium" exists even on short term securities, where the risk in many cases should be quite negligible. A third argument sustains the view that investors are never risk neutral and the premium must be due to risk aversion. Now a risk premium in portfolio theory must be a function of not just risk aversion as a preference parameter, but also the function of the covariance between an investor's consumption (total yield) and the yield on the particular portfolio. In this respect it is hard to see why even risk averse well diversified international investors should require a substantial premium on fixed income securities issued by a small country's government. However there is another possible explanation: suppose that developing country monetary authorities consciously set their interest rate and exchange rate policies in a way that would give a premium on domestic currency denominated bonds. Suppose it is possible because there are enough imperfections to deny the existence of effectively risk neutral investors. (Regulatory obstacles may help.) Then the premium is a domestic affair and foreign investors play a passive role in setting domestic money denominated yields than is sometimes thought. What are the reasons for such a policy, and what sort of consequences does it have if practiced?

Let us see briefly how one can explicate the problem as formulated in simple stochastic dynamic model of a small open economy. In many models when domestic and foreign currency denominated one period bonds are freely traded the next equality characterizes equilibrium

$$\mathrm{E}_t\left[\Lambda_{t+1}\left(I_t - I_t^*\frac{S_{t+1}}{S_t}\right)\right] = 0, \tag{1}$$

where I_t the gross interest rate on domestic bonds. I_t^* the gross domestic interest rate on foreign bonds, S_t the nominal exchange rate (in units of home currency per one unit of foreign currency), and Λ_{t+1} the home nominal stochastic discount factor. In the case of logarithmic utility the stochastic discount factor is

$$\Lambda_t = \frac{CN_t^{-1}}{PN_t},$$

where CN_t is consumption, and PN_t is the price of the consumption good. Then the expected premium on the home currency can be written as

$$\mathrm{E}_t(\Pi_{t+1}^n) = I_t - I_t^*\mathrm{E}_t\left(\frac{S_{t+1}}{S_t}\right).$$

Simple arithmetics show that *there is a premium on home currency assets if and only if* $\mathrm{cov}(\Lambda_{t+1}, S_{t+1}) > 0$, since

$$\begin{aligned}\frac{\mathrm{E}(S_{t+1}\Lambda_{t+1})}{\mathrm{E}(\Lambda_{t+1})} &= \frac{\mathrm{cov}(\Lambda_{t+1}, S_{t+1}) + \mathrm{E}(S_{t+1})\mathrm{E}(\Lambda_{t+1})}{\mathrm{E}(\Lambda_{t+1})} \\ &= \frac{\mathrm{cov}(\Lambda_{t+1}, S_{t+1})}{\mathrm{E}(\Lambda_{t+1})} + \mathrm{E}(S_{t+1}).\end{aligned}$$

Now Λ_{t+1} decreases in both consumption and in consumer prices. Thus there will be a premium on home assets if weaker than average currency will be associated with a higher rise in the marginal utility of consumption than the increase in consumer prices caused by the weaker currency.

An alternative expression can be obtained by defining the premium via ratios.

$$\mathrm{E}_t(R\Pi_{t+1}^n) + 1 = \frac{I_t}{I_t^*\mathrm{E}_t\left(\frac{S_{t+1}}{S_t}\right)}.$$

If one is willing to take a second order approximation (exact in the case of joint lognormality) then this premium takes the form

$$\log(\mathrm{E}_t(R\Pi_{t+1}^n) + 1) = i_t - i_t^* - (E_t(s_{t+1} - s_t)) - \frac{1}{2}\mathrm{var}_t(s_{t+1}),$$

where lowercase letters denote natural logarithms of the corresponding uppercase variables. One can rewrite (1) as

$$\frac{I_t\mathrm{E}_t(\Lambda_{t+1})S_t}{I_t^*\mathrm{E}_t(\Lambda_{t+1}S_{t+1})} = 1,$$

which results in

$$\begin{aligned}&i_t - i_t^* - (\mathrm{E}_t(s_{t+1} - s_t)) - \frac{1}{2}\mathrm{var}_t(s_{t+1}) = \\ &-\mathrm{cov}_t(cn_{t+1}, s_{t+1}) - \mathrm{cov}_t(pn_{t+1}, s_{t+1}).\end{aligned}$$

The second covariance on the right hand side is presumably, but not necessarily positive, thus it seems imperative that the first must be negative to get a positive premium. The real premium is

$$\Pi^r = \mathrm{E}_t \left(I_t \frac{P_t}{P_{t+1}} - I_t^* \frac{S_{t+1} P_t}{S_t P_{t+1}} \right).$$

$\Pi^n = 0$ implies $\Pi^r = 0$ if $\mathrm{cov}(S_{t+1}, P_{t+1}) = 0$. If $\mathrm{cov}(S_{t+1}, P_{t+1}) > 0$, which is plausible, then $\Pi^n = 0$ implies $\Pi^r > 0$.

$$\begin{aligned} & \mathrm{E}_t \left(I_t \frac{P_t}{P_{t+1}} - I_t^* \frac{S_{t+1} P_t}{S_t P_{t+1}} \right) = \\ & \mathrm{E}_t \left(\frac{I_t P_t - I_t^* S_{t+1} P_t}{S_t} \right) \mathrm{E}_t \left(\frac{P_t}{P_{t+1}} \right) + \mathrm{cov} \left(-\frac{S_{t+1}}{S_t}, \frac{P_t}{P_{t+1}} \right). \end{aligned}$$

Therefore the nominal premium that results in 0 real premium can be written as

$$\mathrm{E}_t \left(\frac{I_t P_t - I_t^* S_{t+1} P_t}{S_t} \right) = \frac{\mathrm{cov} \left(\frac{S_{t+1}}{S_t}, \frac{P_t}{P_{t+1}} \right)}{\mathrm{E}_t \left(\frac{P_t}{P_{t+1}} \right)} < 0.$$

Thus if the intuition that says that foreign currency bonds are hedges against macroeconomic risks in developing countries is correct, it still does not entail the conclusion that nominal interest premia be positive.

The usual questions concerning interest rate premia were first formulated by Fama (1984): why are there excess returns, and why are they so volatile? (See Lewis (1995) for a summary of the literature.) Of course, the first part of the problem can be dealt with outright: if one drops the assumption of risk neutrality there is no reason why excess returns should not exist. Still, there remains the problem of “too much” volatility.

Two recent attempts that addressed the risk premium issue include Obstfeld-Rogoff (1998) and Engel (1999). Our approach is closely related to these papers, since we also formulate the problem in the framework of an open economy macromodel that may involve nominal rigidities. There are, however, important differences. For instance, Obstfeld-Rogoff (1998) puts money supply shocks, and money demand parameters to the centerstage, whereas in our investigation we do not examine money supply shocks at all, and money demand gets (some) importance only when monetary policy has interrelations with fiscal policy. Engel (1999) also focuses on the effects of money supply shocks, and studies the effects of different types of price setting behavior, namely pricing to market and exporter’s currency pricing. In contrast, we study a small-country tradable producers that take as given the export price in foreign currency, and determine only the home currency prices of their products. Also we try to compare nominal and real rigidities.

In general we ask the question whether emerging markets may have permanently positive interest rate premia, and if yes, what is the main source of this phenomenon. Our approach is based on policy reaction functions, but we ignore policy shocks. Positive or negative premia may emerge because policy reacts systematically to exogenous shocks, and thereby can generate covariances between consumption, prices, and the nominal exchange rate. The basic intuition behind why a positive premium is more likely than a negative one is that foreign currency investment can be a good hedge against macroeconomic risks, if it is true that "troubles" are associated with depreciation. As we will see this simple intuition has much force, but it has to be qualified significantly.

In Section 2 we describe a stochastic dynamic general equilibrium model of a small open economy. In Section 3 we will analyze the model numerically in eight versions, in order to derive conditions for non-zero interest rate premia. Section 4 concludes.

2 Description of the model

2.1 Household behavior

The economy is populated by an infinity of identical households. A representative household (indexes are suppressed as unnecessary) decides at the beginning of each period on how to divide their wealth among two financial assets (domestic currency bonds (BH_t), foreign bonds (BF_t)), how much to spend on the (perishable) consumption good (CN_t), and how much to hold in the form of money (M_t). Also they decide how much labor to supply (L_t). Disposable wealth includes assets carried over from the previous period, interest earned on them, profits distributed by firms own by households, and wages paid out by the non-tradable sector and the tradable sector, minus labor taxes (the tax rate is denoted by τ_t). There is a preference shock ψ_t,which is realized at the beginning of each period, thus household decisions are based on them.

The representative household has a per period utility function

$$U_t(CN_t, L_t) = \psi_t \log CN_t + \frac{\omega}{1-\varepsilon}(1-L_t)^{1-\varepsilon} + \frac{1}{1-\gamma}\left[\frac{M_t}{PN_t}\right]^{1-\gamma},$$

where ψ_t is a preference shift parameter (a random variable), and ω is a positive parameter whose higher values represent higher disutility to working. Total available time is normalized to 1. The preference shock as formalized here works both intra and intertemporally, if it is larger it increases marginal utilities today versus tomorrow, and also the relative attractiveness of consumption today visá-vis leisure.

Then the household's program can be written as

$$\max \mathrm{E}_0 \left[\sum_{t=0}^{\infty} \beta^t U_t(CN_t, L_t, \frac{M_t}{PN_t})\right]$$

subject to

$$\begin{aligned} &BH_t + S_t BF_t + PN_t CN_t + \tau_t W_t L_t + M_t = \\ &I_{t-1} BH_{t-1} + S_t I^*_{t-1} BF_{t-1} + M_{t-1} + W_t L_t + \Pi T_t + \Pi N_t. \end{aligned}$$

Here β is the time preference parameter, PN_t is the non-tradable price, S_t is the nominal exchange rate, W_t is the nominal wage, I^*_t and I_t, are gross interest rates on foreign liabilities, and on domestic bonds, respectively, T_t is taxes that may involve labor taxes as well, ΠT_t and ΠN_t are profits in the tradable and non-tradable sectors, respectively. This is a standard problem frequently studied in the literature, for which first order conditions can be derived either by the method of Lagrange multipliers, or by dynamic programming.

Let us denote by NW_t nominal wealth denominated in the home currency in period t. Then one can define the optimal value function in the usual way

$$V(NW_t) = \max_{CN_s, M_s, L_s, BF_s} \mathrm{E}_t \left[\sum_{s=t}^{\infty} \beta^s U \left(CN_s, L_s, \frac{M_s}{PN_s} \right) \right] \tag{2}$$

where

$$\begin{aligned} NW_t &= I_{t-1}NW_{t-1} + (S_t I^*_{t-1} - I_{t-1})S_{t-1}BF_{t-1} + (1 - I_t)M_{t-1} \\ &+ (1 - \tau_t)W_t L_t + \Pi T_t + \Pi N_t - I_{t-1}PN_{t-1}CN_{t-1} - T_t. \end{aligned}$$

Under certain conditions this exists, and the Maximum Principle can be written as

$$V(NW_t) = \max_{CN_t, CA_t, CP_t, D_t, BF_t} \left\{ U \left(CN_t, L_t, \frac{M_t}{PN_t} \right) + \beta \mathrm{E}_t \left[V(NW_{t+1}) \right] \right\}. \tag{3}$$

The set of first order conditions for this problem can be derived by differentiating (2) with respect to the decision variables, making the first derivatives equal to zero, and using the envelope condition applied to (3).

Let us define the auxiliary variable Λ_t (the marginal indirect utility of nominal wealth in $t, \partial V / \partial NW_t$). The following is the standard dynamic first order condition, the Euler-equation

$$\Lambda_t = I_t \beta \mathrm{E}_t(\Lambda_{t+1}). \tag{4}$$

It can be proved that

$$\Lambda_t = \frac{\psi_t}{CN_t PN_t}. \tag{5}$$

The implicit labor supply relationship is

$$\frac{PN_t}{(1 - \tau_t)W_t} = \frac{\psi_t (1 - L_t)^{\varepsilon}}{\omega CN_t}. \tag{6}$$

Money demand is

$$\left[\frac{M_t}{PN_t} \right]^{-\gamma} = \frac{I_t - 1}{I_t} \frac{\psi_t}{CN_t PN_t}. \tag{7}$$

One can also derive from the optimal choice between domestic and foreign bonds, the portfolio choice equation:

$$\mathrm{E}_t \left[\Lambda_{t+1} \left(I_t - I^*_t \frac{S_{t+1}}{S_t} \right) \right] = 0. \tag{8}$$

The transversality condition may be written as[1]

$$\lim_{T \to \infty} \frac{\beta^{T-t} \Lambda_{t+T}}{\Lambda_t} NW_{t+T} = 0.$$

[1]We will study stationary equilibria, in which case the transversality condition is satisfied.

2.2 The structure of domestic goods markets

Production

Production has a hierarchical structure. Differentiated producers produce a continuum of tradable goods using homogenous labor with a diminishing returns to scale technology. This output can be sold domestically or exported. If sold domestically a competitive sector aggregates these differentiated products into a domestically produced tradable aggregate. Then another competitive sector produces, via a Cobb-Douglas technology, an intermediate input-capital good aggregate of this domestic tradable aggregate and of an imported. Non-tradables are made of this latter good and by homogenous labor via another Cobb-Douglas technology. We can proceed backwards to determine demand and prices.

The non-tradable sector

Let QN_t denote non-tradable output, LN_t labor demand by the non-tradable sector and YN_t the demand for the intermediate good in that sector. The Cobb-Douglas technology can be written as

$$QN_t = LN_t{}^{\eta} YN_t^{1-\eta}.$$

Thus non-tradable prices (PN_t), nominal wages (W_t), and intermediate prices (PI_t) must satisfy

$$PN_t = \eta^{\eta}(1-\eta)^{1-\eta} W_t{}^{\eta} PI_t, \tag{9}$$

while input demands can be written as

$$LN_t = (1-\eta)\frac{PN_t}{W_t} QN_t, \tag{10}$$

and

$$YN_t = \eta \frac{PN_t}{PI_t} QN_t. \tag{11}$$

The intermediate good sector

This sector applies a Cobb-Douglas technology again.

$$Y_t = X_t^{\rho} MX_t^{1-\rho},$$

where Y_t is the output of the sector, X_t and MX_t are the demand for the home tradable and imports, respectively. Then prices and input demands can be expressed as

$$PI_t = \rho^{-\rho}(1-\rho)^{1-\rho} PM_t^{\rho} PQ_t^{1-\rho}, \tag{12}$$

$$X_t = (1-\rho)\frac{PI_t}{PQ_t} Y_t, \tag{13}$$

$$MX_t = \rho \frac{PI_t}{PM_t} Y_t, \tag{14}$$

where

$$PM_t = PM_t^{*} S_t. \tag{15}$$

is the import price in domestic currency, PM_t^{*} the import price in foreign currency, and S_t is the nominal exchange rate.

The tradable sector and real rigidity

The tradable sector is modelled in two versions. In the first one there is real rigidity, whereas in the second there is some nominal rigidity. In both versions there exist a continuum of tradable producers, indexed by j, and it is assumed that they are distributed on $[0, 1]$ uniformly.

Here we assume that selling output has a one-period lag behind the application of inputs, which is only labor here. We assume that the production function is

$$QT_t(j) = \theta_t LT_t(j)^\alpha, \tag{16}$$

where $QT_t(j)$ is the quantity of output, $LT_t(j)$ labor, θ_t and α are production function parameters.

Output can be sold either domestically, or abroad (exports) with one period lag.

$$QT_t(j) = X_{t+1}(j) + Z_{t+1}(j), \tag{17}$$

where $X_t(j)$ is domestic purchases, and $Z_t(j)$ exports.

First let us assume that prices are flexible, and firms can set period $t+1$ prices based on $t+1$ period information. A firm entering period $t+1$ with $QT_t(j)$ inherited amount of goods will have to decide on which market it wants to sell. This problem is simply maximizing revenues, given prices and demand conditions. We assume that firms are price-takers abroad, which seems natural for small economy producers, and price-makers on domestic markets. This assumption implies the ability to price-discriminate, and leads to a higher domestic price at home than at abroad. Thus if the firm possesses a certain amount of its product and faces the problem of dividing it between domestic sales and exports it will first satisfy domestic demand and export the rest. The possibility of international price discrimination can be explained by the presence of transportation and other transaction costs, tariffs etc. that make perfect arbitrage impossible. This subproblem can be written therefore as

$$\max_{PQ_{t+1}(j), Z_{t+1}(j)} S_{t+1} Z_{t+1}(j) + PQ_{t+1}(j) X_{t+1}(j),$$

where S_{t+1} is the export price in home currency as export prices in foreign exchange are taken to be constant, $PQ_{t+1}(j)$ the domestic (producer's) price, and the home demand for domestic tradables $(X_{t+1}(j))$ is supposed to be known by the seller, and will be derived later to have a price elasticity of ϕ, which is identical across firms. Monopoly profit maximization implies for domestic tradable prices the following formula.

$$PQ_{t+1} = \mu S_{t+1}, \tag{18}$$

where $\mu = \phi/(\phi - 1)$ by. In this formula the role of marginal cost is assumed by the exchange rate, which is the marginal opportunity cost of selling at the domestic market.

Then we have to derive the t period production (labor demand) choice by taking into account that in the next period short term profit maximization will prevail, and the fact that today's inputs must be financed from the capital market.

For given W_t (the nominal wage) and nominal interest rate (I_t) the cost function $C(Q_t(j))$ can be derived as

$$C(Q_t(j)) = I_t W_t \left(\frac{Q_t(j)}{\theta_t} \right)^{1/\alpha}.$$

The revenue function becomes

$$R_{t+1}(Q_t(j)) = \max_{PQ_{t+1}(j), Z_{t+1}(j)} S_{t+1} Z_{z+1}(j) + PQ_{t+1}(j) \Big[Q_t(j) - Z_{t+1}(j) \Big].$$

Its derivative with respect to $Q_t(j)$ can be obtained by the Envelope Theorem as $PQ_{t+1}(j) = \mu S_{t+1}$. We suppose that tradable firms are owned by domestic households and they maximize expected utility "using" their value function to evaluate future cash flows. Then the implicit supply function becomes

$$\mathrm{E}_t \left[\Lambda_{t+1} \left(\mu S_{t+1} - \frac{W_t}{\theta_t \alpha} \left(\frac{Q_t(j)}{\theta_t} \right)^{\frac{1-\alpha}{\alpha}} I_t \right) \right] = 0,$$

where Λ_{t+1} is the marginal utility of nominal wealth for domestic households.

From which output can be explicitly determined with the help of the asset pricing relationship (8) as

$$Q_t(j) = \theta_t^{\frac{1}{1-\alpha}} \left(\frac{\mu \alpha S_t}{W_t I_t^*} \right)^{\frac{\alpha}{1-\alpha}}, \tag{19}$$

and labor demand is

$$LT_t(j) = \left(\frac{QT_t(j)}{\theta_t} \right)^{\frac{1}{\alpha}}.$$

The tradable sector and nominal rigidity

Here the production function is the same but output can be sold simultaneously

$$QT_t(j) = X_t(j) + Z_t(j). \tag{20}$$

Now we can consider nominal rigidity in price setting, by assuming that period $t+1$ prices must be set based on period t information. Now the $t+1$ period problem is

$$\max_{LT_{t+1}(j)} S_{t+1} \Big[\theta_{t+1} LT_{t+1}(j)^{\alpha} - X_{t+1}(j) \Big] + PQ_{t+1}(j) X_{t+1}(j) - W_{t+1} LT_{t+1}(j),$$

where PQ_{jt+1} is predetermined. To carry out maximization the firm must take into account the demand function again. Then labor demand can be explicit expressed from the other first order condition as

$$LT_{t+1}(j) = \left(\frac{\alpha \theta_{t+1} S_{t+1}}{W_{t+1}} \right)^{\frac{1}{1-\alpha}}. \tag{21}$$

It is clear that the labor demand (and production) decision does not depend on the predetermined domestic price. Therefore the new pricing equation must be derived from the maximization of $(PQ_{t+1}(j) - S_{t+1})X_{t+1}(j)$ evaluated by the value function of the household. The resulting pricing equation is now

$$PQ_{t+1}(j) = \mu \frac{\mathrm{E}_t \left[S_{t+1}\Lambda_{t+1}X_{t+1}(j)\right]}{\mathrm{E}_t \left[\Lambda_{t+1}X_{t+1}(j)\right]}. \tag{22}$$

Thus the marginal opportunity cost, the variable to be marked-up, is modified by taking into account uncertainty. The "effective" marginal opportunity cost

$$\frac{\mathrm{E}_t \left[S_{t+1}\Lambda_{t+1}X_{t+1}(j)\right]}{\mathrm{E}_t \left[\Lambda_{t+1}X_{t+1}(j)\right]}$$

is higher (lower) than the expected export price if the export price and the marginal utility of nominal wealth times demand are positively (negatively) correlated since

$$\frac{\mathrm{E}_t \left[S_{t+1}\Lambda_{t+1}X_{t+1}(j)\right]}{\mathrm{E}_t \left[\Lambda_{t+1}X_{t+1}(j)\right]} = \mathrm{E}_t(S_{t+1}) + \frac{\mathrm{cov}_t \left(\Lambda_{t+1}X_{t+1}(j), S_{t+1}\right)}{\mathrm{E}_t \left[\Lambda_{t+1}X_{t+1}(j)\right]}.$$

As usual if shocks are small in the sense that $S_{t+1} \leq PQ_{t+1}(j)$ for sure then it is ex post rational to satisfy domestic demand at the predetermined prices. In the following it is always assumed to be the case. With predetermined home prices the new supply function and labor demand can be expressed as follows.

To derive the demand elasticity we start with the Dixit-Stiglitz technology for the aggregate home tradable good

$$X_t = \left(\int_0^1 X_t(j)^\nu \, dj\right)^{\frac{1}{\nu}},$$

where $0 < \nu < 1$. Then the aggregate domestic tradable price index PQ_t can be written as

$$PQ_t = \left(\int_0^1 PQ_t(j)^{\frac{\nu}{\nu-1}} \, dj\right)^{\frac{\nu-1}{\nu}}.$$

and the demand for the jth good as

$$X_t(j) = \left(\frac{PQ_t(j)}{PQ_t}\right)^{\frac{1}{\nu-1}} X_t.$$

Thus $\phi = 1/(\nu - 1)$ and $\mu = 1/(2 - \nu)$.

Total labor demand of the home tradable sector is

$$LT_t = \int_0^1 L_t(j) \, dj.$$

2.3 Fiscal policy

The government's net foreign liabilities accumulate according to

$$\begin{aligned} S_t BFG_t &= I_{t-1}B_{t-1} + S_t IG^*_{t-1} BFG_{t-1} - B_t \\ &+ M_{t-1} - M_t - \tau W_t L_t + PN_t G_t + T, \end{aligned} \tag{23}$$

where BFG_t is net foreign liabilities (denominated in foreign currency) of the government, IG_t^* is the foreign interest rate on net government liabilities, B_t is total domestic currency denominated debt,

$$\tau_t = \tau_t^d + \overline{\tau} \tag{24}$$

is the labor tax rate, T is lump-sum taxes, and

$$G_t = \overline{G} + G_t^d \tag{25}$$

is government purchases of the non-tradable good. The government has potentially three instruments: taxes, expenditures and one debt variable. It is clear that by adjusting only domestic currency bonds foreign debt cannot be stabilized. In the following we disregard this policy instrument and set $B_t = 0$ each period. Then we will distinguish between two types of government behavior, one that uses labor taxes and another one that relies on controlling spending. We can define RT_t as

$$RT_t = \frac{\tau_t W_t L_t + M_t - M_{t-1} - G_t}{S_t}.$$

This is a real variable, measured in foreign currency and therefore in imports, and represents the total net transfer (primary balance plus seigniorage) to the government in period t. We assume that

$$RT_t = RT \left(\frac{BF_{t-1}}{BF} \right)^{\vartheta_1} \left(\frac{BFG_{t-1}}{BFG} \right)^{-\vartheta_2} \tag{26}$$

characterizes government behavior, where ϑ_i are positive, and BF and BFG are the steady state value of net household and government foreign currency denominated debt. This means that real transfers increase when the government's foreign debt is higher than its steady state value, and decrease when the households' foreign debt is higher than its steady state value. To carry out this policy we assume that the government behaves in either of the following two ways.

Spending adjustment

$$G_t^d = M_t - M_{t-1} - S_t RT_t + \overline{\tau} W_t L_t - \overline{G}, \tag{27}$$

where the (excess) labor tax rate

$$\tau_t^d = 0. \tag{28}$$

Tax adjustment

$$\tau_t^d = \frac{S_t RT_t + \overline{G} - M_t - M_{t-1}}{W_t L_t} - \overline{\tau}. \tag{29}$$

Here (excess) government spending is supposed to be zero, that is

$$G_t^d = 0. \tag{30}$$

2.4 Monetary policy

Monetary policy has also two varieties: striving for price stability and for stabilizing foreign debt.

Stabilizing prices

This leads to the implicit exchange rate rule

$$PN_t = P, \tag{31}$$

where P is the steady state price level. Inspection of the pricing formulas show that this policy is feasible irrespective of price flexibility.

Debt motive

$$S_t = \left(\frac{BF_t + BFG_t}{BF + BFG} \right)^{\chi}. \tag{32}$$

Here we assume that monetary policy reacts with a depreciation to an increase in the country's foreign debt.

Here we assume that a depreciation tends to improve the current account. In the case of price rigidity this effect is via import substitution and seigniorage, whereas with real rigidities only seigniorage is relevant.

2.5 Market clearing conditions

Labor demand is determined as the sum of non-tradable and tradable sector demands and the labor market clears every period, i.e.

$$L_t = LT_t + LN_t. \tag{33}$$

implicitly determining the equilibrium wage rate. Goods market equilibria require

$$QN_t = CN_t + G_t, \tag{34}$$

$$YN_t = Y_t. \tag{35}$$

2.6 International capital markets

From now on we assume that both households and the government are net debtors to abroad.

We assume that interest rates for households satisfy

$$I_t^* = \frac{1}{\beta} \left(\frac{BF_t + BFG_t}{BF + BFT} \right)^{\xi}, \tag{36}$$

thus the steady state interest rate equals the $1/\beta$, and ξ is a positive parameter.

For the government we assume that it has the opportunity to borrow at a fixed rate, which is below the steady state rate applicable to households,

$$IG^* < \frac{1}{\beta}.$$

Our assumptions imply that international markets discipline private borrowers, but not the government. Also it is an implicit assumption that foreigners do not hold domestic currency denominated bonds.

By our assumptions $\beta IG^* - 1$ is negative. Thus the larger the ability of the government to tax (RT), the smaller is the equilibrium trade surplus. If $\beta IG^* - 1$ were 0, (the case of Ricardian equivalence in the long run), taxing ability would be irrelevant. Under our assumptions larger taxes are favorable since they help decrease foreign liabilities of the private sector, which is a more costly way of borrowing for the country as a whole.

Here we meet an unattractive feature of the small open economy (partial equilibrium) model. Long run asset positions are essentially arbitrarily determined. Some justifications can be invoked, though. Having an exogenously given foreign debt capacity for the country is a conjunction of giving an arbitrary limit to debt by referring to capital market imperfections, and also an assumption concerning the desirability of fully using that capacity. In a stationary model the justification should be rather artificial. We can say that for the developing country optimal long run debt would be higher, but the imperfection of capital markets does not admit it to achieve the optimal level. Setting a bound to real transfers may be reasoned for as implying limitations for government actions, when by our assumptions a higher long run real transfer level is desirable because of switching the debt burden towards the government, that has a "better" interest rate than the private sector.

There are two sorts of asymmetry that must be noticed. First the exclusion of foreigners from domestic fixed income securities markets. Now emerging country currencies are sometimes styled as exotic. Indeed even without formal restrictions, that exist nonetheless, foreigners may find it difficult to enter an exotic currency market.

Another issue is that there is no international trade in stocks. (We could introduce a stock market, and price (tradable) stocks without difficulty.) Again in reality there is substantial evidence for a home country bias, even among industrialized countries. Emerging stock markets may be more difficult to enter than government bond markets. Still the substantial amount of foreign direct investment makes our assumption suspicious.

Asset accumulation equations

Government debt evolves according to (23). Then we can specify the evolution of the foreign debt of the household,

$$BF_t = I^*_{t-1} BF_{t-1} - (Z_t - PX^*_t MX_t) - BFG_t + IG^*_{t-1} BFG_{t-1}. \qquad (37)$$

Here $Z_t - PX^*_t MX_t$ is the trade balance. It is clear that if the two foreign interest rates were equal then the composition of foreign debt would be irrelevant for the solution of the model.

2.7 Summary of essential model equations

Any version of the model has 28 equations and 28 endogenous variables.[2] There exist a total of eight versions classified by the dichotomous criteria of rigidity,

[2] Λ_t, CN_T, Y_t, YN_t, QT_t, QN_t, X_t, MX_t, Z_t, LT_t, LN_t, L_t, PN_t, PM_t, PQ_t, PI_t, W_t, S_t, I_t, I^*_t, BF_t, BFG_t, RT_t, G, G^d_t, τ_t, τ^d_t, M_t.

fiscal and monetary policies.

All the model versions comprise the following 22 equations: (4) – (16), (23) – (26) and (33) – (37). Besides, versions with real rigidity contain eq. (17) – (19), and with nominal rigidity eq. (20) – (22). If fiscal policy is described by spending adjustment, then one has to add eq. (27) and (28) to the system, while tax adjustments requires eq. (29) and (30). Finally, we can complete this set of equations by eq. (31) if price stability is the objective, and by eq. (32) if debt motive governs monetary policy.

The model is driven by three exogenous stochastic processes: ψ_t, PM_t^*, θ_t, that is, by the taste, import price and productivity shocks.

3 Numerical analysis

We denote by $\widetilde{X}_t$ the percentage deviations from the steady state of the 28-vector of endogenous variables, and by $\widetilde{Z}_{t+1}$ the triplet of the same transformation of the driving processes. The algorithm proposed by Uhlig (1996) looks for a solution of the following form:

$$\widetilde{X}_{t+1} = A\widetilde{X}_t + B\widetilde{Z}_{t+1}.$$

Then conditional covariances between any two endogenous variables can be calculated from the elements of B. As we do not wish to rely on any guess about the relative size of variances of the shock processes we report selected elements calculated on the assumption of equal variances, and then proceed to analyze the results.

As we do not intend to simulate the model with a view towards replicating any particular economy we choose parameter values that appear broadly plausible for small open economies, with the implicit interpretation that the model is an annual one. Thus we set $\alpha = 0.3$, $\beta = 0.94$, $\mu = 1.2$, $\gamma = 2.5$, $\eta = 0.3$, $\rho = 0.6$, $\varepsilon = 2$, $\overline{\tau} = 0.3$, $IG^* = 1.04$.

For other parameters we cannot easily establish intuitively reasonable values, here we experimented with a range of values, and we did not find that results were very sensitive to these. In the numerical calculations we report the following setting was used: $\xi = 10$, $\vartheta_1 = 1$, $\vartheta_2 = 1$, $\varkappa = 10$.

To determine the labor supply parameter ω we employed a steady state criterion, as usual in the literature. Setting ω so that leisure be 80% of total available time in the non-stochastic steady state. This reads

$$0.8 = \frac{\omega PNCN}{W(1-\tau)},$$

where non-indexed variables refer to the corresponding steady state values. To determine the steady state we needed three numerical conditions fixing (implicitly) the equilibrium levels of government and household debt, and the “size” of the government. The first of those expressed the long run government spending/GDP ratio, the second the amount of real transfers as a percentage of GDP, and the third exports/foreign debt ratio.

$$\frac{G}{QT+CN-Y} = 0.4, \qquad \frac{RT}{QT+CN-Y} = 0.02, \qquad \frac{Z}{BF+BFG} = 2.$$

The calculation of the steady state values is described in the Appendix.

Several versions with tax adjustment become unstable with the parameter setting described above. In all of these cases increasing gamma γ, whose reciprocals the interest semielasticty of money demand, to 20 restored the stability of the solution. In those cases where the original choice of $\gamma = 2.5$ did not cause any problem we found that the solution did not qualitatively change when γ was modified. Thus the first lesson we draw from our numerical exercises is that if the government uses the labor tax rate as its principal instrument to stabilize its finances then without an inelastic money demand this may play havoc with the economy.

Let us see now one-by-one the responses of the variables of interest (personal consumption, the price of non-tradables, the marginal utility of nominal wealth and the nominal exchange rate) to the various shocks.

Consumption

As expected the taste shock (a positive demand shock) always leads to higher unexpected consumption, and if there is nominal rigidity this effect is more pronounced. the import price shock (a negative supply shock) results in the opposite effect concerning personal consumption. But here the impact os not remarkably different when nominal prices can adjust, and when they cannot. The impact of the productivity shock (a positive supply shock) when there is nominal rigidity is against as expected, since consumption increases significantly immediately when technology unexpectedly improves. The cases of real rigidity show some interesting variation. When monetary policy has a debt motive and the government adjusts labor taxes the effect is similar to the nominal rigidity cases. However, in the remaining three instances the sign is opposite, though admittedly small.

Consumer prices

Obviously consumer prices change when the debt motive of monetary policy is in effect. Consumer prices unexpectedly decrease when there is a positive taste shock. This is a warning that the classification of demand-supply disturbances may be misleading. The particular reason for this anomaly is that a positive taste shock makes leisure less desirable, and therefore shifts the labor supply schedule leftward, resulting in a decline in the equilibrium real wage. The import price shock increases consumer prices, as expected. However, the effect of the productivity shock again defies simplistic notions about supply shocks. It has a positive impact on prices. This is the appearance of the much discussed Balassa-Samuelson effect in our framework. It is interesting to notice that this positive effect is the smallest when there is nominal rigidity, the debt motive is in effect, and fiscal policy adjusts via labor taxes.

The marginal utility of nominal wealth

The effect on the marginal utility of nominal wealth is the negative of the sum of the former two effects, plus the direct effect of the taste shock. In the versions with price stability the impacts of the productivity and import price shocks on the marginal utility of nominal wealth are simply minus 1 times those on consumption. The effects of the import price shock are positive when there is nominal rigidity. However, with real rigidity the numbers are generally small, and in one case it is even negative. The effects on marginal utility reflect mostly the effects on consumption in the case of the technology shock.

The nominal exchange rate

The effects on the nominal exchange rate reflect whether the shocks cause an incipient increase (decrease) in prices in the price stability scenario, and whether the shocks cause an incipient increase (decrease) in the current account in the debt motive scenario. Accordingly positive taste shocks result in depreciations in all scenarios. In the case of import price shocks the requirement of price stability entails appreciation, whereas debt stabilization involves more complexity. The negative current account effect of an import price shock must result in a depreciation according to our intuition, an indeed this is the outcome in all but one versions. We experience again that the effects of adjusting labor taxes can reverse first order effects. Here the debt motive coupled with real rigidity results in an improvement in the current account despite the import price rise, and accordingly in an appreciation. In case of productivity shocks the inflationary and positive current account impacts result in an appreciation in all but one case. In the real rigidity scenarios the lag in exports causes a rise in foreign debt immediately, and therefore invites depreciation if the debt motive is in effect.

When is the premium positive?

To find out which version can imply a positive premium we have to compare the signs of the different shocks on the nominal marginal utility , and on the nominal exchange rate. If the respective signs are the same, then the shock in question favors, as it were, the emergence of a positive premium. The following tables contain the numerical results.

Version 1: Nominal rigidity, price stability, tax adjustment, $\gamma = 20$

	Taste shock	Import price shock	Technology shock
Consumption	0.85	-0.34	0.34
Consumer prices	0	0	0
Nominal exchange rate	0.22	-0.27	-0.84
Tradable production	0.57	-0.11	0.82
Non-tradable production	0.72	-0.29	0.29
Employment	0.82	-0.13	-0.14
Household foreign debt	-0.0066	0.0096	0.0259
Government foreign debt	0.0088	-0.011	-0.0336
Nominal wage	-0.07	-0.22	0.25
Stochastic discount factor	0.15	0.34	-0.34

Version 2: Nominal rigidity, price stability, spending adjustment

	Taste shock	Import price shock	Technology shock
Consumption	0.64	-0.22	0.33
Consumer prices	0	0	0
Nominal exchange rate	0.16	-0.24	-0.84
Tradable production	0.43	-0.03	0.81
Non-tradable production	0.54	-0.19	0.28
Employment	0.62	-0.01	-0.15
Household foreign debt	-0.004	0.01	0.02
Government foreign debt	0.01	-0.01	-0.03
Nominal wage	-0.05	-0.22	0.25
Stochastic discount factor	0.36	0.22	-0.33

Version 3: Nominal rigidity, debt motive, tax adjustment

	Taste shock	Import price shock	Technology shock
Consumption	0.65	-0.17	1.00
Consumer prices	-0.03	0.16	0.18
Nominal exchange rate	0.13	-0.03	-0.44
Tradable production	0.44	0.04	1.30
Non-tradable production	0.57	-0.14	0.85
Employment	0.65	0.06	0.52
Household foreign debt	-0.002	0.0005	0.006
Government foreign debt	0.0052	-0.0013	-0.0178
Nominal wage	-0.09	-0.05	0.41
Stochastic discount factor	0.36	0.01	-1.18

Version 4: Nominal rigidity, debt motive, spending adjustment

	Taste shock	Import price shock	Technology shock
Consumption	0.64	-0.21	0.35
Consumer prices	-0.10	0.20	0.60
Nominal exchange rate	0.05	0.002	-0.10
Tradable production	0.41	0.02	0.95
Non-tradable production	0.54	-0.18	0.30
Employment	0.60	0.02	-0.05
Household foreign debt	-0.0006	0.0000	0.0013
Government foreign debt	0.0018	-0.0001	-0.0038
Nominal wage	-0.16	-0.01	0.93
Stochastic discount factor	0.46	0.02	-0.95

Version 5: Real rigidity, $\gamma = 20$, price stability, tax adjustment

	Taste shock	Import price shock	Technology shock
Consumption	0.53	-0.27	-0.09
Consumer prices	0	0	0
Nominal exchange rate	0.45	-0.23	-0.08
Tradable production	0.50	-0.04	1.13
Non-tradable production	0.45	-0.23	-0.08
Employment	0.72	-0.05	0.06
Household foreign debt	-0.0068	0.007	0.0177
Government foreign debt	0.0179	-0.0091	-0.0034
Nominal wage	-0.22	-0.19	0.04
Stochastic discount factor	0.47	0.27	0.09

Version 6: Real rigidity, price stability, spending adjustment

	Taste shock	Import price shock	Technology shock
Consumption	0.48	-0.22	-0,05
Consumer prices	0	0	0
Nominal exchange rate	0.40	-0.19	-0.05
Tradable production	0.45	0.02	1.20
Non-tradable production	0.40	-0.19	-0.04
Employment	0.6	0.02	-0.06
Household foreign debt	-0.006	0.0006	0.017
Government foreign debt	0.016	-0.007	-0.002
Nominal wage	-0.20	-0.21	0.02
Stochastic discount factor	0.52	0.22	0.05

Version 7: Real rigidity, debt motive, tax adjustment, $\gamma = 20$

	Taste shock	Import price shock	Technology shock
Consumption	0.54	-0.17	0.40
Consumer prices	-0.03	0.19	0.82
Nominal exchange rate	0.42	0.05	1.14
Tradable production	0.52	0.07	1.69
Non-tradable production	0.46	-0.14	0.33
Employment	0.73	0.10	0.80
Household foreign debt	-0.0059	-0.0007	-0.0161
Government foreign debt	0.0168	0.0019	0.0457
Nominal wage	-0.26	-0.04	0.66
Stochastic discount factor	0.49	-0.02	-1.21

Version 8: Real rigidity, debt motive, spending adjustment

	Taste shock	Import price shock	Technology shock
Consumption	0.48	-0.22	-0.05
Consumer prices	-0.03	0.20	0.88
Nominal exchange rate	0.37	0.01	0.83
Tradable production	0.45	0.02	1.20
Non-tradable production	0.40	-0.19	-0.04
Employment	0.65	0.02	0.14
Household foreign debt	-0.005	-0.0002	-0.0118
Government foreign debt	0.015	0.0006	0.0333
Nominal wage	-0.23	-0.01	0.90
Stochastic discount factor	0.55	0.02	-0.83

It is easy to see that taste shocks are in favor of a positive premium irrespective of other assumptions. Equal signs appear in the cases of the import price shocks in only two versions, when there is a debt motive, and the government uses spending adjustment. Still the effects are too small to be taken too seriously. It can be seen that the opposite coefficients in other versions are comparatively larger. With productivity shocks the nominal rigidity versions militate for the positive premium hypothesis, and with some force. On the other hand there opposing forces at large in some of the real rigidity versions.

It is not straightforward to summarize our findings. The only unequivocal case for a positive premium is Version 4 (nominal rigidity, debt motive, spending adjustment). A very likely case is Version 3 (taxes rather than spending adjust), and, provided that import price shocks are unimportant, the other two cases with nominal rigidities, i.e. those with stable prices. Real rigidity cases would imply a positive premium only if the dominant shock is the taste shock. All in all, these results would suggest that if the presumption of that emerging markets exhibit positive premia is true, then it would be an indirect reason to believe that nominal rigidities may be important in these economies, and that price stability may not be so much in the forefront of the thinking of policy makers.

4 Conclusions

It is frequently claimed that emerging market currencies command a premium over dollar, yen and the euro because of exchange rate risk. More formally this means that the expected yield on default free emerging market currencies is higher than that of developed market currencies. In this paper we ask what may be the main force of this phenomenon. We have developed a stochastic dynamic general equilibrium model to address the question of interest rate premia in small, open emerging economies. Our (implicit) definition of an emerging market was that it has a foreign debt problem, and that fiscal policy certainly, and monetary policy possibly, is concerned with this issue.We analyzed the model numerically in eight versions to derive conditions for positive or negative premia.The novelty of our approach is to attack the problem from the point of view of state dependent policy mixes, rather than from the perspective of monetary policy shocks. The quantitative-theoretical analysis of our series of models provided some interesting lessons. It seems that if positive premia were universal, then nominal rigidity would be important, except when taste shocks (as specified in our model) play aa significant role in the economy. The model highlighted the fact that taking a structural view of shocks, rather than using the simple classification of demand-supply, offers a richer picture, and at least for small open economies the traditional dichotomization may be utterly misleading.

A Appendix

The steady state

Some steady state values can be directly expressed as functions of parameters, such as

$$I = \frac{1}{\beta}, \;\; I^* = \frac{1}{\beta}, \;\; PQ = \mu, \;\; PI = \rho^{-\rho}(1-\rho)^{1-\rho}\mu^{1-\rho}, \;\; \tau = \overline{\tau}.$$

Then solving for the steady state amounts to solve the previous four equations together with the following set of equations simultaneously.

$$G = 0.2\tau W - RT,$$

$$\Lambda = \frac{1}{CNPN},$$

$$M = \left[(1-\beta)CN^{-1}PN^{(1-\gamma)/\gamma}\right]^{-\frac{1}{\gamma}},$$

$$PN = \eta^{\eta}(1-\eta)^{1-\eta}\rho^{-\rho}(1-\rho)^{1-\rho}\mu^{1-\rho}W,$$

$$LN = (1-\eta)\frac{PN}{W}QN,$$

$$QN = CN + G,$$

$$Y = \eta\rho^{\rho}(1-\rho)^{-1+\rho}\mu^{-1+\rho}PNQN,$$

$$X = (1-\rho)\rho^{-\rho}(1-\rho)^{1-\rho}\mu^{-\rho}Y,$$

$$MX = \rho^{-\rho}(1-\rho)^{1-\rho}\mu^{1-\rho}Y,$$

$$LT = 0.2 - LN,$$

$$QT = LT^{\alpha},$$

$$QT = \left(\frac{\alpha\beta\mu}{W}\right)^{\frac{\alpha}{1-\alpha}},$$

$$Z = QT - X,$$

$$BFG = \frac{1}{1-IG^*}RT,$$

$$\frac{1-\beta}{\beta}BF + RT = Z - MX.$$

It is trivial that in the steady state $S = 1$, $G^d = 0$, and $\tau^d = 0$. Therefore this is a complete set of equations allowing us to pin down an unique steady state in principle.

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