The Macroeconomics of Inflow Controls when Assets are Imperfect Substitutes*

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Abstract

This paper describes the macroeconomic effects of taxing short-term capital inflows, using a demand side (derived from a Capital Asset Pricing Model) and a supply side (from risk-averse profit-maximising firms) in a three-asset economy. A single model can then reconcile the literature on the welfare effects of controls, which too often assumes an infinitely elastic demand as in Smith and Reinhart (2002), and the literature on determinants of capital flows and financial volatility, which underlines the importance of "push factors", as in Calvo *et al.* (1993). The model confirms the importance of push factors and shows that taxation on short-term flows can affect the composition of inflows. The effect on volume is less clear. When short-term flows are driven by "chartist" behaviour, the model suggests that asymmetric taxation can reduce capital flow and exchange rate volatilities. However, there is a risk that controls maintain the exchange rate off its equilibrium value. Hence, controls would be justified only in periods where the other key financial variables are already volatile. These results are broadly consistent with the empirical literature, in particular Calvo *et al.* (1993), Montiel and Reinhart (1999) and Edison and Reinhart (2001). The general equilibrium then shows how inflow controls can improve welfare.

Keywords: capital controls ; capital flows ; CAPM ; capital account liberalisation

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1 Introduction

This paper models the demand and supply for emerging market assets in order to study theoretically the implications on macroeconomic variables of the unilateral choice, for a developing country, to tax capital inflows. Its key contribution is to model simply the demand for imperfectly substitutable assets by foreigners and to use these demand equations to shed light on the current debate on taxation of capital inflows.

In the public place, taxation on financial flows has often been advocated on the grounds that the last decades of financial deregulation had destabilised the world economy, and especially emerging markets. However, according to the the theoretical case against controls:[1]

> *"[f]ree capital movements tend to allocate capital to its most productive uses across countries and allows residents of different countries to engage in welfare-improving intertemporal consumption smoothing. In a competitive model with perfect foresight and complete markets, the welfare benefit from intertemporal trade is identical to the welfare benefit from international trade in goods and services"* (Dooley, 1995).

Furthermore, it is hoped that liberalised financial markets help to stabilise the economy through diversification and thanks to risk pooling. A limit case is, for instance, when a small economy trades all its risky assets against risk-free bonds and purchases in that way an insurance policy that guarantees a fixed income level (Obstfeld and Rogoff, 1996). There are finally two additional political economy arguments to be made in favour of opening the

[1]Since the literature on capital controls has been surveyed in Dooley (1995), we restrict our presentation to the modern research.

capital account. First, capital account liberalisation may act as a disciplinary device against governments that do not follow sound policies. Second, capital controls may be unfairly enforced and favour firms with links to the political sphere. In a study on Malaysia outflows controls during the Asian crisis, Johnson and Mitton (2003) support this *cronyism* argument. They assert that, while politically connected firm's performance was worse than average before September 1998, the imposition of controls on 1^{st} September triggered a higher return of about 18% for firms related to the Prime Minister.

The orthodox case for capital account liberalisation receives nonetheless pertinent criticisms, based mostly on second-best theoretical arguments and on factual observations. First, the allocative efficiency argument seems weaker when one acknowledges the cross-country differences in tax rates on profits: capital tends rather to flow into "tax havens". Further, empirical evidence downplays the role of capital flows for consumption smoothing (the so-called Feldstein-Horioka puzzle). And while risk-diversification arguments can apply to portfolio investors in rich countries, their importance for the welfare of host developing countries is less clear. Indeed, Demirgüç-Kunt and Detragiache (1998) found that economies with liberalised financial markets exhibit higher volatility.

In this paper I explore how an optimal tax levied on short-term capital flows modifies inflow composition and may affect welfare. This research is inspired by the measures adopted in Chile in the 1992-1999 that targeted especially short-term inflows. The widely quoted Chilean Unremunerated Reserve Requirement (URR) applied to capital inflows in Chile in the 90s had the particular property to implicitly tax short-term investments with higher rates than long-term ones: in addition to a 1.2% per year tax rate on all foreign loans, the Chilean authorities imposed a reserve requirement for a period of one year on capital stocks from abroad (Agosin and Ffrench-Davis, 2001). Since this reserve did not receive any interest payment and had to be borrowed in addition to what was actually needed by Chilean borrowers, the URR represented a supplementary implicit tax on foreign loans. Because the reserve had to be held for one year whatever the maturity of the loan, the implicit tax was higher for short-term loans than for long-term ones. Edwards (1999b), for instance, shows that the implicit tax level reached 600 base points for 6-month loans, while it represented less than 100 base points for 3-year loans. Montiel and Reinhart (1999) underline that asymmetric taxation affects the composition of flows and lengthens the maturity of investments, therefore reducing vulnerability of borrowing countries. The relative immunity of the Chilean economy to the 1995 Mexican and 1997 Asian crises tended to support this view.

This paper focuses on inflow composition and welfare consequences, and thus shares a common goal with Rodrik and Velasco (1999), Reinhart and Smith (2002) and Campion and Neumann (2003) and Neumann (2005). Rodrik and Velasco (1999) study the choice of debt maturity by firms that engage into illiquid investments. The riskiness of investments is endogenous to their model and depends on the probability that foreign lenders be unwilling to roll-over short-term debt, because in that case, firms suffer the losses incurred by illiquidity. In spite of lower short-term interest rates, firms that understand that borrowing short-term makes their project more risky will prefer to borrow long-term and reach the social optimum. However, if private agents fail to internalise the effect of short-term borrowing on riskiness, private and social optimum are different and a tax on short-term flows may be welfare improving.

Reinhart and Smith (2002) study the welfare consequences of inflow controls with a model of a 2-good open economy where a representative consumer maximises her inter-temporal utility under an inter-temporal external balance for the traded good. Debt issues by home agents to foreign investors are affected by a tax on interest rate: domestic nominal and real interest rates have to increase above their foreign counterparts so that the no-arbitrage equation, between perfectly substitutable foreign and home assets, holds. The authors show that large levels of taxes (from 60 to 85%) are needed to reduce the capital account deficit by 5% of GDP. This is because Reinhart and Smith consider only the *supply* side of debt, driven by inter-temporal consumption smoothing, and large changes in the interest rates are required to affect this supply (the inter-temporal elasticity of substitution is empirically low). Finally, the authors study the welfare properties of inflow controls, an analysis that is possible because their model is micro-founded on household inter-temporal utility maximisation. They show that, when foreign inflation decreases temporarily, capital inflows finance a consumption boom. Because the real interest rate, the discount rate and the resource constraints did not change, the Pareto optimal consumption is constant, and therefore any temporary consumption boom is sub-optimal: this provides an original rationale for temporary inflow controls, although the size of the welfare gain is negligible.

Campion and Neumann (2003) and Neumann (2005) focus on the compositional effect of controls on debt and equity financing. To break the Modigliani-Miller result according to which all source of financing are equivalent, the authors include asymmetric information and bankruptcy costs and this creates a unique debt-equity mix. The authors show that this mix can be tilted towards equity with heavier taxation on debt. Since the overall level of investment decline with taxes, and since she does not model the effects of inflow composition, investment and welfare are reduced with controls.

All these papers have in common that, although the *supply* of assets is carefully investigated, the *demand* of assets from foreign investors is only simply modelled. For instance, in Reinhart and Smith (2002), a basic interest parity holds. This is a simplification done in most international macroeconomic models, but it is a severe handicap when the goal of the analysis is to determine the effects of controls, since many modern capital account regulations discriminate in some way between long-term and short-term flows. This situation also tends to create a gap between the theoretical literature on capital controls cited above and the more empirical research on capital flows illustrated by Calvo *et al.* (1993, 1994) or Montiel and Reinhart (1999).

Calvo *et al.* (1993, 1994) investigate the importance of external factors in explaining the volatility of financial flows to Latin America. They assert that the strong co-movements among Latin American countries' domestic financial variables can only be explained if the weight of "push factors" (external factors such as US interest rates) with respect to "pull factors" (domestic factors such as fiscal deficits) is acknowledged. They show in an econometric investigation that the variance of push factors can explain from 30 to 60% of the variance of domestic variables such as the real exchange rate and foreign reserves.

Montiel and Reinhart (1999) also study the composition of inflows, during the 90s, towards fifteen emerging markets taken from Asia, Latin America and Africa. They first show that volatility of short-term flows was indeed higher than volatility of long-term flows. Also, there was large disparities between continents: short-term flows to Latin America had a volatility three times higher than short-term flows to Asia. Then, the authors investigate the effect of macroeconomic policies on the capital account. They confirm the theoretical prior according to which sterilisation tilts the composition of inflows towards short-term, and more importantly for this paper, the authors show that capital account regulations did affect the composition of the capital account, but not the overall volume of inflows.

Edwards (1999b), discussing the Chilean experience, agrees that the peculiar tax implied by the URR dramatically decreased the share of short-term investments in overall flows, from 96.3% in 1988 to 2.8% in 1997, but he argues that what matters to assess the vulnerability of a country is not the share of short-term investments but the ratio of investments that come to an end within one year. Because this ratio is subject to strong inertia, the URR would have had little effects on it, so that taxes on yields would not have had significant influence on Chile's vulnerability to financial crises.

Finally, Edison and Reinhart (2001) cover several capital control episodes (Thailand and Brazil in 1997, Malaysia in 1998 and Brazil in 1999) and assess their effectiveness using Principal Component Analysis and Vector Autoregressions. They show that, although controls did not deliver the intended outcomes - limiting contagion and reducing interest rate and stock market volatility - for the Brazilian and Thai experiments because of enforcement problems, Malaysia was successful in de-linking its financial markets from external disturbances. The common view is that the Malaysian government was more efficient at enforcing controls because they had a long experience in restricting financial flows. But the interaction with other key policy decisions - such as the closure of the off-shore ringgit market in September 1998 - probably explain why the control experiment was more successful in Malaysia.

In this paper, we model both the *supply* and the *demand* sides of financial markets and works out the effect of market-based capital controls (taxes on assets or on yields) on key macroeconomic variables. In section 2 and 3, a simple Capital Asset Pricing Model is used in order to describe demand for assets that are imperfect substitutes, distinguishing between short-term flows (bank loans and bonds with less than one year maturity) and long-term flows (bonds with maturity longer than one year, equity portfolio and FDI). Section 4 then uses this partial equilibrium to make explicit the determinant of capital flows while section 5 gives insights into the current debate on capital controls, including the effect of controls on the volume, composition and volatility of inflows. The model is extended along the lines of Frankel (1996) to show how taxation of short-term flows reduce exchange rate volatility when exchange rate expectations are non-rational and driven by "chartist" and "fundamentalist" traders. In section 6, the supply of asset equation are derived from risk-averse firms that issue short and long-term assets. The general equilibrium is solved and the paper shows how it is easy to exhibit cases in which taxation of short-term flows is optimal.

2 Investors' Portfolio and Capital Flows in a Multi-Asset Model

This section models the North investor's various options in international assets using a Capital Asset Pricing Model (CAPM). The assets can be thought of as bonds with increasing maturities, the size of equity flows to emerging markets being almost negligible. Although the CAPM has numerous flaws [2], it is more sophisticated than most of the capital flow models used in inter-

[2] For instance, the Equity Home-Bias puzzle. See Lewis (1999) for a survey.

national economics. In particular, because it acknowledges the existence of imperfect substitutes, it lifts the indeterminacy on capital flows and yields proper demand curves. I assume that the North investor has the choice between

- a North risk-free asset noted A_0, say a US Treasury bond, the return of which is $\tilde{r_0}$ and assumed constant. Therefore, $\tilde{r_0}$ has mean $\mathbb{E}[\tilde{r_0}] = r_0$ and variance $var(\tilde{r_0}) = 0$. Adding equity or bond markets in the North would not change the structure of the model but would render the interpretation and extension of the model more difficult.

- n South assets, ranked according to their maturity from 1 (the shortest maturity) to n (the longest one), and described by their random one period-returns, which are written in vectors: $\tilde{\mathbf{r}} = (\tilde{r_1}, \tilde{r_2}, ..., \tilde{r_n})^T$ with mean vector $\mathbf{r} = \mathbb{E}[\tilde{\mathbf{r}}]$ and covariance matrix $\mathbf{V} = (\sigma_{ij})_{i,j}$

We assume that the returns on each asset are linearly independent and that $\mathbf{V}$ is non-singular. This matrix is non-diagonal because the risky asset returns covary. Since longer maturities imply higher risk[3], we also have $\forall i < j \quad \sigma_{ii} < \sigma_{jj} \quad \text{and} \quad r_i < r_j$ Hence, higher mean returns compensate for greater risk. The returns of all assets are expressed in US$ and therefore, variances also include exchange and country risks. The risk-averse investor chooses the share x_0 and the vector of shares $\mathbf{x} = (x_1, x_2, ..., x_n)^T$ of his portfolio in order to maximise his expected utility function that we can approximate at the first order, or linearise when returns are jointly log-

[3] In a discrete model, Campbell (1995) recalls us that the elasticity of one-year bond returns to change in yields is equal to the maturity of the bond minus one. Therefore, the longer is the maturity, the more sensitive - and thus the riskier - is the one-year return to changes in the yield curve.

normal:

$$\max\ \mathbb{E}[U(\tilde{R})] \Longleftrightarrow \max\ U(\mathbb{E}[\tilde{R}] - \rho\ var(\tilde{R})) \tag{1}$$
$$\Longleftrightarrow \max\ \mathbb{E}[\tilde{R}] - \rho\ var(\tilde{R})$$

where $\tilde{R}$ is the overall portfolio return and ρ is one half of his absolute risk aversion. We assume that the absolute - rather than the relative - risk-aversion is constant for pure mathematical convenience since this separates well, in the objective function, the mean and the variance of the portfolio return. An investor with a higher ρ dislikes risky assets and switches to less risky investments, at the cost of lower mean portfolio return.

We further assume that domestic savings do not play any role. As a result, one can identify capital flows with changes in demand for South assets. Although the demand for assets given by the model are stock variables, we will use the traditional terms "capital flows" to describe $\mathbf{x}$ all along this paper. *Stricto sensu*, capital flows are given by $\Delta\mathbf{x}$.

An important assumption here is the absence of domestic savings. If South agents were to face the same problem than North agents, there would choose the same optimal portfolio and we could still link simply capital flows to changes in shares. Since this is hardly the case, as witnessed by the Home-Bias puzzle, and since capital flows to emerging markets are principally driven by foreign savings, we do not model independently the behaviour of domestic savings, and choose arbitrarily that domestic savings are null.

Hence, short sales cannot exist when aggregating across all foreign investors. To be rigorous, we should restrict the representative portfolio shares to be positive using inequality constraints. Since the Lagrangian vector will play no role in the model, we omit it to keep the presentation simple. Let

$\mathbf{1}$ be the vector $(1,1,...,1)^T$. We include a tax scheme represented by the vector $\boldsymbol{\tau}$ to analyse the effect of taxation on financial yields. Taxes are levied on assets rather than yields, and therefore the vector of returns to foreign investors is now $\mathbf{r}-\boldsymbol{\tau}$. Since we can write the share of risk-free assets as $x_0 = 1-(x_1+x_2+...+x_n) = 1-\mathbf{x}^T\mathbf{1}$, the portfolio mean return is $\mathbb{E}[\tilde{R}] = (1-\mathbf{x}^T\mathbf{1})r_0 + \mathbf{x}^T(\mathbf{r}-\boldsymbol{\tau})$. The portfolio variance is $\mathbf{x}^T\mathbf{V}\mathbf{x}$, and therefore, the problem modelled in (1) is now described by equation (2), keeping in mind the constraints $\forall i \geq 0 \;\; x_i \geq 0$:

$$\max_{\mathbf{x}} \;\; \{L = (1-\mathbf{x}^T\mathbf{1})r_0 + \mathbf{x}^T(\mathbf{r}-\boldsymbol{\tau}) - \rho\mathbf{x}^T\mathbf{V}\mathbf{x}\} \tag{2}$$

The vectorial first-order condition $\dfrac{\partial L}{\partial \mathbf{x}} = \mathbf{0}$ implies

$$-r_0\mathbf{1} + \mathbf{r} - \boldsymbol{\tau} - 2\rho\mathbf{V}\;\mathbf{x} = \mathbf{0} \quad \text{Equivalently} \quad \mathbf{x} = \frac{1}{2\rho}\mathbf{V}^{-1}(\mathbf{r}-\boldsymbol{\tau}-r_0\mathbf{1}) \tag{3}$$

Equation (3) is the traditional CAPM result on optimal portfolio shares, see for instance Dumas (1994).

3 Taxes on short-term capital flows

In the subset of $[0,1]^n$ where none of the constraints is binding, one can write the effect of taxes on the portfolio shares as

$$\frac{\partial \mathbf{x}}{\partial \boldsymbol{\tau}} = \left(\frac{\partial x_i}{\partial \tau_j}\right)_{i,j} = -\frac{1}{2\rho}\mathbf{V}^{-1}$$

Since $\mathbf{V}$ is symmetric definite positive, so is $\mathbf{V}^{-1}$. Therefore,

$$\forall i \;\; \frac{\partial x_i}{\partial \tau_i} < 0$$

As expected, taxes reduce the portfolio share of the taxed asset. What is interesting though is that $\dfrac{\partial x_i}{\partial r_j} \neq 0$ since $\mathbf{V}$, and therefore $\mathbf{V}^{-1}$, are not diagonal. Because of covariance effects in the choice of investors, a tax on a particular asset can affect the choice of investment for other assets.

One of the key question in the literature on controls is whether Chilean-style controls reduce the volume of inflows. Intuitively, one would expect that a single tax on short-term flows would reduce the overall volume of inflows. If we write $\mathbf{V}^{-1} = (b_{ij})_{1 \leq i,j \leq n}$, the effect of a unique tax rate τ_1 on overall capital inflows is given by

$$\sum_{i=1}^{n} \frac{\partial x_i}{\partial \tau_1} = -\frac{1}{2\rho} \sum_{i=1}^{n} b_{i1} \tag{4}$$

In fact, this expression can be positive[4], and sometimes is, although not with common covariance matrices. To derive more telling results on capital flows, we assume now that $n = 2$ so that there is only two South assets: a short-term one, s, and a long-term one, l. Because of the Cauchy-Schwartz inequality, we have $\sigma_{sl}^2 < \sigma_{ss}\sigma_{ll}$. Since $\sigma_{ss} < \sigma_{ll}$, we also deduce $\sigma_{sl} < \sigma_{ll}$. The solution to the CAPM model is now, if the constraints are not binding:

$$\left\{ \begin{array}{l} x_s^* = \dfrac{\sigma_{ll}(r_s - \tau_s - r_0) - \sigma_{sl}(r_l - \tau_l - r_0)}{2\rho(\sigma_{ss}\sigma_{ll} - \sigma_{sl}^2)} \\ \\ x_l^* = \dfrac{\sigma_{ss}(r_l - \tau_l - r_0) - \sigma_{sl}(r_s - \tau_s - r_0)}{2\rho(\sigma_{ss}\sigma_{ll} - \sigma_{sl}^2)} \end{array} \right. \tag{5}$$

[4]If α is $\mathbf{V}$'s highest eigenvalue and β is $\mathbf{V}$'s lowest eigenvalue, I prove in an annex available on request that

$$\frac{1}{2}\left(\frac{1}{\alpha} - \frac{1}{\beta}\right)\sqrt{n} + \frac{1}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right) \leq \sum_{j=i}^{n} b_{i1} \leq \frac{1}{2}\left(\frac{1}{\beta} - \frac{1}{\alpha}\right)\sqrt{n} + \frac{1}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$$

These bounds do not preclude the sum $\sum_{j=1}^{n} b_{1j}$ to be negative because $\dfrac{1}{\alpha} - \dfrac{1}{\beta} < 0$

When $x_s \neq 0$, we deduce that:[5]

$$\frac{\partial x_s^*}{\partial \tau_s} = \frac{-\sigma_{ll}}{2\rho(\sigma_{ss}\sigma_{ll} - \sigma_{sl}^2)} < 0 \text{ and } \frac{\partial x_l^*}{\partial \tau_s} = \frac{\sigma_{sl}}{2\rho(\sigma_{ss}\sigma_{ll} - \sigma_{sl}^2)} > 0 \tag{6}$$

because of the Cauchy-Schwartz inequality : $\sigma_{sl}^2 < \sigma_{ss}\sigma_{ll}$.

Hence, taxation on short-term capital flows reduces the portfolio share of short-term assets but increases the share of long-term ones. This is just a *co-variance effect*, and needs no further assumption. Furthermore, it is obvious that x_s^* is a decreasing function of the risk σ_{ss} of the asset S. Similarly, x_l^* is a decreasing function of σ_{ll}. The demand functions for South assets thus behave as expected. It is interesting to note that the change in the investors' return $r_s - \tau_s$, implied by a change in τ_s, modifies the demand of long-term assets because the covariance between short and long term asset returns is non-null. The intuition behind this result is that, as the investors reduces x_s when short-term assets are taxed, the portfolio covariance decreases, and it is then possible to increase the share of high-risk assets x_l in order to benefit from their higher return. Overall, the effect of a change in τ_s on the share of the South assets is $\dfrac{\partial(x_s^* + x_l^*)}{\partial \tau_s} < 0$ and is negative since $\sigma_{sl} < \sigma_{ll}$.

Therefore, in a three-asset model, a tax on short-term yields lowers the volume of inflows. This result contradicts the findings from Montiel and Reinhart (1999), who conclude in their empirical paper that capital controls do not seem to reduce the overall volume of inflows. A first explanation is that this result cannot be extended when there are more than 3 assets, as we saw above. However, with common covariance matrices, it seems that $-\dfrac{1}{2\rho}\displaystyle\sum_{i=1}^{n} b_{i1}$ is negative. A more interesting economic explanation could be

[5]When $x_s = 0$, an increase in τ_s has no further effect on the economy since all the shares are constant

that the variance terms are also modified by taxation. This would be the non-orthodox explanation put forward by Stiglitz (2000): controls on financial markets would have positive effects on the risk of the economy, as suggested empirically in Demirgüç-Kunt and Detragiache (1998) and as modelled for instance by Cordella (1998), who shows how capital controls can stimulate inflows if they limit the risk of bank runs and hence reduce the country risk. This theoretical result has to be weighted against many other plausible effects of taxation on risk. It could also be that capital controls worsen the perceived risk to invest in the economy because they create a payment risk and signal inconsistent policies. Therefore, in the remainder of this paper, I do not take into account the potential effects of taxation on perceived risk.

The CAPM confirms that the share of short-term flows in overall flows is reduced by differentiated taxation: since $\frac{\partial x_s}{\partial \tau_s} < 0$ and $\frac{\partial x_l}{\partial \tau_s} > 0$, $\frac{x_l}{x_s}$ is an increasing function of τ_s. Therefore, $\frac{x_s}{x_s + x_l} = \frac{1}{1 + x_l/x_s}$ is a decreasing function of τ_s. The importance of this result, empirically supported by Montiel and Reinhart (1999), is downplayed by Edwards (1999b), who argues that what matters to assess a country's vulnerability is instead the ratio of investments that come to an end within one year. Because this ratio is subject to strong inertia, differentiated taxation imposed for short periods would have insignificant effect.

For a high enough tax rate, the demand for South short-term assets vanishes and then remains null, whatever is τ_s. The value of the tax at which short-term capital flows out from South is small (around 50 base points)[6]. This contrasts with the results from Reinhart and Smith (2002) who argue that large tax rates are necessary in order to modify significantly the volume

[6]for the following plausible values: $r_\$ = 0.03$, $r_s = 0.05$, $r_l = 0.10$, $\sigma_{ss} = 0.17$, $\sigma_{sl} = 0.46$, $\sigma_{ll} = 2.14$. The variance and covariance terms were taken from actual data on Chilean interest rates.

of inflows. In their model, capital flows are supply-driven and hail from consumption smoothing since demand is not modelled (an interest parity holds). Because the inter-temporal elasticity of substitution is low, large levels of taxation are required to change the volume of flows. Here, on the contrary, because the capital account is demand-driven and substitution between US and emerging market assets is high, small changes in rates of return are possible but create they large outflows. A market equilibrium that brings together both supply and demand is drawn in section 6.

4 The Effect of External Parameters on the Demand for South Assets

It is straightforward from equation (5) to show the importance of *push factors* (risk-free interest rate, risk aversion and world stock of capital) on the volume of flows into an emerging market. Since these parameters are out of the range of domestic policies, economic disarray due to these external parameters often gives voice to critiques against the supposed ill-functioning of the international markets. There are indeed good reasons for which developing economies are worried when external parameters change, although the issue of the ill-functioning of markets cannot be dealt with such a restricted focus. As is clear from equation (5), yield spreads determine volume of inflows: therefore, foreign interest rates are as important as domestic monetary policy in attracting capital. Because investment in emerging markets are riskier, changes in risk aversion have a direct impact, with elasticity 1, on changes in capital flows. Finally, since only portfolio shares are computed in the CAPM, the model predicts that changes in world savings affect proportionally capital inflows.

5 Volatility of Macroeconomic Variables

The previous sections derived the CAPM shares that investors are willing to hold. There was however little difference between short-term and long-term assets. In this section, we add two simple market imperfections to ensure that this distinction is relevant.

5.1 Volatility of Capital Flows

The first one is to assume that there is no secondary trading for the assets. This is justified ion our model because only the representative foreign investor can invest, since there is no savings rom the South. Because long-term investments cannot be liquidated, this creates a gap between the desired stock and the actual stock of long-term assets, a gap that does not exist for short-term assets. As a result, we show that short-term flows are more volatile than long-term flows.

We suppose that short-term assets are invested during one period, while long-term ones are invested during two periods. To focus on one source of perturbation only, we will assume here that desired shares of portfolio are kept constant, *i.e.* $\forall t \quad x_{s,t} = x_{s,t-1} = x_s$ and $x_{l,t} = x_{l,t-1} = x_l$ where t is the subscript for time. The origin of fluctuations in demand is therefore a change in the world stock of capital: we assume that W_t is a stochastic process such that

$$\forall t \;\; \mathbb{E}[W_t] = \mathbb{E}[W_{t-1}] = W \;\; \text{and} \;\; var(W_t) = var(W_{t-1}) = \sigma_{WW}$$

We also define the coefficient of autocorrelation $\xi = \dfrac{cov(W_t, W_{t-1})}{\sigma_{WW}} \leq 1.$

Because short-term assets can be liquidated in one period, the desired amount of short-term assets $S^d = x_s W$ is always equal to the actual stock held S^*: $\forall t \ \ S^*_t = x_s W_t$. On the contrary, because long-term assets cannot be sold, the desired stock of capital is different from the one actually held. We assume that the actual stock of long-term assets follows an adjustment process with adjustment speed θ, where $0 < \theta < 1$. θ depends essentially on the maturity of assets: since the South never buys back assets that it emitted earlier, the only way to adjust the actual shares to the desired portfolio is to keep the assets until maturity and not to roll-over. Other parameters, such as transaction costs, may decrease the speed of adjustment. The adjustment process is:

$$L^*_t = L^d_{t-1} + \theta(L^d_t - L^d_{t-1})$$

and it can be re-written as

$$L^*_t = (1-\theta)L^d_{t-1} + \theta L^d_t \tag{7}$$

With this definition, when $\theta \to 0$, the actual stock cannot adjust to the new desired level, while when $\theta \to 1$, adjustment is instantaneous. The volatility of demand for short-term assets is defined by

$$vol(S^*) = \frac{var(S^*)}{\mathbb{E}[S^*]^2} = \frac{x_s^2 \sigma_{WW}}{x_s^2 W^2} = \frac{\sigma_{WW}}{W^2}$$

The volatility of demand for long-term assets is, from equation (7)

$$\begin{aligned} vol(L^*) &= \frac{var(L^*)}{\mathbb{E}[L^*]^2} = \frac{x_l^2 \ var((1-\theta)W_{t-1} + \theta W_t)}{x_l^2 \ \mathbb{E}[(1-\theta)W_{t-1} + \theta W_t]^2} \\ &= \frac{((1-\theta)^2 + \theta^2)\sigma_{WW} + 2(1-\theta)\theta \ cov(W_{t-1}, W_t)}{W^2} \\ &= \frac{\sigma_{WW}}{W^2}\left(1 - 2(\theta - \theta^2)(1-\xi)\right) \leq vol(S^*) \end{aligned} \tag{8}$$

since $\theta > \theta^2$ and $1 > \xi$. Of course, if adjustment is instantaneous (*i.e.* $\theta = \theta^2 = 1$), or if W_t is not a stochastic process (*i.e.* $\xi = 1$), the volatility of investment does not depend on maturity. But in general, because of the adjustment process, the volatility of short-term investments is higher than the volatility of long-term ones. There may be other reasons for this, since herding behaviour or changes in perception of risk are more likely to occur for short-term flows. However, what is interesting in the proof above is that a simple dynamic characteristic of long-term investments is enough to explain why short-term flows are more volatile. A tax scheme that reduces the proportion of short-term assets in capital flows would, one could argue, reduce the volatility of these flows. This last affirmation is however controversial. The volatility of the sum of two flows is not simply related to the share of the more volatile flow, because correlation and volume are also important determinants. This is another way to understand the risk-pooling argument in favour of capital liberalisation: even if short-term flows are volatile, the way they are correlated to the other macroeconomic variables is decisive.

5.2 Volatility of the Exchange Rate

Most arguments in favour of controls underline their role in promoting exchange rate stability, not capital flows' stability. Frankel (1996) shows how a tax on flows can reduce volatility of exchange rates. He argues that the weight of "chartists" in overall demand is lowered by a tax on flows; because volatility is generated by chartists while stability is provided by "fundamentalist investors", a tax that reduces chartist demand should reduce volatility of the exchange rate. Inspired by his model, we complete our CAPM to include exchange rate dynamics. The exchange rate e is in South currency per US$; therefore, an increase in e represents a depreciation of the South currency. We will present the model assuming e increases (*i.e.* depreciates), but of course the model is symmetric. As in Frankel (1996), e is given by the following accounting identity

$$eK^D = K + u_t$$

where K is the supply of domestic assets denominated in South currency, u_t is a random shock and K^D is demand of assets as defined above and denominated in US$. We extend our CAPM to include explicitly the role of expected depreciation on the foreign investor rate of return. At short-term horizon, the investor expects future depreciation to be proportional to current depreciation, so that current depreciation has a negative effect on demand for short-term assets. This corresponds to what is often called "chartist behaviour". On the contrary, at long-term horizons, investors expect current depreciation to be reversed, so that demand for long-term assets is positively related to current depreciation. This corresponds to the "fundamentalist behaviour", which assumes that some kind of mean-reversion process drives the exchange rate. These two ways to form expectations are now well-documented in the empirical exchange rate literature, with chartist analysis being as important as fundamental analysis for the majority of traders at short-term horizons (see chapter 9 in Sarno and Taylor, 2002, for a survey of this literature). These non-rational expectations interact with the distinction between short-term and long-term term flows to prevent the exchange rate to adjust instantaneously to its equilibrium level. The tax rate on short-term assets then has effects on both the equilibrium level and the speed of adjustment, as we will see now.

Because the tax is levied on repatriation of returns, expected return in dollar for short-term flows is $r_s^{\$} = (r_s - \frac{\dot{e}}{e})(1-\tau_s\ )$, where current depreciation (subscript 0) is used as expected depreciation for period 1 (subscript 1) $\mathbb{E}_0\left[\frac{\dot{e_1}}{e_1}\right] = \frac{de_0}{dt}\frac{1}{e_0}$. The tax rate is here modelled as a tax on yields and thus appears in a multiplicative way, instead of the additive tax assumed in the CAPM. This choice is made for expositional convenience, and although it increases the effect of taxation on volatility of exchange rates, it does not alter the qualitative results we want to show. For long-term assets, expected depreciation for period 2 is equal to minus curent depreciation: $\mathbb{E}_0\left[\frac{\dot{e_2}}{e_2}\right] = -\frac{de_0}{dt}\frac{1}{e_0}$ The CAPM demand equations are now

$$S_t^* = x_s W_t = \left(s_0 - \sigma_{ll} r_s \tau_s - \frac{\dot{e_0}}{e_0}(\sigma_{sl} + \sigma_{ll}(1-\tau_s))\right)\frac{W_t}{D}$$

$$L_t^* = x_l W_t = \left(l_0 + \sigma_{sl} r_s \tau_s + \frac{\dot{e_0}}{e_0}(\sigma_{ss} + \sigma_{sl}(1-\tau_s))\right)\frac{W_t}{D}$$

s_0, l_0 and D are positive parameters that can easily be deduced from the CAPM results, as long as we assume that variance terms are not modified by the tax rate τ_s. This is a strong assumption but we have already underlined that economic theory had no clear result on the effect of τ_s on variance terms. If these parameters were modified by τ_s, the model would remain the same - because the form of the differential equation would not be affected - but one would have to discuss the relative weight of these parameters in determining the speed of adjustment defined below. When the parameters are not affected by τ_s, the exchange rate is given by:

$$e_0 = \frac{D(K_S + u_t)}{W_t(s_0 + l_0 + (\sigma_{sl} - \sigma_{ll}) r_s \tau_s + (\sigma_{ss} - \sigma_{sl} + (1-\tau_s)(\sigma_{sl} - \sigma_{ll}))\frac{\dot{e_0}}{e_0})}$$

This can be re-written as

$$\dot{e_0} = \frac{D(K_S + u_t)}{W_t(\sigma_{ss} - \sigma_{sl} + (1-\tau_s)(\sigma_{sl} - \sigma_{ll}))} - e_0 \frac{s_0 + l_0 + (\sigma_{sl} - \sigma_{ll}) r_s \tau_s}{(\sigma_{ss} - \sigma_{sl} + (1-\tau_s)(\sigma_{sl} - \sigma_{ll}))}$$

One of the influence of chartist behaviour is that, if $(\sigma_{ll} - \sigma_{sl})(1-\tau_s) > \sigma_{ss} - \sigma_{sl}$, the system is unstable: a strong influence of chartist investment will generate bubbles. This instability is unlikely to happen with higher tax rates. On the contrary, if we assume that $(\sigma_{ll} - \sigma_{sl})(1-\tau_s) < \sigma_{ss} - \sigma_{sl}$, e converges to its equilibrium value

$$e_{eq} = \frac{D(K_S + u_t)}{W_t(s_0 + l_0 + (\sigma_{sl} - \sigma_{ll}) r_s \tau_s)}$$

This is the assumption we make from now. Taxation has an effect on the equilibrium exchange rate because a higher tax on short-term flows implies a reduction in overall demand for domestic assets (we know that $\sigma_{sl} - \sigma_{ll} < 0$) and thus an equilibrium depreciation. It is clear that the tax on short-term flows reduces the speed of convergence

$$\eta = \frac{s_0 + l_0 + (\sigma_{sl} - \sigma_{ll}) r_s \tau_s}{\sigma_{ss} - \sigma_{sl} + (1-\tau_s)(\sigma_{sl} - \sigma_{ll})}$$

The intuition is that the overall volume of flows is lower, and thus the reaction of the market is slower (numerator effect), while the influence of chartist investment is also limited by the tax on short-term flows (denominator effect). Note that adjustment is instantaneous (or η is infinite) if expectations are rational[7] or if there is no distinction between short-term and long-term assets[8].

[7] in that case, expectations of depreciation are null since there is no shock in period 1 and 2

[8] in that case, $\sigma_{ss} = \sigma_{sl} = \sigma_{ll}$

Now, assume that the shocks, on W_t, u_t or even K_s are random non-persistent shocks. They first effect is on the equilibrium exchange rate. Then, a higher speed of convergence implies that the actual exchange rate will jump from one equilibrium to another and so volatility will be higher. With a lower speed of convergence, the exchange rate is sticky and thus less volatile. If, however, there is a persistent shock, a lower speed of convergence means that the actual exchange rate is maintained longer off its equilibrium value, with possible distortionary consequences. Hence, the potential benefits of taxation appear only when the other economic variable are already volatile, supporting thus the idea that, if anything, controls should be implemented during crisis but not in stable periods.

6 Is Capital Account Liberalisation Optimal?

Having explained the implications of short-term flow taxation for volatility and levels of key variables, we want now to conclude on the effects on a small economy welfare. We solve the market equilibrium and show that, in a three-asset economy, because the overall volume of flows is reduced by asymmetric taxation, capital account liberalisation is optimal unless a distortion is included. Here, a difference between private risk-aversion and average risk-neutrality is enough to show that at the market equilibrium, a small tax on short-term flows is optimal.

To complete the capital flow model and conclude on welfare effects, we thus turn to the problem of the South supply of assets. The literature on capital controls includes several analyses on welfare. Early articles simply argued that capital controls reduce welfare, because they limit consumption smoothing (Stockman and Hernandez, 1988, see also Obstfeld and Rogoff, 1996) and distort the allocation of capital. More recent articles acknowledge other effects of the composition of flows, as we already discussed in the introduction.

Ideally, a model for the supply of assets should be based on first principles and inter-temporal consumption smoothing, as in Reinhart and Smith (2002). A model set in discrete time with three periods (borrowing short-term S and long-term L in period 1, paying back S and taking a new short-term B in period 2, paying back L and B in period 3) would give two supply curves decreasing in the interest rates from which one could draw the properties of the equilibrium. A problem with this type of model is that, when the only source for current account deficit is inter-temporal consumption smoothing, it becomes difficult to understand why S, L and B would be imperfect substitutes.

This is why, in the following model, we focus on a risk-averse entrepreneur who can borrow short-term to invest in a short-term project, yielding low but little risky returns, or who can borrow long-term to invest in a long-term project with high but risky profitability. The welfare properties are analysed at the country level. Because a country output is the sum of a very large number of entrepreneurs profits, country's welfare is risk-neutral with respect to any single project. This wedge between individual and aggregate risk-aversion drives the result that taxation of short-term flows is welfare-improving. Thus, this model catches the argument from Stiglitz (2000) that short-term capital flows are not beneficial for the economy because "*firms are unlikely to engage in productive long-term investments on the basis of short-term funds*".

Consider an entrepreneur who can choose how much to borrow short-term S and long-term L so as to invest in a short-term project that yields $\tilde{A}_S y(S)$ and a long-term project that gives $\tilde{A}_L y(L)$ where y is non-stochastic and $y' > 0$; $y'' < 0$. $\tilde{A}_S$ and $\tilde{A}_L$ are random variables with

$$A_S = \mathbb{E}[\tilde{A}_S] < \mathbb{E}[\tilde{A}_L] = A_L$$

$$\Sigma_{SS} = var(\tilde{A}_S) < var(\tilde{A}_L) = \Sigma_{LL}$$

Profits are $\tilde{V} = \tilde{A}_S y(S) + \tilde{A}_L y(L) - r_S S - r_L L$. The entrepreneur maximises expected utility modelled linearly as in section 2, with risk aversion χ:

$$\max_{S,L} \quad \mathbb{E}[\tilde{V}] - \chi var(\tilde{V})$$

$$\max_{S,L} \quad A_S y(S) + A_L y(L) - r_s S - r_l L - \chi(\Sigma_{SS} y(S)^2 + \Sigma_{LL} y(L)^2)$$

The first-order conditions yield the supply of asset equations

$$y'(S)(A_S - 2\chi y(S)\Sigma_{SS}) = r_s \tag{9}$$

$$y'(L)(A_L - 2\chi y(L)\Sigma_{LL}) = r_l \tag{10}$$

Note that $y'(S) > 0$ and $r_s > 0$ imply $A_S - 2\chi y(S)\Sigma_{SS} > 0$. Similarly, $A_L - 2\chi y(L)\Sigma_{LL} > 0$. Let us define

$$X_S = \frac{d}{dS}\left[y'(S)(A_S - 2\chi y(S)\Sigma_{SS})\right] = y''(S)(A_S - 2\chi\omega y(S)\Sigma_{SS}) - 2\chi y'(S)^2\Sigma_{SS} < 0$$

X_L is defined similarly and $X_L < 0$. Then, differentiating (9)

$$\frac{dr_s}{dS} = y''(S)(A_S - 2\chi y(S)\Sigma_{SS}) + y'(S)X_S \quad < 0. \text{ Similarly } \frac{dr_l}{dL} < 0 \tag{11}$$

The supply of asset equations are downward-sloping, as expected. In order to find the equilibrium and show the comparative statics effect of the inflow tax, we have to combine now these two supply equations with the two CAPM demand equations, which we re-write:

$$S = c_1(r_s - \tau_s) - c_2 r_l + c_3 \tag{12}$$

$$L = -c_2(r_s - \tau_s) + c_4 r_l + c_5 \tag{13}$$

where $c_1 > 0$, $c_2 > 0$, $c_4 > 0$ and, $c_1c_4 > c_2^2$. Replacing r_s and r_l in (12) and (13) from (9) and (10) yields the equilibrium equations

$$\begin{cases} S^{eq} = c_1 y'(S^{eq})(A_S - 2\chi y(S^{eq})\Sigma_{SS}) - c_1\tau_s - c_2 y'(L^{eq})(A_L - 2\chi y(L^{eq})\Sigma_{LL}) \\ L^{eq} = -c_2 y'(S^{eq})(A_S - 2\chi y(S^{eq})\Sigma_{SS}) + c_2\tau_s + c_4 y'(L^{eq})(A_L - \chi y(L^{eq})\Sigma_{LL}) \end{cases} \tag{14}$$

Differentiating the system (14)

$$\begin{cases} dS^{eq} = c_1 X_S dS^{eq} - c_1 d\tau_s - c_2 X_L dL^{eq} \\ dL^{eq} = -c_2 X_S dS^{eq} + c_2 d\tau_s + c_4 X_L dL^{eq} \end{cases} \tag{15}$$

and solving it for dS^{eq} and dL^{eq} yields

$$\begin{cases} dS^{eq} = \dfrac{((c_1c_4 - c_2^2)X_L - c_1)d\tau_s}{\Delta} \\ dL^{eq} = \dfrac{c_2 d\tau_s}{\Delta} \end{cases} \tag{16}$$

where $\Delta = (c_1c_4 - c_2^2)X_S X_L - c_1 X_S - c_4 X_L + 1 \ > 0$. Therefore, $\dfrac{dS^{eq}}{d\tau_s} < 0$ and $\dfrac{dL^{eq}}{d\tau_s} > 0$. Because τ_s does not shift the supply curves, we deduce from (11) that

$$\frac{dr_s^{eq}}{d\tau_s} > 0 \ \text{ and } \ \frac{dr_l^{eq}}{d\tau_s} < 0$$

These results also appear clearly in Figure 1, which draws the equilibrium in both markets.

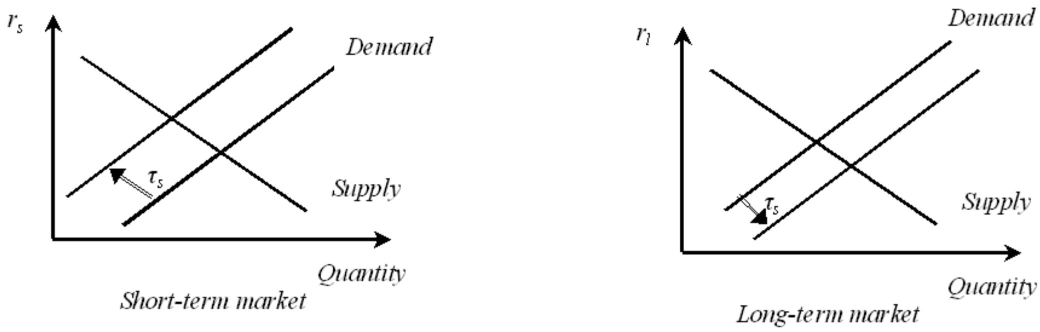

Figure 1: Equilibria in Asset markets with Taxation of Short-Term Flows

In the short-term market, the tax reduces demand for short-term assets, and therefore the equilibrium level of short-term assets in the market, S, is reduced. In the long-term market, the curve representing the world demand moves downwards when τ_s increases, because of the covariance effect, while the curve for South liabilities does not change. The new equilibrium thus leads to an increase in the amount of long-term capital flows at a lower interest rate. Without any external effect of short-term or long-term investment, taxation is sub-optimal because it decreases the volume of inflows, as we had underlined in section 3.

Now assume that domestic welfare is proportional to output, say because labour income (labour has not been included in the model for simplicity) is proportional to output as in a Cobb-Douglas production function. Then, investment choices by foreign investors directly affect domestic welfare, and it is easy to exhibit a situation in which taxes on short-term inflows is beneficial.

For instance, assume that the country is composed of many firms ; therefore only average output matters for welfare, whereas risk matters for investment decisions. The welfare function is $W(\tau_s) = \beta(A_S y(S) + A_L y(L))$ where β is the share of labour income in GDP. At the equilibrium described above

$$\left.\frac{dW}{d\tau_s}\right|_{eq} = \beta A_S y'(S) \left.\frac{dS}{d\tau_s}\right|_{eq} + \beta A_L y'(L) \left.\frac{dL}{d\tau_s}\right|_{eq}$$

Since $y'(L) \left.\frac{dL}{d\tau_s}\right|_{eq} > 0$, it may be that $\left.\frac{dW}{d\tau_s}\right|_{eq} > 0$ if only A_L is large enough compared to A_S.

Hence, it is easy to model a situation in which, despite a decrease in the overall amount of inflows, a change in composition of flows makes a small tax welfare improving. Here we have done this assuming that the private choice for composition of inflows is not the optimal social choice. External effects can give the same result. For instance, Stiglitz (2000) argues that FDI also bring in embedded technology, human capital and access to markets, in addition to control and supervision of firms' activities, all elements that if they are not internalised by the private sector will create a wedge between the optimal private and the social inflow composition.

7 Conclusion

In the last twenty years, developing economies have been urged to liberalise their financial markets and to open their capital accounts. This policy recommendation was based on theoretical arguments that do not seem to be consistent with the experience we have with financial markets. In particular, the idea that liberalised capital markets improve risk-diversification and thus reduce the volatility of economies is largely contradicted by the history of high volatility and, more dramatically, by the number of financial crises that have occurred in emerging markets since the 80s. We have seen in this paper why developing economies may suffer from "short-termism", since short-term capital flows are volatile, threaten exchange rate stability, and are used for less productive investments.

In doing so, we presented an equilibrium model where both demand and supply of assets are described. Although the demand side has been described in a realistic way, with proper demand curves for several imperfect substitutes, the supply part has been simplified compared to what is done in the modern literature on capital flows. Ideally, the riskiness of projects should be endogenous and should depend on the composition of flows, as in Rodrik and Velasco (1999) where the issue of illiquidity is presented. But then, four "prices" would enter the equilibrium: the two interest rates and the two risk premium, making the model difficult to solve, without necessarily giving more results than what has already been done in separate models.

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