

The Composition of International Capital Flows: Risk Sharing Through Foreign Direct Investment

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Abstract

Evidence on international capital flows suggests that foreign direct investment (FDI) is less volatile than other financial flows. To explain this finding, I model international capital flows under the assumptions of imperfect enforcement of financial contracts and inalienability of FDI. Imperfect enforcement of contracts leads to endogenous financing constraints and the pricing of default risk. Inalienability implies that it is not as advantageous to expropriate FDI relative to other flows. These features combine to give a risk sharing advantage to FDI over other capital flows. This risk sharing advantage of FDI translates into a lower default premium and lower sensitivity to changes in a country's financing constraint.

The model offers the new implication that financially constrained countries should borrow relatively more through FDI. This is because FDI is harder to expropriate and not because FDI is more productive or less volatile. Using several creditworthiness and country risk ratings to measure financing constraints, I present new evidence linking FDI and financing constraints. Moreover, numerical simulations of the model generate stronger serial correlation for FDI than for other flows into developing countries. This corroborates the view that non-FDI flows are more short-term and more likely to change direction.

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1 Introduction

International private capital flows represent a major source of financing of economic activity in developing countries. For these countries, it is often argued that a critical component of international financing is foreign direct investment (henceforth FDI).¹ The argument is based on two observations. First, foreign direct investment is less volatile than other forms of international capital flows. Second, the share of FDI is higher for developing versus developed countries.² As discussed below, existing theories of FDI have difficulty in accounting for these facts. This paper attempts to fill in this vacuum by arguing that FDI is a form of investment that is best suited to provide risk sharing in a world economy where financial contracts are plagued by imperfect enforcement mechanisms.

There is substantial evidence that FDI flows are less volatile than other forms of financial flows to developing countries. Some of this evidence comes from crisis episodes. The World Bank's (1999a) "Global Financial Development" reports that during the Latin America debt crisis of the 1980's FDI flows to these countries collapsed, but the fall in other long-term (and short-term) flows from banks and the bond market was 7 times greater. A parallel story occurred during the Mexican debt crisis in 1994. FDI inflows fell from US \$11 billion in 1994 to US \$8 billion in 1996, a drop of 27 percent, and recovered fully by 1997. However, portfolio equity and debt flows fell by 89 percent and 45 percent respectively in just one year, from 1994 to 1995. The 1997 currency and banking crisis in East Asia saw a drop of 22 percent in net-long term inflows to these countries, while FDI was extremely resilient falling by less than 5 percent from 1997 to 1998.³

Evidence of differential volatility is also abundant outside crisis periods. Figure 1 plots the histogram of the (absolute value of the) ratio of the coefficient of variation of net private FDI inflows versus that of net private non-FDI inflows.⁴ The data is from the World Bank

¹Investment through FDI alone represents a large portion of overall domestic investment. For example, in the 10 major recipient countries of FDI during the 1990-97 period—all developing countries—FDI accounted for an average of roughly 20 percent of total private investment. For the overall sample of developing countries it accounted for 8.7 percent of gross fixed capital formation in 1996 (see World Bank 1999a). Furthermore, FDI outflows from developing countries were roughly non-existent over the 1990-97 period. The evidence is quite different for developed countries. While these countries have the largest inflows and outflows of FDI, the net flow is typically small.

²Evidence on the relative size of FDI into developing countries is briefly discussed in section 5.1.

³The countries considered are Indonesia, Korea, Malaysia, the Philippines, and Thailand. The data on net inflows to these countries includes FDI and official flows, so 22 percent is presumably a lower bound on the reduction of private capital inflows.

⁴Both flows are normalized by gross private capital flows. Normalizing by GDP adjusted for purchasing power parity or using HP-filtered flows in constant dollar terms gives similar results.

(1999b) “World Development Indicators” (WDI) and covers 111 countries from 1975 to 1997, with varying time spans. According to Figure 1, 89 percent of the countries in the sample have lower coefficient of variation of FDI than that of other inflows. The median (average) coefficient of variation is 0.77 (1.11) for FDI and 1.88 (8.81) for non-FDI flows.

This difference in volatilities is also present when restricting attention to long term flows. Lipsey (1999) computes the coefficient of variation of several capital flows from 1969-1993. He reports significant differences in volatility between FDI and other net long term flows for developing countries and to a lesser extent to developed countries: the ratio of FDI’s volatility to that of long term non-FDI flows is about 0.59 for Latin America, 0.74 for South East Asia, 0.86 for Europe, and 0.88 for the US.⁵

[Figure 1 here.]

My point of departure is this: a typical characteristic of FDI into developing countries is that recipient countries are generally unable to operate (at least as efficiently, if at all) these investments without the intangible assets of the multinational company. Examples of these intangible assets include human and organization capital, and technological advances. Because these assets are *inalienable* to a large extent, their residual value to the recipient country is relatively small. For example, multinationals typically rely on blueprints to secure their investments. This is true in high technology industries such as pharmaceuticals, but also in low technology ones such as the soft drink industry.⁶ However, most other investments including

⁵UNCTAD (1998), World Bank (1999a), and Lipsey (1999, 2001) also report that FDI is unconditionally less volatile than other flows. Also related are the studies by Chuhan, Perez-Quiros and Popper (1996) who observe that FDI responds less to shocks, and Sarno and Taylor (1999) that show that FDI is mostly composed of a permanent component. Claessens, Dooley and Warner (1995) is the only study I know of that fails to confirm this finding. However, they use a much smaller sample of 5 developed and 5 developing countries.

⁶Clearly, though, by investing abroad multinationals increase the likelihood of dissipating the value of their intangible assets. This occurs because host countries of FDI can hire a specialized workforce from abroad, or train their own work force. However, these possibilities are financially costly and typically involve a large time lag from expropriation to using the capital in place. Reverse engineering is one of the most popular ways to imitate a technology. Mansfield et al. (1981) report the estimated imitation cost and time for 48 new products in the Chemicals, Drugs, Electronics, and machinery industries. These estimates are based on surveys to some of the largest US firms in these 4 industries. For innovations costing over \$1 million, an average of 23 percent of the products cost more to imitate than they did to innovate and an average of 17 percent of the products took more time to imitate than they did to innovate. These authors also report that most products cost at least 50 percent in time and dollars to replicate. It is our belief that these imitation costs are likely to be much higher for firms in developing and low income countries. In a different survey, Mansfield and Romeo (1980) report that 10 out of 26 technologies became known to some non-US competitor after at least 4.5 years.

bank loans and bond financing are fully appropriable. For my analysis, partial inalienability is the main difference between direct investment and other international inflows of capital.

The existence of intangible assets in many production/managerial activities together with market imperfections that prevent the correct pricing of these assets has been used to justify transnational corporations, i.e., intra-firm as opposed to arm's length relationships (e.g. Caves (1982, 1996)). The empirical evidence recently surveyed by Caves (1996) broadly suggests that this is an important force driving FDI. For example, research and development and advertising expenditures—typically associated with the presence of intangible assets—are larger in industries in which there is a stronger presence of transnational corporations.

The second main assumption of the paper is that international financing contracts lack the proper mechanisms to enforce repayment. In Section 2, I build a model of the composition of international capital flows to developing countries based on these two main premises: (i) that FDI is partly inalienable to the extent that it comprises intangible assets, and (ii) that sovereign capital flows are subject to expropriation due to the lack international enforcement mechanisms.

Section 3 analyses the predictions of the model for the optimal composition of international capital flows. First, because of expropriation risk, capital flows into financially constrained countries command a default premium. Second, because FDI is partly inalienable, the default premium associated with FDI inflows is lower than that of non-FDI inflows giving it a risk sharing advantage. This implies that financially constrained countries get a larger share of FDI. Moreover, a higher default premium to non-FDI flows means that changes in a country's borrowing constraint affect non-FDI flows to a greater extent.

In section 4, I use numerical simulations methods to investigate the ability of the model to quantitatively match the empirical volatility of FDI versus other capital flows. I start by illustrating the dynamics of international capital flows implied by the financing contract. I then extend the model to allow for the possibility of exogenous contract terminations. This permits the computation of the stationary distribution of countries implied by the model. Using the stationary distribution I find that the model is able to capture the relative volatility differences in capital flows observed in the data. The model also generates considerable persistence in flows partly because it contains an endogenous propagation mechanism. The dynamics of capital flows into developed and developing countries are also analyzed.

In Section 5, I investigate empirically the model's new prediction that financially constrained

countries have relatively larger inflows of FDI capital. I identify financing constraints with low sovereign credit ratings, but also, more broadly, with low overall country risk ratings. I find a negative association between the FDI share of gross private flows and a country's credit rating. Moreover, the association between FDI share and credit rating is robust to conditioning on other variables, including GDP. The variation in credit rating accounts for a significant portion of the total variation in FDI inflows. This represents new evidence on the dynamics of FDI and is broadly supportive of the model. Also supportive of the model is the evidence presented in subsection 5.2 that FDI and non-FDI private capital flows (as percentages of gross flows) display considerable persistence.

The combined empirical findings I discuss are hard to understand with other explanations for FDI. First, theories based on competitive advantages (e.g. lower input costs, supply of skilled/unskilled workers, market proximity) or taxation do not seem able to explain the systematic cross sectional evidence that FDI flows are less volatile than other investment flows, though they are certainly useful in accounting for the level of FDI (see Razin, Sadka, and Yuen (1998) for a discussion of taxes and capital flows). Second, FDI flows to developing countries are mostly in the form of Greenfield investments as opposed to mergers and acquisitions.⁷ Hence, it does not seem a good starting point to explain FDI flows to developing countries by appealing to high domestic corporate costs of external financing (see Froot and Stein 1991).⁸

Finally, my theory does not make use of investment irreversibilities (e.g. Dixit and Pindyck 1994) or inertia type arguments as in Albuquerque and Rebelo (2000). Though these are likely candidates to explain the lower volatility of FDI, they would have a hard time in explaining the connection between a country's credit worthiness and FDI flows. Two important remarks about FDI being irreversible are in order. In practice, FDI can be easily reversed. For example, the subsidiary can borrow against its collateral domestically, and lend the money back to the parent company. As another example, note that a considerable portion of FDI is intercompany debt, which the parent company may recall at short notice. (Both strategies would result in a drop in measured FDI.⁹) The second remark is that in bad times all financial products are

⁷Greenfield investments (e.g. setting up a subsidiary from scratch) accounted for roughly 87 percent of the FDI into developing countries in 1997, and 94 percent in 1991 (see UNCTAD (1998)).

⁸It could be argued that more favorable asset prices resulting from large exchange rate depreciations, like those in East Asia in 1997, would favor FDI. But, then, how do we rationalize the large decrease in portfolio equity flows in East Asian countries?

⁹Measures of FDI usually report all financial transactions between a foreign multinational and a subsidiary that is at least 10 percent owned by the former (e.g. retained earnings, equity capital, and intercompany debt transactions). An investment with an equity share of less than 10 percent may be counted as FDI if a management

illiquid and thus costlier to move around. Thus, the role of irreversibility becomes an empirical question.

The model is closely related to that of Thomas and Worrall (1994). They analyze the investment dynamics of multinational companies. I extend their framework to accommodate heterogeneous capital flows, the possibility of exogenous contract terminations and the simulation of a worldwide distribution of countries. I also explicitly model the lifetime utility maximization problem of the domestic consumer in autarky. The model is also related to Eaton and Gersovitz (1984) who study foreign direct investment under the risk of expropriation. They argue that the level of intangible assets is an important determinant of heterogeneity in international capital flows. They show that it may be optimal for investors to overinvest in technologies with more intangible assets in order to reduce the risk of expropriation. I extend their analysis by also modeling foreign *indirect* investments, where the absence of intangible assets increases the incentives to expropriate.

Section 6 concludes the paper with a discussion of the normative implications of my results. Appendix A contains the proofs of the propositions in the paper.

2 The Model

I think of the model as one of lending to developing countries.¹⁰ First, for these economies there is a stronger belief that legal enforcement of international contracts is subject to political willingness and uncertainty, and hence is more fragile. Second, I think that capital flows among developed countries are very different in nature.¹¹ In line with this interpretation, I model the supply of international capital by assuming that international investors are risk neutral and unconstrained.

The basic framework is from Thomas and Worrall (1994). As discussed above, I enrich their model along several dimensions. I allow heterogeneous capital flows. In doing so, I impose considerable symmetry between the different capital flows. Besides tractability, the main purpose is to isolate the effect of the inalienability of FDI.

position is implied. Balance of payments data do not include capital raised in host countries as FDI. Also they omit cross-border flows of goods and services. For more details see UNCTAD (1999).

¹⁰However, my choice of interpretation should not constrain the reader's.

¹¹An example of this differential behavior is the much higher percentage of Mergers and Acquisitions that accounts for FDI between developed countries. Mergers and Acquisitions in total FDI for developing countries was only 12.4 percent in 1997, up from 5.4 percent in 1991. In contrast, the worldwide share of Mergers and Acquisitions in FDI inflows averaged 50 percent during 1985-97 (UNCTAD (1998)).

The economy consists of many international investors and a domestic representative consumer. All international investors are alike and the domestic consumer is indifferent between whom he meets. The domestic consumer is risk averse while international investors are risk neutral. There are three investment opportunities available to international investors. One is the international bond market which offers a constant interest rate r . International investors can also invest in two projects located in the host country. The two projects differ first and foremost in the degree to which they can be appropriated by the domestic consumer. I interpret flows into the inalienable project as FDI and flows into the alienable project as non-FDI.¹² I do not model the location/entry decision of multinational companies. This is an extremely useful abstraction that allows me to focus on the dynamics of the financial capacity of the host country.

In this setup long term contracts between investors and borrowers are written contingent on any possible history of events. As Spear and Srivastava (1987) and Green (1987) originally showed, there exists a recursive representation to these contracts. To conserve on notation and space I make use of these results to write the problem directly in a recursive fashion. I shall make brief use of the sequence representation of these contracts in the next section.

There is only one aggregate shock s . The aggregate shock s follows the continuous autoregressive process with serial correlation ρ , and unconditional mean \bar{s} ,

$$\ln s' = \rho \ln s + (1 - \rho) \ln \bar{s} + \varepsilon', \text{ and } \varepsilon' \sim N(0, \sigma_\varepsilon^2). \quad (1)$$

The choice of a single aggregate shock is motivated by a desire to remove any asymmetries between the investment choices besides those originating from the inalienability of FDI. It is easiest to think of the aggregate shock as being total factor productivity shocks, but we may also think of shocks to the country's banking system, or to the exchange rate system. The initial shock s_0 is drawn from a distribution $F(s)$.

At the beginning of the period the long term contract assigns an utility level V to the

¹²The International Monetary Fund's definition of FDI comprehends all investments with lasting *corporate control interests* on firms residing in other countries, typically with equity shares of 10 percent or more (see Lipsey (1999) for a summary and history of several definitions). It is clear from discussions at the IMF on measurement issues that the goal in the breakdown between FDI and Foreign Portfolio Investment (e.g. equity securities, debt securities, money market instruments and financial derivatives) and Other Investments (e.g., trade credit, loans, financial leases, currency deposits) is to capture under FDI those flows which normally include the transfer of intangible assets (see for example UNCTAD 1999). Therefore, the focus of IMF's definition and mine is on measuring the same flows. As Caves (1996, p. 1) puts it: "Exact definitions are unimportant for this study, because economic analysis in fact emphasizes that at the definitional margins decision makers face close trade-offs rather than bimodal choices."

developing country. This life-time utility level is obtained through a period utility of $\ln(c)$ and a continuation value $V(s')$. Thus, the promise keeping constraint:

$$V = E \left[\ln(c) + \frac{1}{1+r} V(s') \mid s \right], \quad (2)$$

where $E(.|s)$ is the conditional expectations operator.

The contract specifies how output is divided between domestic consumption (c), repayment of the loan's principal and interest ($(k_f + k_o)(1+r)$), and additional transfers ($\tau(s')$) (these may include additional interest charges for default premia or more loans to the country). The output results from two investment projects in which international investors participate. These projects may differ in their capital share α_f , $\alpha_o < 1$. This gives the aggregate resource constraint:

$$c + (1+r)(k_f + k_o) + \tau(s') = s' A k_f^{\alpha_f} + s' k_o^{\alpha_o}, \quad (3)$$

where k_f is the level of FDI or inalienable capital input, k_o is the level of appropriable capital input, and A is a relative scale factor. The model embeds tax advantages of FDI whenever $A > 1$. As it will become clear later on the scale factor can explain FDI levels, but not the relative volatility of FDI in the absence of inalienability. I abstract from other factors of production by assuming they are fixed factors. This of course ignores any crowding out or crowding in that might ensue, but is irrelevant if the impact on the domestic factor markets of these heterogenous forms of capital is symmetric.¹³

For simplicity, I assume full depreciation for both capital stocks. Besides the different capital shares, the only other distinction I make between FDI and other capital flows is in the way each of the inputs affects the developing country's utility level under autarky, $U(k_f, k_o, s')$. (More on this below.)

The host country's representative consumer cannot commit to a long term contract. International investors have commitment, but of a limited nature in that a participation constraint must be satisfied. As in Thomas and Worrall (1994) I define a *self-enforcing contract* by requiring that capital flows obey two participation constraints.¹⁴ For both types of agents the

¹³Since all of the financing comes from the international lender, one might think that the contract would look different if the domestic investor was allowed to self-finance some of the production. In fact the international lender is doing *all* the feasible and efficient financing. In the simulations below, the time series of average consumption growth for the domestic investor is positive, which reflects the fact that his required rate of return is higher than r . However, he can only save at r . See also the discussion on contract implementation in Albuquerque and Hopenhayn (2002).

¹⁴This assumption is more in line with real life scenarios. Giving full commitment to the international investor does not change the qualitative nature of my main results.

participation constraint says that the utility under the contract is at least as large as the utility outside the contract. That is, for the domestic consumer:

$$\ln(c) + \frac{1}{1+r}V(s') \geq U(k_f, k_o, s'), \quad (4)$$

for every $s' \in S$. Constraint (4) is a necessary condition to generate endogenous barriers to international capital flows by limiting the size of k_o and k_f . The international investors' participation constraint limits long term losses at any time. Denoting the utility function of an international investor in state (V, s') by $B(V, s')$, this restriction dictates that $B(V, s') \geq 0$.

Before continuing, I describe the timing of the model in a more organized fashion. Figure 2 presents a visual description of the main events during each period. At the beginning of each period, and before the shock s' is realized, the investment of k_o , and k_f is made, and consumption is decided.¹⁵ Afterwards, the aggregate shock is observed and output is generated. At this stage the consumer may choose to default on the contract. If default does not occur, output is allocated into consumption and other transfers as previously determined.

[Figure 2 here.]

The utility of an international investor is the expected sum of discounted net flows (at rate r) from the borrowing country:

$$B(V, s) = \max_{c, k_f, k_o, \tau, V(s') \geq \underline{V}} E \left[\tau(s') + \frac{1}{1+r} B(V(s'), s') \mid s \right] \quad (5)$$

subject to (2)-(4) and to $B(V(s'), s') \geq 0$ for all s' . The constraint that $V(s') \geq \underline{V}$, with $\underline{V} > -\infty$, is introduced because the period utility of the domestic consumer is unbounded. The value of \underline{V} can be interpreted as the lowest utility the domestic consumer can expect to get under autarky.¹⁶

Note that the problem of maximizing (5) subject to (2)-(4) is formally very similar to the usual small open economy problem in International Macroeconomics. Except for the non-default constraint (4), the main difference is that instead of maximizing the consumer's lifetime utility

¹⁵The reader can imagine that the international investor actually produces the capital one period in advance, since the capital allocation decision is made before the productivity shock is realized and before output is produced.

¹⁶An alternative interpretation is that \underline{V} is the utility level the domestic consumer can obtain by joining another investor as in Phelan (1995).

subject to resource and balance of payments constraints, I solve for the dual problem in which the international investor's lifetime utility is maximized subject to a resource constraint and the agents' utility (2). I show below that the solution to (5) lies on the Pareto frontier and so the two problems coincide.

Let me now describe the borrower's autarky problem. In solving for the borrower's autarky solution it is assumed that: (i) default occurs on both capital flows simultaneously;¹⁷ (ii) without the human capital from the international investor the FDI technology cannot be operated any longer once the country defaults; and (iii) only a share of the current revenues $\theta \in [0, 1]$ can be transformed into investment towards the appropriable activity or consumption. Thus, $1 - \theta$ is the degree of inalienability of FDI. Even though I model (ii) and (iii) as exogenous, they can be motivated as a rational response of multinational firms to country risk (Eaton and Gersovitz 1984).

Under these assumptions, the value of the host country's representative consumer under autarky is given by:

$$U(k_f, k_o, s) = \max_{k'_o, c \geq 0} \left[\ln(c) + \frac{1}{1+r} EU(k'_o, s') \right],$$

subject to the resource constraint

$$\theta s A k_f^{\alpha_f} + s k_o^{\alpha_o} = c + k'_o,$$

and the Bellman equation

$$\mathcal{U}(k_o, s) = \max_{k'_o \geq 0} \left[\ln(s k_o^{\alpha_o} - k'_o) + \frac{1}{1+r} EU(k'_o, s') \right].$$

It is easy to check that

$$U(k_f, k_o, s) = d_0 + d_1 \ln(\theta A k_f^{\alpha_f} + k_o^{\alpha_o}) + d_2 \ln(s), \quad (6)$$

where d_0 , d_1 , and d_2 are positive constants.¹⁸ In deriving (6), I make extensive use of the assumptions of log-utility and full depreciation.

What is the role of the assumptions on the FDI activity? It is critical that some output from the FDI activity be lost if the country defaults. This is the basic assumption of the paper. It is

¹⁷Note that the possibility of default on only one flow at a time favors the risk sharing role of FDI. Again, this symmetry is intended to isolate the effect of the inalienability on the volatility of both flows.

¹⁸These constants are: $d_1 = \bar{d}_1 / \alpha_o$, $\bar{d}_1 = \alpha_o / (1 - \beta \alpha_o)$, $d_2 = (1 + \beta \bar{d}_1) / (1 - \beta \rho)$, and

$$(1 - \beta) d_0 = \beta \bar{d}_1 \ln(\beta \bar{d}_1) - (1 + \beta \bar{d}_1) \ln(1 + \beta \bar{d}_1) + \beta d_2 (1 - \rho) \ln(\bar{s}),$$

with $\beta = 1 / (1 + r)$.

not important that the output from the FDI activity can also be used for investment, although this makes the results stronger and easier to derive. Finally, I want to emphasize that θ does not act like a tax, though it could be interpreted as a state-contingent tax: FDI flows are not subject to this tax if the country does not default (see (3)).

Equilibrium Contracts

At the start of the contract the international investor makes a take-it-or-leave-it offer of contingent sequences of $\{k_{ot}, k_{ft}, \tau_t, c_t\}_{t=0}^{\infty}$ to the domestic consumer. An equilibrium contract gives just enough expected revenues to the international investor that compensates her for any initial fixed costs I , hence $V_0 = \sup\{V : \int B(V, s') F(ds') \geq I\}$. These fixed costs may be related to setting up a factory or promoting a brand name.

Having formulated the problem I now turn to a characterization of the solution.

3 The Optimal Composition of Capital Flows

The self-enforcing nature of the contract, in particular the constraint $B(V, s) \geq 0$, makes it infeasible to use standard dynamic programming arguments to show the existence and uniqueness of a value function $B(\cdot)$. However, I can show an important property of the function $B(\cdot)$. Let $h_t = \{s_l, k_{ol}, k_{fl}, \tau_l, c_l\}_{l=0}^t$ be an history of events up to time t . Consider the set $\Gamma(h_t)$ of all contract *feasible* sequences $\gamma(h_t) = \{k_{ol}, k_{fl}, \tau_l, c_l\}_{l=t}^{\infty}$. Define recursively the domestic consumer's utility $V(\gamma; h_t) = E \left[\ln c(h_t) + \frac{1}{1+r} V(\gamma; h_{t+1}) \right]$ from following the recommendations of contract γ after history h_t . Any contract in Γ satisfies the self-enforcing constraints, the resource constraint (3), and $V(\gamma; h_{t+1}) \geq \underline{V}$ from time $t \geq 0$ onwards. The constrained-Pareto frontier at time t that yields at least utility V_t to the domestic consumer is defined by the mapping:

$$B^P(V_t, s_t) = \sup_{\gamma \in \Gamma(h_t)} \left\{ E \left(\tau(h_{t+1}) + \frac{1}{1+r} B(\gamma, h_{t+1}) \right) \mid V(\gamma; h_t) \geq V_t \right\}$$

where $B(\gamma, h_t)$ is defined recursively by $B(\gamma, h_t) = E[\tau(h_{t+1}) + \frac{1}{1+r} B(\gamma, h_{t+1})]$. Finally, define B^F to be the Pareto frontier that results if the self-enforcing constraints are dropped. That is B^F characterizes the Pareto frontier when full commitment is possible by both agents.

The first result says that the constrained-Pareto frontier can be computed using the recursive approach outlined in the previous section. Let T be the operator described in (5), that is

$$T(f)(V, s) = \max_{c, k_f, k_o, \tau, V(s') \geq \underline{V}} E \left[\tau(s') + \frac{1}{1+r} f(V(s'), s') \mid s \right]$$

where the maximization is subject to (2)-(4) and $f(V(s'), s') \geq 0$ for all s' . Construct the sequence of functions $f^{(0)} = B^F$, $f^{(n)} = T(f^{(n-1)})$, for $n \geq 1$, by iterating on the operator T .

Lemma 1 (*Thomas and Worral 1994, Lemma 1*) $f^{(n)}$ converges to B^P pointwise.

Thus, I can take $B(V, s) = B^P(V, s)$. An immediate consequence of this lemma is that the optimal contract will give allocations that lie in the downward sloping portion of the constrained-Pareto frontier. Together with the fact that in equilibrium the domestic consumer is extracting the maximal surplus from the investor, these allocations are the best possible ones the domestic consumer would have chosen if he were to choose a contract γ himself for any given value of B .

Assume that B is concave in V for each s . This will be confirmed in all the simulations below. Suppose the current state is (V, s) . Let π' be the conditional density of the aggregate shock. Attach the Lagrange multipliers λ , $\pi'\psi(s')$, $\pi'\delta(s')$, and $\pi'\phi(s')$, respectively to constraints (2), (4), $B(V(s'), s') \geq 0$, and $V(s') \geq \underline{V}$ for each shock s' . Eliminating the variable τ , the first order conditions for the investor's problem are:

$$c = \lambda + E[\psi(s') | s]$$

$$E(s'|s) A \alpha_f k_f^{\alpha_f - 1} = 1 + r + E[\psi(s') U_{k_f}(k_f, k_o, s') | s] \quad (7)$$

$$E(s'|s) \alpha_o k_o^{\alpha_o - 1} = 1 + r + E[\psi(s') U_{k_o}(k_f, k_o, s') | s] \quad (8)$$

$$\left(\frac{1}{1+r} + \delta(s') \right) B_V(V(s'), s') + \frac{1}{1+r} [\lambda + \psi(s')] + \phi(s') = 0, \text{ for all } s',$$

together with the constraints (2), (4), and $B(V(s'), s') \geq 0$ and $V(s') \geq \underline{V}$ for each shock s' . The envelope condition is: $B_V(V, s) = -\lambda$. Let the solution to this system of equations be the functions $\{k_o^*, k_f^*, \tau^*, c^*, V(s')\}$ with associated Lagrange multipliers.

The first condition together with the envelope condition just say that the slope of the constrained-Pareto frontier is given by $E[\psi(s') | s] - c < 0$. Thus, the expected value of the shadow cost of the default constraints is bounded above by c . The second and third conditions dictate the optimal composition of capital flows. In each, the rate of return, denoted r_{k_x} , or marginal expected product of capital, is equated to its marginal cost r , plus a default premium. The *default premium* for capital k_x is defined as $E[\psi(s') U_{k_x}(k_f, k_o, s') | s]$; it measures the marginal cost of higher incentives to default brought about by a marginal unit of capital. Finally, the last condition describes the trade-off across different states of nature when choosing continuation utility levels.

I use the first order conditions (7) and (8) to define financing constraints in the model. A *financially constrained country* has positive default premium of either capital. This is a definition of financing constraints on the intensive margin.

I start with the analysis of capital flows when there is full commitment by both agents. This will give a benchmark for comparison and will help understand the role of commitment in generating financial constraints.

3.1 The Perfect Enforcement Solution

To better understand the role of imperfect enforcement and the inalienability of FDI, I start by analyzing the solution under perfect enforcement. Eliminating the self-enforcing constraints from the problem yields the following solution (i.e. set $\delta(s') = \psi(s') = 0$):

Proposition 2 *Under perfect enforcement, the optimal choices (k_f^F, k_o^F) solve:*

$$\alpha_f E(s'|s) A k_f^{\alpha_f - 1} = \alpha_o E(s'|s) k_o^{\alpha_o - 1} = 1 + r,$$

for a country starting the current period with shock s . There is no default premium. The ratio of the elasticity of k_f to changes in s to the elasticity of k_o to changes in s is $(1 - \alpha_o) / (1 - \alpha_f)$.

Proofs of all propositions can be found in the appendix. Clearly, the self-enforcing constraints are at the heart of the financing friction. In an economy with perfect enforcement the default premium is zero and marginal revenues are equalized. The different sensitivity of capital flows can only arise because the capital shares differ across the investment opportunities. Inalienability plays no role. Hence, the role of inalienability is directly linked to the existence of borrowing constraints and default risk.

What is the role of taxes in explaining the relative volatility of FDI? Recall that $A > 1$ has the interpretation of a subsidy to FDI. Subsidies are irrelevant to the relative sensitivity of FDI (though they are a key determinant of the level of FDI). As we will see below this will also be the case when $\theta = 0$ (maximum inalienability of FDI).

3.2 The Imperfect Enforcement Solution

The first main prediction of the model concerns the default premium and level of FDI versus other flows.

Proposition 3 *The default premium is higher for non-FDI flows. When the elasticities $\alpha_f = \alpha_o$ and $A \geq 1$, the level of FDI is no smaller than the level of appropriable capital, i.e., $k_f^* \geq k_o^*$. Furthermore, both flows will be below their full enforcement levels $k_f^* \leq k_f^F$ and $k_o^* \leq k_o^F$, with inequality holding strictly every time the country is constrained.*

If $A < 1$ then the concavity of the production functions is not the only ingredient affecting the composition of capital flows. Hence, it is possible to have $k_f^* < k_o^*$ when A is small enough.

With the financing frictions in place the default premium becomes positive for both flows. FDI's default premium is lower because these flows are less appropriable under default, which implies that FDI flows are relatively closer to their unconstrained optimum. This leads to a corollary that constitutes a new prediction of the model regarding FDI flows:¹⁹

Corollary 4 *The FDI share of total private inflows is higher for financially constrained countries if, and only if $\theta < 1$.*

How does the relation between default premia and size translate into volatility? This question is in general very hard to answer, but when shocks are iid it turns out that there is a sharp result.

Proposition 5 *Let the aggregate shock be iid. The ratio of the elasticity of k_f to changes in V to the elasticity of k_o to changes in V is smaller than $(1 - \alpha_o) / (1 - \alpha_f)$ if, and only if $\theta < 1$.*

This is the second main result of the paper. It implies that for financially constrained countries FDI is less volatile than non-FDI flows, provided FDI is partly inalienable $\theta < 1$ and $\alpha_o \geq \alpha_f$.²⁰ To understand this result, and for simplicity of exposition, let the input shares be identical (i.e., $\alpha_f = \alpha_o$). Recall from Proposition 3 that in this case FDI carries a smaller default premium or rate of return. Thus, shocks that increase the borrowing capacity of the host country (by increasing future V) lead to larger adjustments of non-FDI flows, because these flows have higher rates of return and are farther away from the optimum.

¹⁹This result contrasts with Kraay et al. (2000) who also use the inalienability of FDI to discuss its relative size. Their result seems to depend upon the assumption that the probability of default does not change as more FDI and non-FDI capital flow into the country.

²⁰Note that this proposition and proposition 2 cannot be used to compare relative volatilities across constrained and unconstrained countries. This is so because with iid shocks volatilities of flows under perfect enforcement are trivially zero.

Several comments are in order. First, since under perfect enforcement there is no difference in volatilities (with equal input shares), this difference must arise because of the financing constraint and of the inalienability of FDI ($\theta < 1$). Second, the qualitative result is independent of the size of subsidies A . Third, only if the capital share of FDI is larger than that of non-FDI flows ($\alpha_f > \alpha_o$), could FDI become relatively more volatile. The reason is that, even if the optimal values k_f^* and k_o^* were equal, the relative convexities of the production functions might induce a stronger response of k_f . This makes it harder to analyze the volatility of capital flows. However, when shocks are iid and FDI is fully inalienable ($\theta = 0$), k_f is constant through time and equal to k_f^F . In this case, the relative volatility of FDI is trivially smaller than that of non-FDI flows independently of the capital shares. (And independently of the subsidy parameter A as well.) Hence, one would expect a significant role for the capital shares, but one that vanishes as the inalienability of FDI becomes maximal. Finally, the result is only proved for iid shocks. Below I provide numerical results that show that it holds for reasonable parameter values (and in particular for positive persistence).

This result rationalizes, based on the risk sharing properties of FDI, the composition of the recent outflows of capital from the East Asian Tigers all of which suffered a negative aggregate shock that tightened (at least temporarily) their access to international credit markets.

4 Quantitative Properties of the Model

In this section I report results from numerical simulations of the model.²¹ I start by analyzing the path dynamics of the model. Using the time series of a contract, I then report how relative volatilities change with the persistence of aggregate shocks and with the degree of appropriability of FDI. Finally, I extend the model to allow for exogenous contract terminations. I use this new setup to construct a worldwide stationary distribution of countries and recompute the relevant statistics at the stationary distribution. I also use the stationary distribution to break the sample into developed versus developing countries and analyze the behavior of these two groups of countries. Despite ignoring important features of production and investment (recall that there is full depreciation of capital and no domestic investment or labor supply), the model fares quite well in explaining the differential volatilities in FDI and non-FDI flows reported in the Introduction of the paper.

Table 1 summarizes the baseline parameter choices. The period considered is one year. The

²¹Details on the numerical approximation are available from the author upon request.

choice of all parameters except θ is borrowed from the real business cycle literature (see Cooley and Prescott 1995). The real interest rate is the standard value of 4 percent. The choice of 0.4 for the capital share coincides with estimates for the US economy. It is also consistent with estimates of the capital share for several developing countries in Barro and Sala-i-Martin (1995, Table 10.8). These estimates range from .29 to .69. I vary the values of the inalienable parameter θ and the auto-correlation parameter ρ in the experiments.

[Table 1 here.]

To solve the model I discretise the state space. The aggregate shock takes on one of 5 possible values. The transition matrix $[\pi_{ij}]$, with $\pi_{ij} = \Pr[s' = s_j | s = s_i]$, is chosen to be a discrete state space representation of the autoregressive process (1). This is done with the numerical quadrature method developed by Tauchen and Hussey (1991). To calibrate the distribution of the initial shock, $F(s)$, I use the invariant distribution induced by the transition matrix $[\pi_{ij}]$. For the values of the life-time utility I choose a equispaced grid of 50 points starting in \underline{V} and ending in \bar{V} . I pick a sufficiently high upper bound for V . At this level (\bar{V}) the country is financially unconstrained for all shocks. Also, this choice does not restrict the optimal solution since $B(\bar{V}, s_j) < 0$, for all j .

I choose \underline{V} to be 10 percent below the autarky level of life-time utility which is capable of sustaining the optimal unconstrained choices of k_f^F and k_o^F for the lowest realization of the shock. I choose the initial investment I such that all countries start at a value of $V_0 = \underline{V}$. At this value, the average starting output is 28 percent below the unconstrained optimal level of output at the mean shock. This number is in line with reported output losses in economies that have experienced banking or currency crisis. Kaminsky and Reinhart (1998) report that in banking crisis, bailout costs alone amounted to 21.6 percent in Latin America during the 1970-1994 period. Numbers for other regions or periods are smaller, with an average of 11 percent. In currency crisis, the main costs arise from loss of reserves and large real devaluations. On top of these costs, the disruption of the financial and trade sectors may also cause significant and long lasting output losses. For example, output declined dramatically in Mexico in 1995 (6.2 percent), in Indonesia in 1998 (13.7 percent), and is predicted to decline by 10 to 15 percent in Argentina in 2002.

4.1 Contract Transition Dynamics

To get a better feel for the model it is interesting to analyze the path dynamics generated by the optimal financing contract. Figure 3 presents the time 0 unconditional expected path dynamics implied by the contract. These dynamics are computed by averaging across 5000 simulations of 10 years each. The dynamics of the default probability, capital flows, utility levels, transfers, rates of return, and consumption are analyzed. Absent in the picture is the plot for the aggregate shock because at time 0 the future expected level of the aggregate shock is its mean.

[Figure 3 here.]

The domestic investor, sitting at time 0, expects the contract to give him increasing amounts of utility over time. By building up the utility level of the domestic investor, the international lender makes staying in the contract more desirable. This implies that more and more capital can be advanced without affecting the incentives to default. In fact, looking forward, the domestic investor faces a downward probability of being financially constrained. At year 5 already, the time zero (unconditional) probability of being unconstrained forever after is 100 percent.²² At this point the borrower is always strictly better off staying in the contract rather than defaulting, and the economy looks like one with a perfect enforcement technology. As financing constraints become less binding and more capital is advanced, particularly non-FDI (which has the highest rate of return), rates of return on domestic investments decline. The feature that capital inflow shares converge to 50 percent of total inflows results trivially from having imposed absolute symmetry on the two technologies in the baseline parameterization.

The easing of financing constraints leads to increased output and consumption. However, growth in both output and consumption slows down over time as the country approaches the economy with perfect enforcement technology.

The low utility values for the domestic investor at the start of the contract contrast with the high levels commanded by the international lender. The international lender makes money earlier in the life of the contract as repayment for the initial investment I and capital advances. Accordingly, transfers (τ) are highest earlier in the life of the contract.

²²This seems a very short time. It is a feature of several things including the low input share α and the fact that contracts are not broken. I discuss these below.

4.2 Model Statistics

Table 2 presents model statistics from 50 simulations of the model, each with 111 countries over 20 years (the dimension of the sample used to construct Figure 1). All shocks are taken to be country specific. All statistics are averages across the individual country statistics. I present the standard deviation of HP-filtered logged flows and the coefficient of variation of the ratio of flows to output. De-trending flows is needed because of the documented non-stationarity induced by the contract.

The simulation results in Table 2 suggest that the unconditional volatility of FDI is smaller than that of other flows even when aggregate shocks are persistent. Quantitatively, the model is able to capture a significant differential in volatilities with the ratio of coefficients of variations (or standard deviations of detrended flows) closely matching the numbers discussed in the Introduction.²³ Recall that Proposition 2 shows that for unconstrained countries $\alpha_f = \alpha_o$ implies that volatilities are also equalized. Thus, the volatility differentials observed in Table 2 depend on countries being constrained during the simulation period.

[Table 2 here.]

Lower persistence of shocks leads countries to start-off relatively less constrained. This explains why the FDI share is closer to 50 percent and the volatilities are reduced to the values that would result in the perfect enforcement case.²⁴ Lower persistence also decreases the unconditional volatility of the aggregate shock. This is an additional explanation for the drop in the absolute magnitudes of the volatilities when flows are measured in absolute values. One startling result though, is the persistent volatility differential across different values of ρ , independently of how flows are measured.

Lowering the degree of inalienability (i.e., increasing θ) reduces the FDI share. Also, independently of how inflows are measured, there is a substantial reduction in the volatility differential. The narrowed volatility gap was to be expected from the analytical results with iid shocks.

When FDI has no subsidies ($A = 1$), the simulated FDI shares are somewhat below the empirical values discussed below. If, for developing countries, FDI is also driven by tax advantages

²³Investment in the model is only 1.5 to 2 times more volatile than output. This lower volatility results mainly from our assumption that capital is fully depreciated and may explain the low absolute volatility of flows.

²⁴When there are no financing constraints and shocks are iid, the volatility of both inflows is zero.

to FDI ($A > 1$), then the model is able to better fit the observed shares of international flows. This improvement comes with almost no change in relative volatilities. This confirms the initial results for the perfect enforcement case that tax advantages are important determinants of the relative level of FDI versus other capital flows, but not so much of the relative volatilities.

Increasing the production input shares results in flatter marginal product of capital curves. This leads to greater volatility of either FDI and non-FDI inflows. It also leads to greater levels of FDI and non-FDI, but relatively more so of the former. A second effect is that countries start relatively more constrained. This second effect tends to amplify both the level and volatility differences between FDI and non-FDI flows.

4.3 Model with Exogenous Exit

One unrealistic feature of the current setup is that countries grow to become unconstrained and that this state is absorbing. For the baseline parameterization used in subsection 4.2 this transition was quite fast. This raises the question of whether flows will ever be constrained in a stationary distribution of countries.

A simple way to eliminate this absorbing state is to allow exogenous separation during the contract's life-time. Let $\nu > 0$ be the exogenous exit probability. Exit is assumed to occur at the end of the period after production has occurred and transfers are paid out. If a country exits the contract a new contract is offered (possibly with a different lender) starting at utility V^e . For simplicity, exit is independent of economic activity and at exit the lender gets nothing. All agents observe and distinguish exogenous from endogenous separations.

The optimal financial contract with exogenous exit is obtained by solving

$$B(V, s) = \max_{c, k_f, k_o, \tau(s'), V(s') \geq \underline{V}} E \left[\tau(s') + \frac{1-\nu}{1+r} B(V(s'), s') \mid s \right]$$

subject to (3), (4), $B(V(s'), s') \geq 0$ for all s' , and the promise keeping constraint:

$$V = E \left[\ln(c) + \frac{1-\nu}{1+r} V(s') + \frac{\nu}{1+r} V^e \mid s \right].$$

In an equilibrium contract $E(B(V^e, s')) = I$, where the expected value is computed under the distribution function $F(\cdot)$.²⁵

For the results in this subsection, I use the baseline parameterization with $\alpha = .4$, and also $\alpha = .5$, and let $\nu = 0.02$. This exit rate is consistent with the worldwide default experience in

²⁵The full enforcement value B^F is changed accordingly.

the 20th century (Kraay et al. 2000). I set I so that $V_0 = V^e$. Using the baseline parameters above, $V^e > \underline{V}$ is calibrated so that there is a 28 percent drop in output upon exit for a financially unconstrained country. As expected, implicit in the stationary distribution is that only 6 percent of the countries are financially constrained in any given year (when $\alpha = .5$ this number is 7 percent). As I show below this is different from the percentage of developing countries in the stationary distribution.

Starting from the stationary worldwide distribution of utility levels, I again run 50 simulations of 111 countries over 20 years. Using these simulated paths, Table 3 reports the worldwide standard deviation of HP-filtered logged capital flows. For example, for $\alpha = .4$, volatility of FDI is .022 and that of non-FDI flows is .170. These numbers are lower than those reported in Table 2 but preserve the relative volatility differences.

It is also possible to break the sample of countries into those that were in ongoing unbroken contracts in the 20 years of simulated data and those that did not. The first group of countries corresponds naturally to developed countries and the second to developing countries. Table 3 also presents the relative sizes of these subsets of countries as well as the numbers for the relative volatility of flows. For $\alpha = .4$, developed countries represent 64 percent of the world, whereas this number drops to a more realistic 26 percent when $\alpha = .5$. As Proposition 2 showed, the capital flow volatilities for developed countries are equal and flow shares are 50 percent. Thus, it is not surprising that the worldwide differences come from differences in volatilities across developing countries.

Overall the quantitative results are particularly good for $\alpha = .5$. Recall that I had picked $\alpha = .4$ for the baseline case because it is the US estimate, but $\alpha = .5$ is also admissible given the numbers discussed above for developing countries.

Table 3 also presents serial correlations of flows along the simulated paths for developed and developing countries using the stationary distribution. The model delivers positive serial correlation in flows for developing countries (.362 for FDI and .122 for non-FDI flows when $\alpha = .4$) as well as for developed countries (.406 when $\alpha = .4$ and .357 when $\alpha = .5$ for both FDI and non-FDI flows). The serial correlation for both flows in developed countries is equal because the appropriable and inappropriable technologies are identical and flows are at the optimal levels. For developing countries, the positive correlation is partly built in the model through the serial correlation of shocks and partly derives from the model's internal propagation mechanism. To see this note that with zero serial correlation in aggregate shocks the serial correlation in

flows for developed countries is zero whereas for developing countries is .171 for FDI and .086 for non-FDI (numbers not reported in the table). The internal propagation mechanism relies on risk sharing being provided to the domestic investor. If a high aggregate shock is followed by a lower shock, risk sharing guarantees that domestic output and consumption decline smoothly.

[Table 3 here.]

The result that FDI flows are more strongly serially correlated than non-FDI flows for developing countries corroborates the view that non-FDI flows are more short-term and footloose than FDI flows (i.e., they are more likely to change direction). I discuss some evidence on serial correlation of flows below.

5 Empirical Evidence on FDI and Financing Constraints

In this section I investigate the model's new prediction that FDI should be relatively higher for countries with greater financing constraints. The main dataset is the World Development Indicators from the World Bank (1999b).²⁶ The sample covers virtually every country with a maximum time span from 1975 to 1997. As before, I use only private flows to these countries and measure FDI and non-FDI flows as percentages of gross private capital flows (normalizing by GDP-PPP adjusted gives similar results). I also present some evidence on the serial correlation of flows and relate this to the numbers in Table 3.

5.1 FDI and Financing Constraints

The crudest test that I can make is to identify financing constraints with income per capita. The International Monetary Fund reports that the 1990-98 average FDI shares of private flows to the middle-income countries was roughly 50 percent and to low-income non-oil exporters (mineral producers) 70 percent. These numbers are consistent with Razin et al. (1998) who estimate that the FDI share on private flows to developing countries was about 53 percent during 1990-95.

²⁶The WDI reports FDI inflows from Balance of Payments data. This is subject to two major potential problems: (1) that investments are reported in the wrong category, and (2) that the 10 percent cut-off rule is misleading. The second point is particularly important since this breakdown between FDI and other flows is mostly intended at capturing the existence of a lasting interest in the company, for example, because of the transfer of intangible assets.

The problem is that GDP per capita does not provide a good exogenous measure of financing constraints. To overcome this difficulty I turn to credit ratings for more direct measures of financing constraints. Credit ratings are correlated with measures of financing constraints to the extent that they measure the ability/cost of countries to access international capital markets.

One such measure is Moody’s sovereign credit ratings. Moody’s ratings are classified as {Aaa,Aa,A,Baa,Ba,B,Caa,Ca,C}, from long term sovereign bonds and notes of the highest quality with interest payments “protected by a large or by an exceptionally stable margin and principal is secure” to a class of bonds with “extremely poor prospects of ever attaining any real investment standing” (Moody’s Investors Service 1999). In each category from Aa through Caa Moody’s applies numeric modifiers of {1,2,3} from high rank to low rank, which I aggregate. I ignore the rating on debt placed through off-shore banks.

There are two main advantages of using sovereign credit ratings as a measure of financing constraints. One advantage of Moody’s credit ratings is that these ratings measure only expected credit loss over the life of the security. “They are not intended to measure other risks [...], such as market risk (the risk of loss in the market value of a security)” and “as opinions of long-term credit strength, they are not intended to rise with the business cycle,” (Moody’s Investors Service 1999). Thus, investment risk (which drives FDI) is not the focus of this credit rating variable. This in principle removes any endogeneity problem from this variable. Nevertheless, I recognize that Moody’s sovereign credit rating may be associated with some Macroeconomic factors that affect the desirability of international investors to lend to domestic private and official institutions, which would concurrently influence the capital budgeting decisions of multinational companies.²⁷ A second advantage of using Moody’s ratings is that sovereign risk is arguably the best way to think about default risk in my model. Because in the model default occurs on both flows simultaneously, it is better viewed as caused by the country’s government. In fact, this is the case for most default that occurs through either direct or indirect expropriation (e.g. raising taxes or tariffs and devaluing the domestic currency).

Figure 4 illustrates the unconditional association between (end of the year) Moody’s ratings and FDI flows. In it, I plot the simple average share of FDI inflows on gross private capital flows by credit rating (solid bars). I treat each data point as a country-year observation and aggregate across country-years with identical credit rating.²⁸ The diamonds in the picture give

²⁷For example, restrictions on capital flows may be observed in countries with lower credit ratings and with relatively higher FDI levels. Nevertheless, the effect on the relative volatility of the different flows is not immediately implied.

²⁸China has had the investment grade rating of ‘A’ since Moody’s started rating its sovereign debt. This

the number of observations used to compute each average (right axis). The figure suggests that countries with lower credit ratings have greater inflows of FDI.

[Figure 4 here.]

I now analyze the power of this association in a conditional sense. I also report the same regressions with two other measures of country risk; one by Euromoney and the other by Institutional Investor. In conducting these regressions I condition on a variety of variables that are relevant for explaining FDI and that may be correlated with the measures of financing constraints: country size (log GDP per capita PPP adjusted= lgdpc), trade openness (trade volume as percentage of GDP= open), financial development (liquid liabilities as percentage of GDP= findepth),²⁹ law and order (law), stock market capitalization as percentage of GDP (mktcapg), and the credit rating. Except for credit rating and law and order all variables were obtained from the WDI dataset. The index ‘law’ was obtained from the International Country Risk Guide of the Political Risk Services Group and measures the willingness to accept and implement laws and adjudicate disputes by the citizens of a country (see also La Porta, Lopez-de-Silanes, Shleifer, and Vishny 1998).

From panel A in Table 4, these variables account for a significant portion of the total variation in FDI: 17-23 percent. In fact, the explanatory power comes exclusively from the credit rating variable. The addition of other variables, though statistically significant in some cases, does not contribute to an important increase in the explanatory power of the regression. Also, the effect is economically significant: going from ‘Aaa’ rating to ‘B’ rating increases the share of FDI in gross private flows by 9-14 percentage points. Furthermore, the slopes associated with the credit rating dummy variable display a quasi-monotonic behavior.³⁰ To conclude, I do not claim to explain most of the variation in FDI based on default risk, but I do think that there is a strong negative link between FDI and the quality of sovereign credit (see also Hausmann and Fernández-Arias 2000).

rating has been under review for downgrading to ‘Baa’ during most of this time. Though China seems to have an abnormally high relative level of FDI, excluding it from this picture—and from the empirical analysis altogether—does not affect the qualitative nature of the results.

²⁹The choice of ‘findepth’ as an indicator of financial development follows Beck, Levine and Loayza (1999). When liquid liabilities (or M3) is not available Money and Quasi-money as percentage of GDP (M2) was used (see Beck, Levine and Loayza 1999). An alternative measure of financial depth is the amount of credit to the private sector as a percentage of GDP. Using this variable instead of Liquid Liabilities produced similar results.

³⁰A Wald test of the null hypothesis of equal parameters (on the dummy variables) against the alternative one-sided hypothesis of increasing parameters rejects the null in all four regressions at the 1 percent level.

The negative sign of ‘lgdpc’ confirms my previous unconditional analysis. Lane and Milesi-Ferretti (2001) document a negative conditional correlation between GDP per capita and the *stock* of FDI to total private inflows.

It is interesting to note that the development of financial markets as measured by ‘findepth’, or the stock market capitalization as percentage of GDP, does not eliminate the explanatory power of the measure of credit rating. This is important because it could be argued that credit rating proxies for underdeveloped capital markets: if there is limited scope for diversification by international investors using marketable securities they will supply relatively more FDI.

[Table 4, Panel A here.]

Finally, the measure of law and order is also insignificant and leaves the estimates on the credit rating dummies almost unchanged.

To assess the robustness of the analysis I also conduct the estimations with two broad measures of country risk: one by Euromoney, ‘EM’, and another by Institutional Investor, ‘iinv’. ‘EM’ measures political risk, access to short term financing, the likelihood of debt rescheduling, and economic risk; 100 being the safest and 0 the riskiest. Data for ‘EM’ is available for 1996 and 1997. ‘iinv’ ranking is based on a survey of international bankers, and is designed to capture political, economic, and financial risks, that might lead to credit default; 100 is the least risky and 0 the riskiest. Data for ‘iinv’ is available from September of 1979 through September of 1997 for most countries. (Using the numbers published in March by Institutional Investor results in very similar estimations.)

[Table 4, Panel B here.]

The results are shown in Table 4B. The regressions with ‘EM’ and ‘iinv’ broadly confirm the previous results that country credit ratings are strongly negatively associated with FDI. By construction, these measures of *country risk* are much broader than Moody’s *sovereign default risk* (hence, more subject to endogeneity problems). Even so, they show a very strong correlation; the Spearman correlation coefficient between ‘moody’ and ‘EM’ is .89 (‘moody’ is a variable that takes the value of 6 for a country with ranking Aaa, 5 if its ranking is Aa, and so on), between ‘iinv’ and ‘moody’ is .95, and between ‘iinv’ and ‘EM’ is .97. These facts could

explain why these different ratings show such strong association with FDI, but also why output is no longer statistically significant when I use EM or iinv instead of the dummy variables from Moody's.³¹ Being broader measures of country risk they are also highly correlated with the index 'law' (linear correlations of .73 in absolute value) though not so much with stock market capitalization (linear correlations below .48 in absolute value). When I ignore the measures of country risk and regress the FDI share on gross flows onto income, trade openness, and each of the other variables separately, only 'law' comes significant, but with a positive coefficient. A positive sign on 'law' indicates that this variable could proxy for better property rights protection or commitment technologies.

These measures of country risk rating still reveal an economically significant impact on FDI. For example, going from the best overall rating of 100 to the lowest possible rating increases the FDI share in gross private flows by 10-40 percentage points according to 'EM' and by 10 percentage points according to 'iinv'. The estimated impact of Institutional Investor's country risk rating on the share of FDI is similar to that of Moody's sovereign credit rating.

Finally, in both panels of Table 4, openness of a country does not seem to be important in explaining FDI flows. It is however hard—and is not the purpose of this paper—to say that trade barriers do not explain FDI flows. The only purpose of including this variable is to show that the robustness of the results survives including a measure of trade barriers. In other robustness checks I have also estimated these regressions including time dummies with similar results. Excluding the OPEC countries in the sample also does not affect the results.

5.2 Serial Correlation of FDI and Other Private Capital Flows

The model simulations indicated another property of the optimal contract and the stationary distribution under the baseline parameters. This property referred to a strong positive serial correlation of detrended capital inflows, with FDI's serial correlation being higher than that of non-FDI flows. Using the same annual WDI dataset, I compute the serial correlation of the share of FDI inflows in gross flows as well as the serial correlation of the share of other inflows in gross flows. As before, computing these statistics is legitimate because these measures of flows are stationary. Most countries display a positive serial correlation in both flows. For FDI the average annual serial correlation is .35 with a t-statistic of 10.3, and for non-FDI flows

³¹Note also that (i) the regression of the FDI share on lgdpc produces a slope coefficient of -.028 significant at the 1 percent level, but an R^2 of only .5 percent, and (ii) the correlation coefficient between lgdpc and EM is 0.87, and that between lgdpc and iinv is 0.75.

the average annual serial correlation is .297 with a t-statistic of 7.4. These are large numbers compared to net portfolio equity inflows (a component of non-FDI flows). For example, for developed countries, Albuquerque et al. (2002) report monthly serial correlations below .6 for net portfolio equity inflows originating in US investors (as percentage of foreign market capitalization), and annual serial correlations close to zero.

Recall from Table 3 that the model can match these serial correlations reasonably well. It can also match the fact that the empirical average serial correlation of FDI is higher than that of non-FDI, though it should be noted that a test of equality of means on the average serial correlations using the WDI data cannot be rejected at the usual significance levels.

6 Policy Implications and Final Remarks

The high volatility and low persistence of non-FDI capital flows to developing economies have generally been negatively portrayed in the media. The model developed here suggests that these characteristics simply reflect the optimal responses of international investors to changes in default risk. The model also suggests that the relatively large proportion of FDI in private capital flows to less developed countries reflects their poor financial status rather than any comparative advantage. This does not mean that FDI is bad for these economies, but rather that FDI is all that they can get. From a normative standpoint the model suggests that countries trying to expand their access to international capital markets should concentrate on developing credible enforcement mechanisms for repayment. Clearly, this is not easy to accomplish, but the international finance theory suggests some ways to go about it, such as opening the domestic economy to trade (e.g. Bulow and Rogoff 1989). This would allow credit-constrained economies to attract more of FDI as well as larger short term portfolio equity and bond flows.

There are other dimensions of international capital flows that are worth exploring in the context of models where imperfect enforcement in international contracts plays a central role. One important question regards the maturity of capital flows. Another open question concerns the levels of international capital flows. This last question is particularly important given the recent observed steep trend in FDI flows to developing countries. Models of risk sharing based on imperfect enforcement (e.g. Kehoe and Levine 1993) tend to yield very dramatic quantitative implications for international capital mobility: countries borrow limited amounts as if they were on the verge of opting out and moving into autarky (e.g. Marcet and Marimon 1992, and Kehoe and Perri 2002). This is because, once capital accumulation is allowed in autarky, it

becomes very difficult to sustain borrowing and lending among countries (similarly to Bulow and Rogoff (1989)). In a sense these models provide an answer to Lucas' (1990) question, but an extreme one.³² This paper studies two international financial instruments, differentiated by their risk sharing potential. Assets that are inalienable—and thus useless under autarky—can be used to provide greater insurance and market integration under imperfect enforcement of contracts. Analyzing these issues in the context of general equilibrium models with enforcement constraints is an interesting research avenue.

A Proofs of Propositions

Proof of Proposition 2 . Letting $\psi(s') = 0$ for all s' in equations (7) and (8) we obtain the first order conditions: $E(s'|s) A \alpha_f k_f^{\alpha_f - 1} = 1 + r$, and $E(s'|s) \alpha_o k_o^{\alpha_o - 1} = 1 + r$. The optimal choices (k_f^F, k_o^F) can be easily computed from these conditions. There is no default premium. Note that countries are heterogeneous only through different realizations of the aggregate shock. Using the first order conditions, the ratio of input elasticities to changes in s is:

$$\frac{\frac{dk_f}{ds} \frac{s}{k_f}}{\frac{dk_o}{ds} \frac{s}{k_o}} = \frac{1 - \alpha_o}{1 - \alpha_f}.$$

■

Proof of Proposition 3. Consider the first order conditions (7) and (8) and replace the values of U_{k_f} and U_{k_o} by their expressions to get:

$$\frac{1 + r}{A \alpha_f k_f^{\alpha_f - 1}} = E(s'|s) - \theta \Psi(V, s) \quad (9)$$

$$\frac{1 + r}{\alpha_o k_o^{\alpha_o - 1}} = E(s'|s) - \Psi(V, s) \quad (10)$$

with $\Psi(V, s) = E[\psi(s')|s] d_1 / [(1 + r)(\theta A k_k^{\alpha_f} + k_o^{\alpha_o})] \geq 0$. Since $E[\psi(s')|s]$ is common to both conditions and determines the extent of financing constraints, it must be that either both forms of capital are constrained or none. Finally, if $E[\psi(s')|s] > 0$, so that the domestic consumer is financially constrained, it must be that $\frac{1}{A \alpha_f k_f^{\alpha_f - 1}} > \frac{1}{\alpha_o k_o^{\alpha_o - 1}}$. That is, the default premium of FDI is lower than that of non-FDI. When $A \geq 1$, and $\alpha_f = \alpha_o$, $k_f > k_o$ obtains. ■

³²Lucas (1990) actually argued that political (country) risk is a recent phenomena, and that it could not explain why capital did not flow from rich to poor countries in the colonial times where there was legal enforcement of contracts. In spite of this, I contend that in the last decades large sovereign debt default and renegotiation deals associated with capital expropriations have made investors wary of the lack of international enforcement of contracts. An alternative analysis of heterogeneous international capital goods is done in Hull and Tesar (1999).

Proof of Proposition 5. Consider conditions (9) and (10) in the proof of Proposition 3. Note that with iid shocks the current shock does not affect the value of capital and countries are heterogenous with respect to V only. Clearly, each time the country is unconstrained $\Psi(V) = 0$ and the elasticities of capital inputs to changes in V are zero. When $\Psi(V) > 0$, solving (9) and (10) for $\Psi(V, s)$, it is possible to write k_f as a function of k_o . Differentiating the resulting expression for k_f I get:

$$\frac{\frac{dk_f}{dV} \frac{V}{k_f}}{\frac{dk_o}{dV} \frac{V}{k_o}} = \theta \frac{1 - \alpha_o}{1 - \alpha_f} \frac{A \alpha_f}{\alpha_o} \frac{k_f^{\alpha-1}}{k_o^{\alpha-1}} = \theta \frac{1 - \alpha_o}{1 - \alpha_f} \frac{E(s') - \Psi(V)}{E(s') - \theta \Psi(V)},$$

where I have used (9) and (10) to get to the second equality. When $\alpha_f \leq \alpha_o$ this ratio is less than one if, and only if $\theta < 1$, because the numerator and denominator are both positive. ■

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TABLE 1. BASELINE PARAMETERS.

Parameter	Value	Description
θ	.1	Appropriability parameter
r	.04	Real interest rate
α_f	.4	capital share of FDI activity
α_o	.4	capital share of non-FDI
A	1	Scale parameter of FDI activity
ρ	.95	Auto-correlation of the shock
\bar{s}	1	Unconditional mean of the shock
σ_ε	.007	Unconditional variance of the shock

TABLE 2. SIMULATION RESULTS.

	$\theta = .1$			$\rho = .95$			$A = 1.2$	$\alpha = .5$
	$\rho = .95$	$\rho = .5$	$\rho = .1$	$\theta = .1$	$\theta = .5$	$\theta = .9$		
FDI share ^a	.551	.537	.532	.551	.519	.505	.618	.621
$\sigma(\text{FDI})^b$	.044	.029	.022	.044	.135	.260	.049	.045
$\sigma(\text{non-FDI})^b$	.738	.352	.283	.738	.334	.304	.721	1.32
CV(FDI/GDP) ^c	.124	.070	.060	.124	.058	.146	.081	.235
CV(non-FDI/GDP) ^c	.320	.251	.224	.320	.196	.172	.310	.542

Notes: (a) Percentage of total inflows; (b) Standard deviation of HP-filtered log flows; and (c) coefficient of variation of non-detrended percentage flows.

TABLE 3. RESULTS USING THE STATIONARY DISTRIBUTION.

	% of countries	FDI share ^a	$\sigma(\text{FDI})^b$	$\sigma(\text{non-FDI})^b$	$\rho(k_{ft}, k_{ft-1})^b$	$\rho(k_{ot}, k_{ot-1})^b$
<i>All Countries</i>						
$\alpha = .4$	–	.520	.022	.170	.391	.304
$\alpha = .5$	–	.583	.028	.876	.376	.230
<i>Developed Countries</i>						
$\alpha = .4$	.64	.50	.023	.023	.406	.406
$\alpha = .5$	.26	.50	.011	.011	.357	.357
<i>Developing Countries</i>						
$\alpha = .4$	.36	.556	.019	.432	.362	.122
$\alpha = .5$	.74	.614	.034	1.18	.383	.184

Notes: (a) Percentage of total inflows; and (b) stand. dev. and correlations of HP-filtered log flows. Numbers refer to simulations ran using the baseline parameters.

TABLE 4

A. FDI AND SOVEREIGN CREDIT RATINGS.						
Dependent Variable: Share of FDI Inflows to gross flows.						
	I	II	III	IV	V	VI
lgdpc		-.050***		-.053***	-.070***	-.057**
open			-7e-5	7e-5	1e-4	1e-4
Aa	.044***	.048***	.046***	.046***	.056***	.058***
A	.116***	.088***	.116***	.082***	.081***	.130***
Baa	.147***	.098***	.146***	.096***	.093***	.088***
Ba	.108***	.060**	.106***	.060**	.060*	.063*
B	.147***	.097***	.144***	.098***	.093**	.092**
findpth				1e-4		
law					.007	
mktcapg						2e-4
cons	.075***	.549***	.079***	.568***	.701***	.617***
R^2	.17	.20	.17	.19	.22	.23
N	532	532	532	488	448	364

Notes: Please refer to panel B of Table 4.

TABLE 4

B. FDI AND COUNTRY RISK RATINGS.

Dependent Variable: Share of FDI Inflows to gross flows.

	I	II	III	IV	V	I	II	III	IV	V
lgdpc	.010	.024	.023	-.014	-.041	-.016	-.021	-.022**	-.046**	-.026**
open		-3e-4	-4e-4	-6e-4	-5e-4		3e-4	2e-4*	1e-4	-6e-6
EM	-.004**	-.004***	-.004***	-9e-4	-.001					
iinv						-.001***	-.001**	-.001***	-.001***	-.001
findepth			3e-4					3e-4		
law				-.008					.026**	
mktcapg					3e-4					2e-4
cons	.348	.268	.265	.438*	.620**	.333***	.371**	.357***	.505***	.429***
R^2	.13	.14	.12	.10	.13	.03	.03	.02	.05	.07
N	201	196	185	156	150	1517	1498	1433	1098	594

Notes: OLS estimates. ‘lgdpc’ is the log of GDP per capita PPP adjusted, and ‘open’ is the trade volume as percentage of GDP. EM refers to Euromoney’s country rating. ‘iinv’ is Institutional Investor’s September country credit rating. A high number means a good credit rating. Moody’s credit rating is the end of calendar year rating of debt placed through domestic banks. ‘findepth’ is liquid liabilities (M3) as % of GDP or money and quasi-money as % of GDP when M3 is not available. ‘law’ is the law and order rating in the International Country Risk Guide of the PRS Group. High points means that there is a strong law and order tradition. ‘mktcapg’ is the stock market value as % of GDP. A ‘***’ indicates significance at the 1 percent (two-sided) level, ‘**’ at 5 percent level, and ‘*’ at 1 percent level. ‘ N ’ is the number of country-year observations. White corrected standard errors.

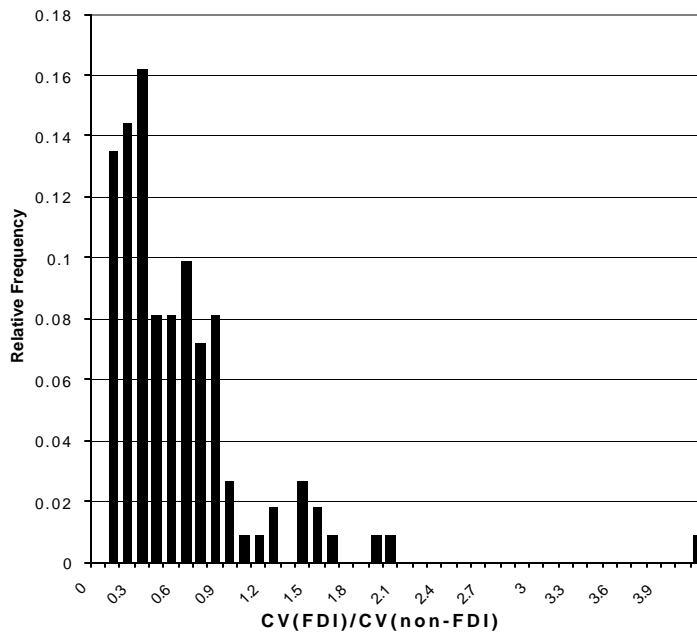


Figure 1: Relative volatility of FDI versus non-FDI flows.

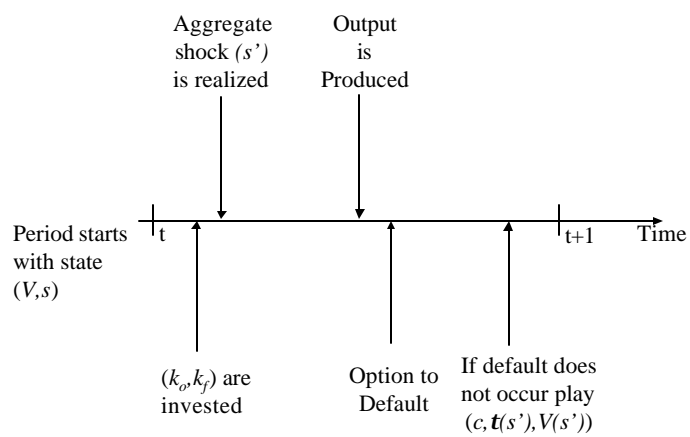


Figure 2: Sequence of events within a period.

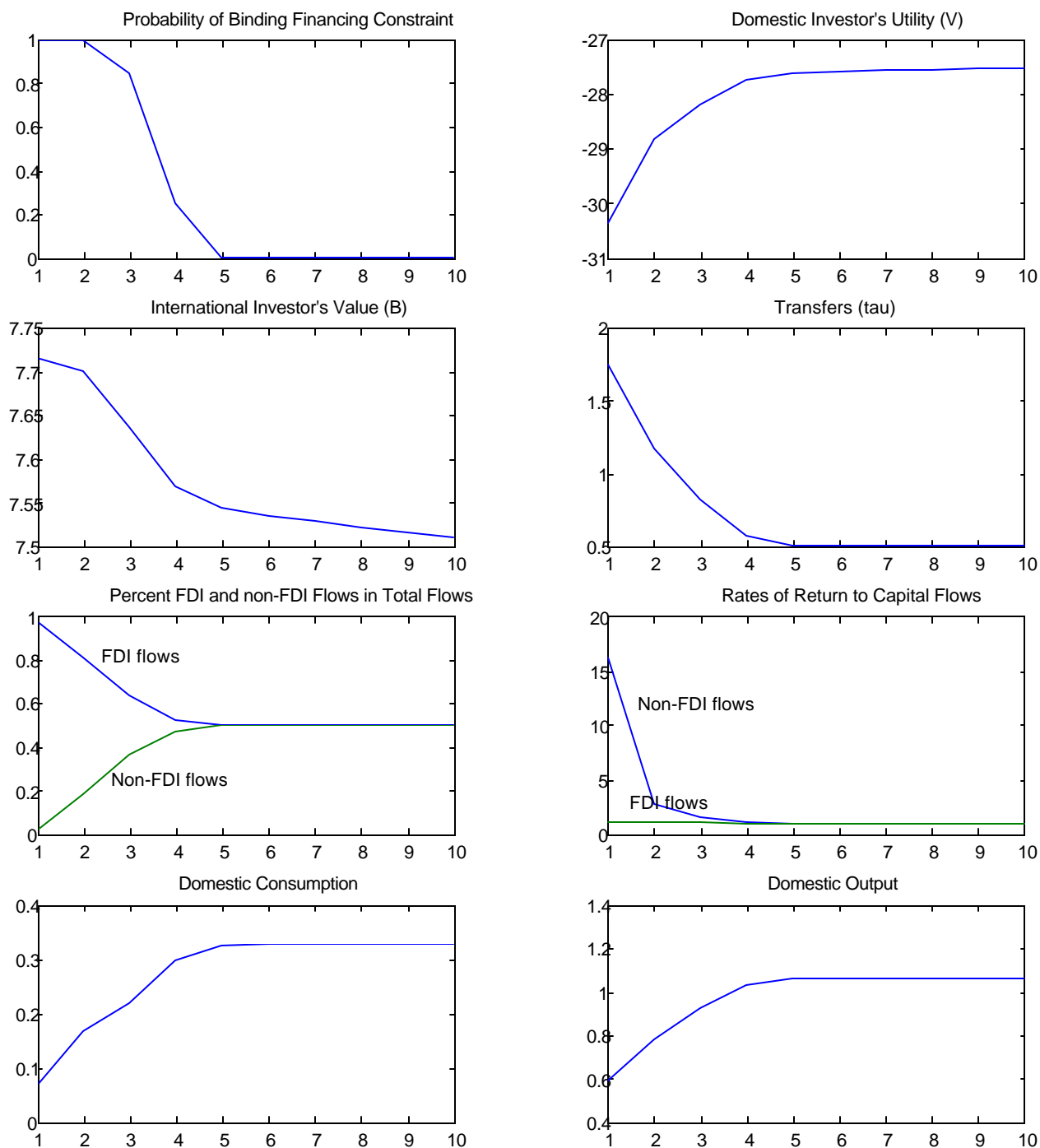


Figure 3: Simulated Path Dynamics of the Optimal Financing Contract.

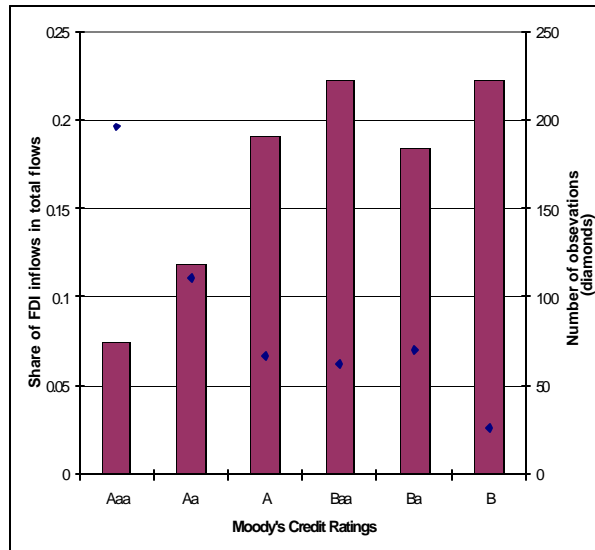


Figure 4: Average share of FDI inflows by Moody's sovereign credit rating. Full sample.