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inflows. This implies that capital controls that are effective in reducing the vulnerability of emerging markets to financial crises may increase the volume of capital inflows.

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anxiously trying to find a solution to the dilemma of how to maximize the benefits of capital flows to developing countries while minimizing the disruptive effects of their eventual abrupt reversal.

The view that short-term capital flows may increase the vulnerability of emerging countries to financial crises, and, for this reason, they should be regulated is becoming increasingly popular. For example, Stiglitz recently suggested that emerging markets should follow the Chilean example, and impose controls on short-term speculative capital flows. In fact, according to the chief economist of the World Bank, 'Even critics of the Chilean system acknowledge that the reserve requirement has significantly lengthened the maturity composition of capital inflows to Chile. This . . . may be the reason that Chile has been relatively unaffected by recent financial crises' (Stiglitz (1998)).

Those who oppose capital controls stress that 'the effectiveness of Chile's capital controls is mixed. While the composition of capital inflows has been altered in favour of longer-term flows, the goal of reducing the total volume of funds entering the country has not been achieved. Once the costs of distorting financial transactions are added to the scheme ineffectiveness, the case for Chile's capital controls is considerably weakened' (Edwards (1998)). But, is this argument correct? Should we really expect that (short-term) capital controls that reduce the vulnerability of an emerging market to financial crises reduce the total volume of funds entering the country?

In this paper, we will attempt to answer to this question with the help of a simple model *à la* Diamond and Dybvig (1983) in which foreign investors facing uncertainty about their liquidity needs have to decide whether to invest in an emerging market. We show that a tax on short-term capital inflows, by avoiding rational panics, and thus bank runs, can increase the expected returns of the investment. The intuition behind this result is simple: If the supply of capital to emerging markets depends on the vulnerability of these markets to financial crises, capital controls that make these markets less vulnerable should, *ceteris paribus,* increase the supply of capital. Of course, the *ceteris paribus* assumption cannot be made here. Capital controls are distortive: They reduce investors' long-run returns, and increase the degree of irreversibility of investment decisions. These are the costs that should be weighted against the gains induced by a safer financial environment. Taxes on

vulnerability of such markets to financial crises.

minimising both the number of panics and the damage they do."[1]

The view that short-term capital flows may increase the vulnerability of emerging countries to financial crises, and, for this reason, they should be regulated is becoming increasingly popular. For example, Stiglitz recently suggested that emerging markets should follow the Chilean example, and impose controls on short-term speculative capital flows.[2] In fact, according to the chief economist of the World Bank, "Even critics of the Chilean system acknowledge that the reserve requirement has significantly lengthened the maturity composition of capital inflows to Chile. This [...] may be the reason that Chile has been relatively unaffected by recent financial crises."[3]

Those who oppose capital controls stress that "the *effectiveness* of Chile's capital controls is mixed. While the composition of capital inflows has been altered in favor of longer term flows, the goal of reducing the total volume of funds entering the country has not been achieved. Once the costs of distorting financial transactions are added to *the scheme ineffectiveness*, the case for Chile's capital controls is considerably weakened" (Edwards (1998), emphasis added). But, is this argument correct? Should we really expect that (short-term) capital controls that reduce the vulnerability of an emerging market to financial crises reduce the total volume of funds entering the country?

In this paper, we will attempt to answer to this question with the help of a simple model *à la* Diamond and Dybvig (1983) in which foreign investors facing uncertainty about their liquidity needs have to decide whether to invest in an emerging market. We show that a tax on short-term capital inflows can prevent bank runs, and through this channel it can increase the expected returns of investing in emerging markets. This in turn implies that there is no reason to measure the *effectiveness* of (short-term) capital controls according to their ability to reduce the volume of foreign investments.[4] In fact, capital controls that are successful in reducing the vulnerability of an emerging market to financial crises can indeed increase the volume of

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1 "Regulation and capital flows," *Financial Times*, March 25, 1998.

2 Since 1991, the Chilian law required that the 30 percent of all non-direct foreign investment entering the country be deposited in an unremunerated account at the central bank for one year. This system is equivalent to the imposition of a tax on capital inflows inversely proportional to the length of the stay of the inflow.

3 Stiglitz (1998).

4 Of course, such statement is only valid when (as in this paper) we do not consider situations in which capital controls are imposed to limit the volume of capital inflows and thus to avoid an excessive appreciation of the exchange rate.

ing market. In period 0, α units are available in period 1, and β units in period 2; for each unit left in period 1 of some amount invested in period 0, β/α units are available in period 2. The parameters of the model satisfy the following restrictions:

$$\frac{1}{2} < \alpha < 1 < \beta < \frac{\alpha^2}{2\alpha - 1}. \tag{A1}$$

Note that in our framework investment is profitable only if the production process is carried out through the two periods. If, instead, it is interrupted in period 1, the returns on the investment are negative ($\alpha < 1$).

Assume also that there are two foreign investors, $i = 1, 2$, endowed with one unit of capital in period 0 facing a probability p_1(resp. p_2) of lasting one (resp. two) period, that is, of being "early," or "late consumers." At the beginning of period 1, each investor receives a signal $s^i \in S^i$, $S^i = \{s_1^i, s_2^i\}$, indicating his life span. We denote by $p_{i,j}$ the (ex ante) probability that investor i receives signal i, when investor j receives signal j, with $i, j = 1, 2$, and we suppose that the investors are identical, as of period 0, that is, $p_{i,j} = p_{j,i}$. We further assume that the signals are observed by both agents, but cannot be used in a court of law to enforce state-contingent contracts.[6]

Investor i has a linear utility function on aggregate consumption, x,

$$U_i(x) = \sum_{i=1}^{\tau} x_i, \tag{1}$$

[5] See, for instance, Valdes and Soto (1996), and Cardoso and Laurens (1998) in the case of Chile, and Cardoso and Goldfajn (1998) for a discussion of the more controversial case of Brazil.

[6] In other words, we assume that the bank cannot offer contracts that discriminate, in period 1, between early and late consumers. Note that this apparently heroic assumption would trivially hold in an economy in which the agents' type is private information. Here, we introduced it for the sake of simplicity, and knowing that if signals were private information our results would *a fortiori* hold (see Section 3).

institution, the "bank," that offers the following deposit contract: If an investor withdraws his deposit in period 1, he does not earn any interest,[7] while, if he withdraws in period 2, he receives a share of profits proportional to his deposit. In our economy, if both investors withdraw their deposits in period 1, the bank becomes insolvent and goes bankrupt. In this case, all assets are distributed proportionally to withdrawal demands.

The emerging market government may impose capital controls in the form of taxes that are inversely proportional to the length of stay of the inflow. Foreign investors have to pay a fraction t, $t \in [0,1]$, of their deposits in a government account. If they withdraw in period 1, they lose t. The tax will instead be recovered completely[8] if the investor stays until period 2.

If in period 0 both investors decide to enter the emerging market, the strategy for investor i is a function $\sigma^i : S^1 \times S^2 \longrightarrow A$, with $A = \{a_1, a_2\}$, and a_i denoting withdrawal in period i. If the foreign investors deposit in the bank at period 0, the consumption they receive in period 1, or 2, depends on their withdrawal decisions, which is summarized in Table 1.

Table 1: Payoffs

	Agent 2	
Agent 1	a_1	a_2
a_1	$(1-t)\alpha\,;\,(1-t)\alpha$	$(1-t)\,;\,\frac{(2\alpha-1)(1-t)}{\alpha}\beta + t$
a_2	$\frac{(2\alpha-1)(1-t)}{\alpha}\beta + t\,;\,(1-t)$	$(1-t)\beta + t\,;\,(1-t)\beta + t$

Let us define $\frac{\alpha^2-2\alpha\beta+\beta}{\alpha^2-2\alpha\beta+\beta+\alpha} \equiv t^* < 1$. One can immediately verify that: (i) for $t \in [0, t^*)$, both investors withdraw in period 1, if either investors is of type 1. This in turn implies that when a late consumer faces an early consumer, in period 1, he will withdraw his money from the emerging market, not for consumption purposes, but because the other investor withdraws:

[7] Notice that, since we implicitly normalize foreign interest rates to zero, here we do not assume a penalty for early withdrawals.

[8] In order for our result to hold it is sufficient to assume that the tax be inversely proportional to the lenght of the stay, i.e., that it discriminate between short- and long-term capital inflows. The assumption of a complete tax rebate (in period 2) is done for the sake of simplicity, and does not affect the qualitative results of the paper.

early consumers in withdrawing their deposit from the bank. Here, herd behavior is perfectly rational, and it is the result of the strategic interaction between agents. The introduction of a tax on short-term capital inflows reduces the returns associated with herd behavior, both by decreasing the payoff associated with an early withdrawal and by increasing the returns associated with keeping the deposit in the bank[9] until period 2. Notice that $\frac{\partial t^*}{\partial \alpha} < 0$, and $\frac{\partial t^*}{\partial \beta} < 0$. This implies that higher bank liquidity (higher values of α), or higher capital productivity (higher values of β), complement Chilean-style controls in the sense that a lower tax is needed to "stabilize" the banking system.

The (pure strategy) Nash equilibria in the different states of nature, for $t \in [0, t^*)$, and $t \geq t^*$ are summarized in Table 2.

Table 2: Nash Equilibria

$t < t^*$	Agent 2	
Agent 1	s_1	s_2
s_1	a_1 ; a_1	a_1 ; a_1
s_2	a_1 ; a_1	a_2 ; a_2

$t \geq t^*$	Agent 2	
Agent 1	s_1	s_2
s_1	a_1 ; a_1	a_1 ; a_2
s_2	a_2 ; a_1	a_2 ; a_2

The imposition of a sufficiently large tax ($t > t^*$) on capital inflows, preventing bank runs, may thus increase investors' expected returns. In our framework, such a tax, by deterring the bank from disinvesting all its assets when only one of the investors is an early consumer, increases investors' returns when they receive different signals. From the investors point of view, these (expected) gains should be weighted against the losses induced by the tax when both investors receive the same signal, and thus they are both early or late consumers. In particular, it can be seen that:

[9] In fact, we find that $\partial(1-t)\alpha/\partial t < 0$, and, from A1, $\partial\left(\frac{(2\alpha-1)(1-t)}{\alpha}\beta + t\right)/\partial t > 0$.

Proof. The expected returns of investor i, in absence of the tax given by

$$E(x_i^o) = (p_{12}+p_{21})\alpha = \alpha, \tag{2}$$

while in presence of a tax $t > t^*$ are given by

$$E(x_i^t) = \frac{\alpha + (1-t)(2\alpha - 1)\beta}{2\alpha}. \tag{3}$$

Furthermore, since from (2), and (3) we can determine that

$$E(x_i^t) - E(x_i^o) > 0 \Longleftrightarrow t < \frac{\beta - \alpha}{\beta} \equiv \widetilde{t}, \tag{4}$$

to complete the proof it is enough to show that the interval $[t^*, \widetilde{t}]$ is non-empty. The reader may easily verify that $\beta > 1 > \alpha \Longrightarrow [t^*, \widetilde{t}] \neq \emptyset$. □

It is important to mention that, when the signals that the investors receive are negatively correlated, the policy of imposing a tax $t = t^*$ maximizes investors' returns. Furthermore, since such a tax makes both foreign investors and the emerging market government strictly better off, it Pareto dominates free capital mobility. By imposing a tax t^*, the government prevents runs, and by doing so it reduces the cost associated with withdrawing from the emerging market.[10] The basic intuition behind our result is the following: A large international bank is more prone to invest in any particular emerging market if it knows that the liquidity conditions in that market would not create obstacles to its eventual disinvestment.

From Remark 2, and by continuity, the reader may easily infer that if the signals are sufficiently negatively correlated, it is always possible to increase foreign investor returns by imposing a tax on short-term capital inflows. It is also possible to envisage situations in which only in the presence of taxes on short-term capital inflows, foreign investors find it profitable to invest in the emerging market. This can well be the case even if signals are uncorrelated.

As an example of the above statement, let $\alpha = 0.55$, $\beta = 2.33$, $p_{11} = p_{12} = p_{21} = p_{22} = \frac{1}{4}$. The reader may easily verify, that, in absence of a tax on capital inflows, $E(x_i^o) \approx 0.99$, so that the utility associated with the consumption of the initial endowment is higher than that associated with the investment in the emerging market. Consider now a tax $t = t^* \approx 0.113$. It yields $E(x_i^o) \approx 1.01$. This, in turn, implies that:

Remark 3 *Taxes on short-term capital inflows may increase gross investments in the emerging markets.*

[10] A tax t^* *de facto* subsidizes early consumers at the expenses of late consumers.

Let us first relax the assumption that the signals are observable by both agents, and consider an economy in which agents' type is private information. Asymmetric information, by increasing the vulnerability of the financial system to runs, also increases the effectiveness of short-term capital controls. Suppose that each agent does not know whether the other agent is an early or a late consumer. In this case, a tax on short-term capital inflows will not only avoid herd behavior when one of the agents is of type 1 and the other of type 2, but also stem the possibility of bank runs when both agents are late consumers, but each of them assigns a positive probability that the other one is an early consumer, as in Postlewaite and Vives (1987). In order to check whether our results are robust to different assumptions on the number of players and the technology, we simulated the effect of Chilean-style controls in Goldfajn and Valdés' (1997) with a continuum of agents that face productivity shocks in period 1. Preliminary findings confirm that the same basic intuition of this model holds in this richer framework. Taxes on short-term capital controls reduce the probability of bank runs, and, through this channel, they can increase the volume of foreign investments.

The fact that the insights that one can derive from our simple model are quite general should not surprise the reader. The reason why a tax on capital inflows can increase the volume of inflows follows directly from basic principles: If the supply of capital to emerging markets depends on the vulnerability of these markets to financial crises, capital controls that make these markets less vulnerable should, *ceteris paribus*, increase the supply of capital. Of course, the *ceteris paribus* assumption cannot be made here. Capital controls are distortive: They reduce investors' long-run returns, and increase the degree of irreversibility of investment decisions.[11] These are the costs that should be weighted against the gains induced by a safer financial environment. Taxes on short-term capital inflows may thus either increase or decrease the volume of capital flows according to which of the two forces prevails. For this reason, it is really misleading to measure the effectiveness of short-term capital controls (in promoting a safer economic environment) according to their ability to reduce the total volume of funds entering in a country.

[11] See Bartolini and Drazen (1997), and Labán and Larrain (1997) for models in which a more liberal policy on capital outflows increases net capital inflows, either giving a signal of the government's future policies, or by making the investment decisions less irreversible,

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