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Abstract

It is often argued that capital should flow from aging industrialized economies to countries with fast-growing populations. However, institutional failures and the risk of expropriation substantially reduce developing economies' attractiveness for foreign investors. We analyze the influence of a country's demographic structure on international investment, using a political-economy model in which population growth potentially affects the risk of expropriation. We first explore how redistributive expropriation affects the welfare of different age groups and derive the government's incentive to expropriate. We then analyze how the relative size of different generations influences the feasible volume of foreign investment.

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1 Introduction

It is often argued that declining birth rates and the resulting increase in capital-labor ratios will eventually cause a sharp drop of the return on capital in industrialized countries. However, the fact that countries differ considerably with respect to their demographic structure and evolution suggests that directing capital flows to economies with higher population growth rates could prevent such a looming "asset price meltdown".[1] As Figure 1 illustrates, the projected evolution of old-age dependency ratios in different world regions seems, indeed, to offer a large potential for demographically induced international investments.[2]

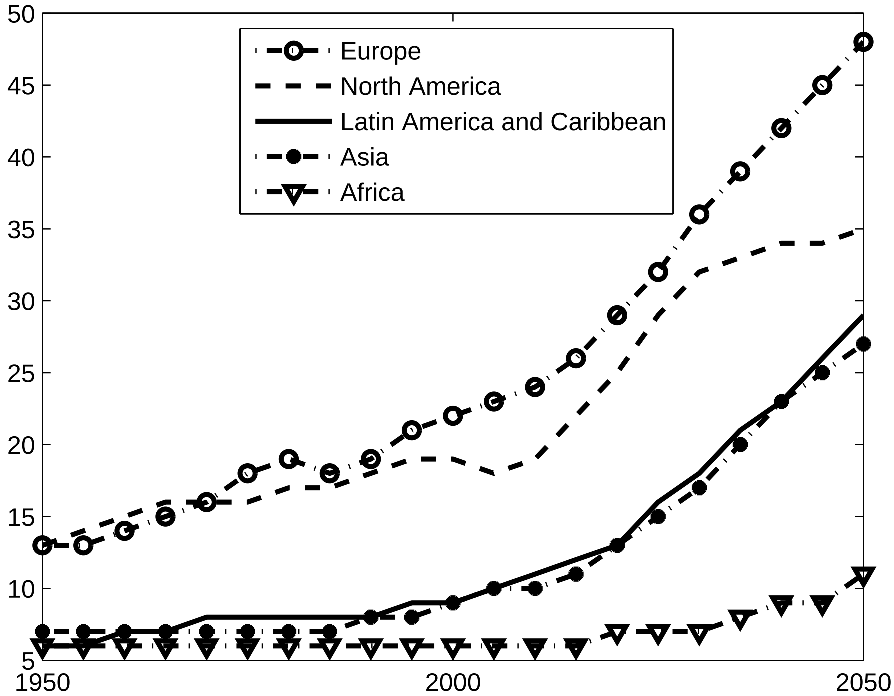

Figure 1: The evolution of old-age dependency ratios in different world regions in percent. Source: United Nations (medium variant)

[1]The "asset meltdown" hypothesis is explored in Poterba (2001), Abel (2001), Bütler and Harms (2001), Geanakoplos et al. (2004). The potential role of international capital flows is discussed in Reisen (2000), Brooks (2003), IMF (2004), Börsch-Supan et al. (2006).

[2]The old-age dependency ratio gives the ratio of persons aged above 64 years to the working-age population (15-64 years).

However, the high degree of capital mobility that is required to exploit this potential is rarely given between industrialized economies and countries with a complementary demographic structure: information asymmetries, corruption, a weak legal system and the risk of – outright or creeping – expropriation are factors which limit the flow of capital from (aging) rich to (younger) poor countries (see Lucas (1990) and Alfaro et al. (2005)). Hence, while high population growth rates could be a driving force for large international capital flows they are correlated with the very institutional failures that deter foreign investors. Does this correlation reflect a *causal* effect or does it merely result from the fact that population growth is related to other factors which are responsible for an uncertain policy environment? To answer this question one needs a deeper understanding of the channels through which population growth affects the security of property rights in developing countries.

In this paper we make a first step in this direction by introducing expropriation risk into an overlapping-generations (OLG) model of a small open economy which captures some salient features of developing countries – namely low levels of total factor productivity, underdeveloped financial markets, and a high population growth rate. We start by identifying population growth as a driver of foreign direct investment (FDI) in a world with secure property rights. We then analyze the behavior of a government which expropriates foreign investors if such a decision maximizes its political support among the generations currently alive. Since, by assumption, foreign firms withdraw their expertise in the wake of expropriation, thus lowering average labor productivity and wages in the host country, a government has to assess the relative strength and political importance of three effects: a positive *transfer effect* which results from redistributing expropriation proceeds among the host-country population, a negative *wage effect* which reflects the fact that the drop in average productivity hurts workers, and a positive *return effect* which stems from the fact that the withdrawal of foreign expertise results in a reallocation of labor which raises the returns of domestic capital owners. Since age cohorts differ both with respect to their factor endowments and with respect to their time horizon these effects possibly give rise to a distributional conflict along demographic lines, with young agents opposing and old agents supporting expropriation.

We use our model to derive the *constrained* volume of FDI which must not be exceeded to prevent the host-country government from expropriating foreign firms. We then show that this *non-expropriation constraint* is binding unless the productivity advantage of foreign firms is very large, and we demonstrate that, in this case, the aggregate capital stock per worker evolves as in a closed economy although the country has removed all formal barriers to international investment. Finally, we show that higher population growth *raises* the volume of foreign investment. Still, the gap between constrained FDI and the level that could be obtained absent the risk of expropriation remains large, especially in the periods immediately following the removal of official investment barriers. Moreover, the positive effect of the population growth rate does not materialize if the political regime is not sufficiently democratic, i.e. if larger cohorts do not have a greater weight in the government's political support function. We conclude that while developing economies are often characterized by an unfavorable investment climate, the high population growth rates observed in these countries mitigate expropriation risk rather than reinforcing it. Hence, the key to enhancing North-South FDI flows lies in strengthening the "wage effect" which positively depends on foreign firms' productivity, and in empowering young workers whose interests are aligned with those of foreign investors.

Our paper is related to the large literature on the risk of default in international lending, as surveyed by Eaton and Fernandez (1995) and Sturzenegger and Zettelmeyer (2006). While our model abstracts from international loans and exclusively focuses on FDI, its logic is also based on the fundamental problem that – absent a supranational enforcement mechanism or some other commitment device – a host country government has an incentive to infringe on the property rights of foreign investors unless the costs of expropriation outweigh the benefits. Cole and English (1991) as well as Thomas and Worrall (1994) explore the risk of expropriation, assuming that the host country government decides to expropriate if the immediate benefits dominate the costs of a future embargo by foreign investors.[3] In this framework, foreign investments must not exceed a critical threshold, which is implicitly defined by the government's indifference between expropriation and non-expropriation. While our model does not rely on an embargo threat to prevent expropriation – and thus avoids the question whether such a threat is actually credible – we adopt the notion that foreign investments are restricted by a *non-expropriation constraint*.[4] As in Harms (2002), we relate the risk of expropriation to an inter-generational distributional conflict and show that, for a given volume of capital inflows, the gains from expropriation are large if the host country's initial income level is low. In contrast to that paper, however, we assume that foreign investors coordinate on the constrained level of investment. Moreover, we analyze how the volume of constrained FDI evolves over time and how it is affected by the population

[3] For a critique of this argument in the context of international borrowing and lending, see Bulow and Rogoff (1989).

[4] Cole and English (1991) also discuss the possibility that the risk of expropriation can be *reduced* by increasing FDI. In that case, larger capital imports make the long-run cost more likely to outweigh the short-run gain of seizing foreign capital.

growth rate.

The rest of this paper is structured as follows: in Section 2, we explore the effect of population growth on capital accumulation both under autarky and after the removal of formal investment barriers. Section 3 introduces the possibility of expropriation, discusses the impact of expropriation on factor prices and the welfare of different generations, and thus describes the fundamental forces that affect the government's decision. Using these insights, we derive and interpret the feasible volume of international investment in different time periods and explore how this volume reacts to changes in the host country's population growth rate. Section 4 summarizes and concludes.

2 The Model

2.1 Model Structure and Assumptions

We consider an economy that is populated by three overlapping generations: children, young workers and old workers. The number of individuals born in period $t-1$ is N_t. The number of children born in period t is N_{t+1}, and the number of old workers in period t is denoted by N_{t-1}. Children are economically passive, but they influence parents' behavior by affecting their utility functions. Specifically, in period t a *typical young worker* maximizes the following utility function:

$$U_t^y = (1 + n_{t+1}) \ln c_t^y + \beta \ln c_{t+1}^o \ . \tag{1}$$

In equation (1), c_t^y represents the agent's young-age consumption, and c_{t+1}^o represents his/her consumption in old age. Young-age utility is weighted by the number of descendants $1 + n_{t+1} \equiv N_{t+1}/N_t$ to account for the fact that parents care about their children's welfare. Throughout this paper, we assume that the population growth rate is constant over time, i.e. $n_t = n \ \forall t$.

Labor supply is assumed to be exogenous and normalized to one unit in both young and old age. The wage paid per unit of labor in period t is denoted by w_t. Hence, labor income at time t is given by w_t for both young and old workers. At time t, a young worker chooses consumption c_t^y and savings s_t subject to the following constraint:[5]

$$c_t^y + s_t = w_t \tag{2}$$

[5]Note that this constraint reflects the assumption that there is no rivalry in consumption between young workers and their descendants.

We assume that there is no formal capital market that allows for borrowing and lending. While this is clearly a restrictive assumption, implying that savings cannot be negative, we believe that it is not completely unrealistic for many developing countries where financial institutions are rudimentary and where a large part of the population saves by accumulating tangible assets.

An agent's savings are costlessly transformed into physical capital which is then used in production during the following period, yielding a capital income. Returns to capital in period $t+1$ are denoted by r_{t+1} and the rate of depreciation is assumed to be one. By assumption, old workers do not care for their grandchildren and do not leave any bequests. Hence, their consumption is constrained by

$$c^o_{t+1} = r_{t+1} s_t + w_{t+1}. \tag{3}$$

The technology of a representative firm whose output we use as the numeraire is

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{4}$$

where labor input is given by

$$L_t = N_t + N_{t-1}.$$

The wage paid for each unit of labor on a competitive labor market in period t is

$$w_t = (1-\alpha) A_t k_t^{\alpha} \tag{5}$$

with k_t as the capital stock per worker, i.e. $k_t \equiv K_t/L_t$. The return to capital is given by the difference between a firm's revenue and its labor costs:

$$r_t = \alpha A_t k_t^{\alpha-1} \ . \tag{6}$$

Throughout the paper total factor productivity A_t is assumed to be constant over time, i.e. $A_t = A \ \forall \ t$.

2.2 Capital Accumulation in a Closed Economy

All agents are assumed to have *perfect foresight*. Given the objective function (1), the constraints (2) and (3), and a constant population growth rate n, optimal savings of a young worker are given by

$$s_t = \frac{1}{1+n+\beta}\left(\beta w_t - (1+n)\frac{w_{t+1}}{r_{t+1}}\right). \tag{7}$$

Note that, in the closed economy, the endogenous evolution of factor prices guarantees that s_t is *non-negative*. Using equations (5), (6) and (7) as well as the fact that $K_{t+1} = N_t s_t$, we can derive the evolution of the capital stock per worker:

$$k_{t+1} = \lambda k_t^{\alpha} \tag{8}$$

with

$$\lambda = \left[\frac{\alpha(1-\alpha)\beta A}{\alpha(2+n)(1+n+\beta)+(1+n)(1-\alpha)}\right].$$

The steady state value of the capital stock per worker is thus given by

$$k = \lambda^{\frac{1}{1-\alpha}}. \tag{9}$$

Apparently, λ (and thus k) is decreasing in n. Hence, *ceteris paribus*, a country with a fast-growing population is characterized by a low per-capita income. This has two reasons: first – as in the neoclassical growth model by Solow (1956) and Swan (1956) – higher population growth lowers the steady-state capital intensity for a given savings rate. In addition, a higher number of children raises young workers' consumption and lowers their savings rate.

2.3 International Investment with Secure Property Rights

We now consider the effects of opening up the country under consideration (the "developing country") to international investment: starting in period t, foreign firms are allowed to set up subsidiaries in the domestic economy and foreign capital starts to operate in the domestic economy in period $t+1$. We continue to assume that there is no borrowing and lending. Hence, all foreign capital flows arrive in the form of *foreign direct investment (FDI)*.

The representative foreign firm's production function is given by

$$Y_t^F = A^F \left(K_t^F\right)^{\alpha} \left(L_t^F\right)^{1-\alpha} \tag{10}$$

with the superscript F denoting "foreign" variables in the host country.

A further – and crucial – assumption is that foreign firms, along with their capital, export their *expertise*, i.e. superior technological and organizational skills which allow them to use a given amount of capital and labour more efficiently. Hence, we assume that $A^F > A^H$ with A^H denoting the total factor productivity of domestic firms[6]. There are various ways to rationalize this assumption: ample empirical evidence documents the vast differences in total factor productivity between industrialized and developing economies. Hall and Jones (1999), for instance, show that total factor productivity (TFP) in the average developing country is about 30 percent of TFP in the United States. While it might be tempting to use this number to quantify the *productivity advantage* of foreign firms, two caveats are in place. First, as shown by Dreher et al. (2007), official GDP figures neglect the shadow economy and may therefore exaggerate productivity differences. Second, it is not plausible that foreign firms' TFP is not affected by host-country conditions. Instead, foreign firms' productivity A^F is likely to be a combination of source-country TFP (A^*) and host-country TFP (A^H), i.e. $A^F = \theta A^* + (1-\theta)A^H$ with $\theta \in [0,1]$ depending on the extent of host-country technology spillovers.[7] Another way to rationalize the productivity advantage of foreign firms is to refer to the literature that explores the impact of foreign takeovers on firms' wages (see, e.g. te Velde and Morrissey (2003), OECD (2008)). While the documented wage jumps of up to 40 percent may be due to a changing skill composition of employees, we interpret the empirical evidence as being supportive to the general idea that foreign investors not only export capital but also expertise. In our framework, this gives rise to a *bi-sectoral* structure in which (low-productivity) domestic firms coexist with (high-productivity) foreign firms.

The international capital market provides foreign investors with a competing investment alternative which offers an exogenous gross return R^*. This implies that, in period $t+j$ with $j \geq 1$ the capital-labor ratio in the foreign sector satisfies

$$\alpha A^F \left(\frac{K^F_{t+j}}{L_{t+j} - L^H_{t+j}} \right)^{\alpha - 1} = R^* \tag{11}$$

where we have already used the fact that the sum of employment in the foreign sector and in the domestic sector has to equal total labor supply, i.e. $L^H_{t+j} + L^F_{t+j} = L_{t+j}$.

[6]In what follows, we will use the superscript H to denote variables that refer to *domestic* firms.

[7]Note that we abstract from the possibility that the presence of foreign firms raises TFP of domestic firms (see, e.g., Haskel et al. (2007) and Bitzer and Kerekes (2008)).

We assume that, once investment has taken place, labor moves freely between the foreign and the domestic sector. As a result, foreign and domestic firms pay the same wage in equilibrium. Using this condition as well as (5) and (10) and solving for L^H_{t+j} yields

$$L^H_{t+j} = \frac{L_{t+j} K^H_{t+j}}{K^H_{t+j} + \Omega K^F_{t+j}} \tag{12}$$

where

$$\Omega \equiv \left(A^F / A^H\right)^{\frac{1}{\alpha}} > 1 \tag{13}$$

reflects the *productivity advantage* of foreign firms. The expression in (12) has a straightforward interpretation: in a bi-sectoral economy, domestic and foreign firms compete for the labor force. In equilibrium, domestic firms attract more workers the higher their capital stock relative to the foreign firms' capital stock (K^H_{t+j}/K^F_{t+j}), and the lower the productivity advantage of foreign firms (Ω). While we postpone the discussion of expropriation risk to the next section, we note that these effects will later be crucial in determining the relative gains and losses from expropriation for different age groups.

Combining (11) and (12) yields the following relationship between the capital stock in the *foreign* sector relative to the economy-wide labor supply ($\bar{k}^F_{t+j} \equiv K^F_{t+j}/L_{t+j}$) and the capital stock in the *domestic* sector relative to the economy-wide labor supply ($\bar{k}^H_{t+j} \equiv K^H_{t+j}/L_{t+j}$):

$$\bar{k}^F_{t+j} = \left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}} - \frac{\bar{k}^H_{t+j}}{\Omega} \tag{14}$$

Equation (14) documents that foreign investment in the economy under consideration is low if international capital markets offer a high interest rate (R^*) and if foreign firms' productivity in the host country (A^F) is low[8]. A high capital stock in the domestic sector (relative to the aggregate labor force) further reduces foreign investment by lowering the effective labor supply available to foreign firms. Conversely, FDI per worker increases in the foreign firms' productivity advantage (Ω). Of course, neither the foreign nor the domestic capital stock can be negative.

Our goal is to derive the time path of $\bar{k}^F_{t+j}$ with $j = 1, 2, ...$ following the elimination of investment barriers in period t. Since – as demonstrated by (14) – foreign investment depends on the capital stock in the domestic sector,

[8]Note that, due to our assumption of a 100 percent depreciation rate, FDI in period $t + j$ coincides with the capital stock in period $t + j + 1$. We will therefore use the two terms interchangeably.

we start by considering domestic saving behavior and capital accumulation in the open economy. Using the relationship $K^H_{t+j+1} = N_{t+j}s_{t+j}$, the savings function in (7), the equilibrium factor rewards from (5) and (6) as well as (12), we can derive

$$\bar{k}^H_{t+j+1} = \frac{\alpha\beta A^H}{1+n} \cdot \frac{\Lambda\left(1+\Omega b_{t+j}\right)^\alpha}{1+\Lambda\left(1+\Omega b_{t+j+1}\right)} \cdot \left(\bar{k}^H_{t+j}\right)^\alpha \tag{15}$$

with

$$\Lambda \equiv \frac{(1-\alpha)(1+n)}{(2+n)\alpha(1+n+\beta)} \tag{16}$$

and where we have defined

$$b_{t+j} \equiv \frac{K^F_{t+j}}{K^H_{t+j}} = \frac{\bar{k}^F_{t+j}}{\bar{k}^H_{t+j}} \tag{17}$$

as the capital stock in the foreign sector relative to the capital stock in the domestic sector. Note that (15) is identical to (8) – the law of motion for capital in the closed-economy – if $b_{t+j} = b_{t+j+1} = 0$. Moreover, $b_t = 0$, i.e. the domestic economy is in autarky through period t, and $b_{t+j} \geq 0$ for $j \geq 1$. We thus have to distinguish between the period that immediately follows the elimination of investment barriers ($t+1$) and subsequent periods ($t+j+1$ with $j \geq 1$). In addition, we have to take into account that neither $\bar{k}^F_{t+j}$ nor $\bar{k}^H_{t+j}$ must be negative. The following Lemma summarizes the behavior of FDI per worker in the short and in the long run:

Lemma 1: Absent the risk of expropriation the time path of FDI per worker is given by the following expressions:

I) Short run (period $t+1$):

i) If $(1+\Lambda)\left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}} < \frac{\alpha\beta A^H\Lambda}{(1+n)\Omega}(\lambda)^{\frac{\alpha}{1-\alpha}}$ then $\bar{k}^F_{t+1} = 0$.

ii) If $\frac{1+\Lambda}{\Lambda} > \left(\frac{R^*}{\alpha A^F}\right)^{\frac{1}{1-\alpha}} \frac{\alpha\beta A^H}{(1+n)\Omega}(\lambda)^{\frac{\alpha}{1-\alpha}} > 1$

then $\bar{k}^F_{t+1} = (1+\Lambda)\left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}} - \frac{\alpha\beta A^H\Lambda}{(1+n)\Omega}(\lambda)^{\frac{\alpha}{1-\alpha}}$.

iii) If $\frac{\alpha\beta A^H}{1+n}(\lambda)^{\frac{\alpha}{1-\alpha}} < \Omega\left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}}$ then $\bar{k}^F_{t+1} = \left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}}$.

II) Long run (periods $t+2, t+3, ...$):

i) If $\frac{1+\Lambda}{\Lambda} < \frac{\beta R^*}{(1+n)\Omega}$ then $\bar{k}^F_{t+j} = 0$ for $j = 2, 3, ...$

ii) If $\frac{1+\Lambda}{\Lambda} > \frac{\beta R^*}{(1+n)\Omega} > 1$ then $\bar{k}^F_{t+j} = \left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}} \left[1 + \Lambda\left(1 - \frac{\beta R^*}{(1+n)\Omega}\right)\right]$ for $j = 2, 3, ...$

iii) If $\frac{\beta R^*}{(1+n)\Omega} \leq 1$ then $\bar{k}^F_{t+j} = \left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}}$ for $j = 2, 3, ...$

Proof: See the Appendix.

Among the results stated by Lemma 1 the most important one is that $\bar{k}^F_{t+j}$ reaches a constant (steady-state) level in period $t+2$. This is due to the essentially stationary nature of the model: with a constant population growth rate in the host country and a constant world interest rate (R^*), there is no reason why FDI per worker should vary over time after the adjustment period $t+1$. Whether steady-state FDI takes place *at all* depends on the world interest rate (R^*) and the productivity advantage of foreign firms (Ω). If R^*/Ω is very high, foreigners do not find it advantageous to invest in the domestic economy. Conversely, if this ratio is very low – indicating that the domestic economy offers high returns relative to world capital markets – FDI may become so large that domestic residents decide not to save at all. In this case, they rely on their old-age wage income and the domestic sector essentially disappears. If R^*/Ω takes on an intermediate value, foreign and domestic firms coexist in the steady state. The same mechanisms work for period $t+1$. Whether FDI is zero or strictly positive in that period crucially hinges on the capital-labor ratio in the autarky steady state as defined by (9): with a high value of λ, wages are high under autarky, domestic savings are high, and after the removal of investment barriers foreign firms have to compete with a large domestic sector. By contrast, the domestic sector is small in case of a low λ and the economy is attractive for foreign investors.

While we have focused on the evolution of FDI *per worker* so far, a more informative measure of capital inflows is FDI *relative to GDP*. We can compute total GDP by adding the outputs of both sectors. Using the production functions (4) and (10) this yields:

$$Y_{t+j} = A^H \left(K^H_{t+j}\right)^\alpha \left(L^H_{t+j}\right)^{1-\alpha} + A^F \left(K^F_{t+j}\right)^\alpha \left(L_{t+j} - L^H_{t+j}\right)^{1-\alpha}. \tag{18}$$

Defining GDP per worker as $\bar{y}_{t+j} \equiv Y_{t+j}/L_{t+j}$ and using equations (12), (13), (14) and (17) we can show that , for $j \geq 1$, $\bar{y}_{t+j}$ is constant, i.e.

$$\bar{y}_{t+j} = A^F \left(\frac{\alpha A^F}{R^*} \right)^{\frac{\alpha}{1-\alpha}}. \tag{19}$$

It thus follows from equation (14) and (19) that FDI relative to GDP is given by

$$\frac{\bar{k}^F_{t+j}}{\bar{y}_{t+j}} = \frac{\alpha}{R^*} - \frac{1}{\Omega A^F \left(\frac{\alpha A^F}{R^*} \right)^{\frac{\alpha}{1-\alpha}}} \bar{k}^H_{t+j}. \tag{20}$$

Lemma 2 describes how the population growth rate n affects FDI – both per worker and relative to GDP – in the short run and in the long run:

Lemma 2: In all periods $t+j$ with $j \geq 1$, the level of FDI per worker and relative to GDP is *non-decreasing* in the population growth rate n.
Proof: See the Appendix.

The proof of Lemma 2 is based on (14) and (20) which state that FDI per worker and relative to GDP decreases in the domestic capital stock. As in autarky, the latter *decreases* in n – both due to the effect of population growth on the savings rate and due to the fact that, with a higher value of n, a given capital stock is used by an ever increasing labor force. If domestic agents completely abstain from saving the entire capital stock is provided by foreign firms and its volume per worker and relative to domestic GDP is unaffected by n.

3 Modeling Expropriation Risk

3.1 The Costs of Expropriation

We now capture the observation that insecure property rights are a major impediment to foreign investments in developing countries by introducing the possibility of expropriation into our model. Expropriation is discriminatory – i.e. it targets foreign investors but leaves domestically-owned capital untouched – and it is initiated by a government that seeks to maximize its political support among domestic workers. Moreover, we assume that expropriation is always complete – i.e. we exclude the possibility of a *partial* expropriation – and that the capital returns of foreign firms are evenly distributed among the host country's labour force.[9]

[9]Note that, due to our assumption of a 100-percent rate of depreciation, there is no capital *stock* to be redistributed.

Obviously, if expropriation were costless, the government would be subject to the well-known time-inconsistency problem: the promise not to harass foreign firms would not be credible since there is a large temptation to expropriate these firms once their capital is installed. As a consequence, foreigners would refrain from investing in the host country. The literature has come up with various approaches to explain why international investments take place despite these obvious risks: it has been argued that host country governments refrain from expropriation for fear of not attracting further investments in the future (see Cole and English (1991)) or because 'direct sanctions' reduce the net benefits of expropriation. In this paper, we follow the approach of Eaton and Gersovitz (1984) and argue that, in case of expropriation, foreign investors withdraw their *expertise*. As a result, TFP in the foreign sector drops from A^F to A^H. We believe that this is a highly plausible assumption: foreign managers are unlikely to further operate firms whose profits entirely accrue to the host-country population. Moreover, by making this assumption, we do not have to worry about the credibility issues that come along with alternative sanctions suggested by the literature. In particular, we do not have to claim that, after expropriation, foreign firms shun the host country for a potentially infinite time span.

To identify the costs and benefits of expropriation for the host-country population, we have to be precise on the sequence of events: most importantly, we assume that workers decide to work in the domestic or the foreign sector *after* the expropriation decision but *before* production and consumption take place. The fact that the productivity level in the foreign sector decreases in case of expropriation has important consequences for wages and capital returns: it directly follows from equation (12) that, in case of expropriation, a higher portion of the labor force is available for the domestic sector and that the economy-wide wage level drops.

We can thus decompose the aggregate benefits and costs of expropriation into three effects: most directly, all domestic citizens benefit from a strictly positive *transfer effect* since by the end of the period, capital returns in the foreign sector are evenly distributed among the two active generations currently alive. By contrast, old and young workers are hurt by a negative *wage effect* which is due to the lower productivity in the foreign sector and the resulting decline in wages. Finally, capital-owners benefit from a positive *return effect*: the larger labor supply in the domestic sector lowers wage costs and boosts profits of domestic firms. The fact that only old workers possess capital while young workers exclusively rely on their labor income relates the resulting distributional interests to the host country's demographic structure.

3.2 The Government's Expropriation Decision

In this subsection, we model the government's expropriation decision in period $t+j$ with $j \geq 1$ as a choice of the variable ξ_{t+j} with

$$\xi_{t+j} = \begin{cases} 0 & \text{if no expropriation occurs in period } t+j \\ 1 & \text{if expropriation occurs in period } t+j \end{cases} \tag{21}$$

The government's goal is to maximize its political support among the host-country's working population. Political support in period $t+j$ is denoted by W_{t+j} and given by the weighted sum of domestic workers' utilities, i.e.

$$W_{t+j}(\xi_{t+j}) = (N_{t+j-1})^{\rho} \left[\ln c^{o}_{t+j}(\xi_{t+j})\right] + (N_{t+j})^{\rho}\, U^{y}_{t+j}(\xi_{t+j}). \tag{22}$$

where U^{y}_{t+j} is defined by equation (1). The parameter ρ captures the notion that "political impact" may be a non-linear function of group-size: if, for example, $0 < \rho < 1$, raising the size of a generation increases its weight in the government's objective function, but at a decreasing rate. Conversely, if $\rho = 0$, group size is irrelevant for a generation's weight. We interpret a lower volume of ρ as an indicator of a "'less democratic"' political system.

Expropriation takes place in period $t+j$ if $W_{t+j}(1) > W_{t+j}(0)$. Whether this condition is satisfied depends on how expropriation affects old workers' consumption and young workers' lifetime utility. Denoting the per-capita transfer resulting from expropriation in period $t+j$ by Φ_{t+j} with $j = 1, 2, ...$ and wages and domestic-sector returns to capital by w_{t+j} and r^{H}_{t+j} respectively, we can use equations (2), (3), (7) and the fact that Φ_{t+j} adds to both generations' current incomes to derive

$$c^{o}_{t+j} = \frac{\beta}{1+n+\beta} \left\{ r^{H}_{t+j} w_{t+j-1} + w_{t+j} + \xi_{t+j}\Phi_{t+j} \right\} \tag{23}$$

$$c^{y}_{t+j} = \frac{1+n}{1+n+\beta} \left\{ w_{t+j} + \xi_{t+j}\Phi_{t+j} + \frac{w_{t+j+1} + \xi_{t+j+1}\Phi_{t+j+1}}{r^{H}_{t+j+1}} \right\} \tag{24}$$

$$c^{o}_{t+j+1} = \frac{\beta}{1+n+\beta} \left\{ r^{H}_{t+j+1} \left[w_{t+j} + \xi_{t+j}\Phi_{t+j} \right] + w_{t+j+1} + \xi_{t+j+1}\Phi_{t+j+1} \right\}. \tag{25}$$

Note that wages and capital returns in period $t+j$ not only depend on the domestic capital stock K^{H}_{t+j} and the volume of foreign investment

K^F_{t+j}, but also on the total factor productivity in the foreign sector A^F. The latter equals the domestic sector's productivity level A^H if $\xi_{t+j} = 1$ and $\theta A^* + (1-\theta)A^H$ if $\xi_{t+j} = 0$. Finally, the per-capita transfer in period $t+j$ is given by

$$\Phi_{t+j} = \frac{K^F_{t+j} r^{F,E}_{t+j}}{N_{t+j-1} + N_{t+j}} \tag{26}$$

where $r^{F,E}_{t+j}$ denotes the return to capital in the foreign sector in case of expropriation.

3.3 Foreign Investment and the Incentive to Expropriate

As stated above, expropriation takes place in period $t+j$ if the difference $\Delta W_{t+j} \equiv W_{t+j}(1) - W_{t+j}(0)$ is strictly positive. We define a *non-expropriation equilibrium* as an equilibrium in which the government has no incentive to expropriate given that agents expect it not to expropriate in the future, and we derive the *constrained* volume of FDI relative to the domestic labor force ($\bar{k}^{F,c}_{t+j}$) that supports such an equilibrium.

In what follows, the ratio $b_{t+j} = \bar{k}^F_{t+j}/\bar{k}^H_{t+j}$ – i.e. the ratio of the capital stock in the foreign sector relative to the capital stock in the domestic sector at time $t+j$ – will play an important role. To illustrate why, we show how it enters the wage effect, the return effect and the relative transfer effect of expropriation. Using (12) and (5) it is easy to derive the wage in case of expropriation (w^E_{t+j}) relative to the wage in case of non-expropriation (w^N_{t+j}):

$$\frac{w^E_{t+j}}{w^N_{t+j}} = \left(\frac{1+b_{t+j}}{1+\Omega b_{t+j}}\right)^{\alpha} \tag{27}$$

This expression is smaller than one and *decreases* in b_{t+j} since $\Omega > 1$. Hence, workers suffer from a declining wage in case of expropriation. The damage done is especially big if there is a strong presence of foreign firms and if these firms' productivity advantage is high. Conversely, using (12) and (6), we can show that capital returns in the domestic sector in case of expropriation ($r^{H,E}_{t+j}$) relative to non-expropriation ($r^{H,N}_{t+j}$) are given by

$$\frac{r^{H,E}_{t+j}}{r^{H,N}_{t+j}} = \left(\frac{1+\Omega b_{t+j}}{1+b_{t+j}}\right)^{1-\alpha}. \tag{28}$$

This expression is greater than one and *increases* in b_{t+j}: capital owners benefit from expropriation since labor flows back into the domestic sector.

The resulting increase in returns is the stronger the higher the relative capital stock of foreign firms and the higher these firms' productivity advantage.

Finally, using (5), (6), (26) and (27) and the fact that $r_{t+j}^{F,E}$ equals $r_{t+j}^{H,E}$ as the productivity advantage vanishes in case of expropriation the wage-cum-transfer in case of expropriation relative to the wage without expropriation is given by:

$$\frac{w_{t+j}^{E}+\Phi_{t+j}}{w_{t+j}^{N}}=\left[1+\frac{\alpha b_{t+j}}{(1-\alpha)(1+b_{t+j})}\right]\left(\frac{1+b_{t+j}}{1+\Omega b_{t+j}}\right)^{\alpha}, \qquad (29)$$

which also depends on b_{t+j} although the reaction of this term to changes in the relative capital stock is ambiguous.

Equations (27) to (29) illustrate that, in every period, the effects which determine agents' attitudes towards expropriation crucially hinge on the relative capital stock in the foreign sector b_{t+j}. Note however, that it follows from (23), (24) and (25) that both old workers' old-age utility ($\ln(c_{t+j}^{o})$) and young workers' lifetime utility ($U_{t+j}^{y}=(1+n)\ln(c_{t+j}^{y})+\beta\ln(c_{t+j+1}^{o})$) are not only affected by period-$t+j$ variables, but also depend on the past and expected future time path of capital stocks and expropriation decisions. Nevertheless, we can show that the host country government's incentive to deviate from the non-expropriation equilibrium at a given point in time (ΔW_{t+j}) is a function of b_{t+j} alone. This is stated in the following Lemma:

Lemma 3: In period $t+j$ with $j=1,2,...$, the government's incentive to deviate from a *non-expropriation equilibrium* only depends on $b_{t+j}\equiv\bar{k}_{t+j}^{F}/\bar{k}_{t+j}^{H}$, i.e. the relationship between the capital stock in the foreign sector and the capital stock in the domestic sector.

Proof: See the appendix.

The intuition behind this result runs as follows: in a non-expropriation equilibrium, agents expect the government not to expropriate in period $t+j+1$ even if expropriation has taken place in period $t+j$. As a consequence, the returns on savings are not affected by today's expropriation decision, and agents save a given share of their period-$t+j$ income, possibly including the proceeds from expropriation. Expropriation thus acts like a – potentially negative – transfer which is spread over two periods and whose size depends on b_{t+j}.

The result stated in Lemma 3 considerably simplifies the analysis since it allows us to focus on ΔW_{t+j} as a function of a single variable b_{t+j}. To sustain a non-expropriation equilibrium in period $t+j$, $\Delta W_{t+j}\leq 0$ has to hold. This allows for several possibilities: ΔW_{t+j} may be negative for *any* value of b_{t+j}.

In this case, the *non-expropriation constraint* is not binding and the economy behaves as described in Section 2.3. Conversely, ΔW_{t+j} may be positive for all positive values of b_{t+j}. In this case, no FDI takes place in equilibrium since the only value of b_{t+j} that supports a non-expropriation equilibrium is zero. Finally, the sign of ΔW_{t+j} may change as b_{t+j} increases. If ΔW_{t+j} is negative for low values of b_{t+j} and positive for higher values, there is a strictly positive value $\tilde{b}$ which must not be exceeded to support a non-expropriation equilibrium. Before establishing conditions under which the latter scenario emerges we make the following assumption:

Assumption 1: $\left(\frac{1}{1+n}\right)^{\rho} < (1 + n + \alpha\beta)\,\frac{\alpha}{1-\alpha}$

This assumption defines an upper boundary on old workers' relative weight in the government's objective function. The boundary decreases in the population growth rate and in the parameter ρ which determines whether the function relating group size to political influence is convex ($\rho > 1$) or concave ($\rho < 1$). The first term on the right hand side magnifies the impact of young workers' utility losses from expropriation, i.e. if workers oppose expropriation the strength of this effect increases in $(1 + n + \alpha\beta)$. Finally, the ratio $\alpha/(1 - \alpha)$ determines the relative strength of the wage and return effects as given by (27) and (28).

Lemma 4: If Assumption 1 is satisfied there exist strictly positive values Ω' and Ω'' such that the volume of FDI which sustains a non-expropriation equilibrium is

i) zero if $\Omega \leq \Omega'$
ii) a finite multiple $\widetilde{b}$ of the domestic capital stock if $\Omega' < \Omega < \Omega''$.

If $\Omega \geq \Omega''$ the non-expropriation constraint is not binding and FDI evolves as described in Lemma 1.
Proof: See the appendix.

The logic behind Lemma 4 is simple: The productivity advantage Ω determines by how much wages drop and returns to capital increase in case of expropriation. A higher value of this parameter thus raises both the costs and the benefits of expropriation. Assumption 1 guarantees that the cost aspect of increasing Ω dominates for the government's decision. If Ω is very large, the workers' income losses are high enough to prevent the host country government from expropriation for *any* positive value of b_{t+j}. Conversely, if the drop in productivity due to the withdrawal of foreign expertise is rather low (i.e. Ω is close to one) the temptation to expropriate dominates for any positive value of b_{t+j}, and there is no FDI in equilibrium. Finally, if Ω takes on an intermediate value, ΔW_{t+j} is first negative then positive and equals zero for $b_{t+j} = \widetilde{b}$. In this case, the host country government refrains from expropriating foreign firms as long as the capital stock in the foreign sector relative to the capital stock in the domestic sector does not exceed a critical threshold $\widetilde{b}$. Note, finally, that foreign firms' productivity advantage can be written as $\Omega \equiv [1+\theta(A^*/A^H-1)]^{1/\alpha}$: it depends on country-specific TFP levels (A^*, A^H) but also on the extent of negative productivity spillovers $(1-\theta)$. Hence, Ω may be low either because productivity differences between source and host countries are small, or because the host country's lower TFP drags down the productivity of foreign firms.

3.4 The Evolution of Foreign Investment with Endogenous Expropriation

In what follows we focus on the (interesting) case that $\widetilde{b}$ is strictly positive and finite – i.e. case **ii)** of Lemma 4 – and assume that $b_{t+j} = \widetilde{b}$ for $j \geq 1$. Hence, foreign investors exploit the potential for international investment, but coordinate on not trespassing the critical boundary $\widetilde{b}$. The following Lemma describes how $(\bar{k}^{F,c}_{t+j}/\bar{y}_{t+j})$ evolves after period t:

Lemma 5: After the elimination of barriers to foreign investment in period t, the constrained capital stock in the foreign sector relative to the host country GDP $(\bar{k}^{F,c}_{t+j}/\bar{y}_{t+j})$ evolves according to the following stable difference equation:

$$\frac{\bar{k}^{F,c}_{t+j+1}}{\bar{y}_{t+j+1}} = \left[\frac{\frac{\alpha}{1+n}\beta\Lambda\tilde{b}}{1+\Lambda\left(1+\Omega\tilde{b}\right)}\right]^{1-\alpha} \cdot \left(\frac{\bar{k}^{F,c}_{t+j}}{\bar{y}_{t+j}}\right)^{\alpha}$$

Hence, $\bar{k}^{F,c}_{t+j}/\bar{y}_{t+j}$ increases over time and converges to a constant level $\bar{k}^{F,c}/\bar{y}$.
Proof: See the appendix

Lemma 5 suggests that, if the non-expropriation constraint is binding, the time path of the economy-wide capital stock resembles the evolution of the capital stock under autarky: instead of reaching the steady state after a brief adjustment period – as described in section 2.3 – the volume of FDI gradually increases over time, mirroring the evolution of the capital stock in the domestic sector. The reason is that expropriation takes place if $b_{t+j} > \widetilde{b}$. Rational investors therefore avoid an excessively rapid growth of the capital stock in the foreign sector, adjusting their investment to the development of the domestic sector. While the latter increases over time due to the gradual inflow of foreign capital and the associated rise of wages and savings, growth is much slower than in the case of secure property rights. Moreover, FDI relative to GDP eventually converges to a level which is smaller than what would be obtained absent the risk of expropriation. This evolution is reminiscent of the result in Barro et al. (1995) who demonstrate that, in the presence of credit constraints, capital accumulation in an economy that is de-jure open to international capital flows resembles the dynamics of the closed-economy neoclassical growth model. In their model, however, the incentive to expropriate is taken as exogenous and a borrowing constraint results from the inability to use human capital as collateral. In our setting, by contrast, international investment is constrained by the government's *endogenous* incentive to expropriate foreign firms.

To conclude this subsection, we compute the evolution of FDI relative to GDP for the parameter values presented in Table 1:

Parameter	Parameter value	Source
α	0.4	Gollin (2002)
n	0.25	United Nations Population Division (2006)
β	0.8	Derived from setting $R^* = 1.06$ per annum
A^H/A^F	0.4	Various sources (see text)
ρ	1	Assumption

Table 1: Benchmark parameter values

Most of these values are fairly standard. Setting α equal to 0.4 is consistent with the results of Gollin (2002) who computes labor shares for a large number of industrialized and developing economies. The population growth rate is taken from the United Nations World Population Prospects (United Nations Population Division (2006)): specifically, we compute $1 + n$ by dividing the number of children per woman by two. For the years $1990 - 2050$, n roughly equals 0.25 for the set of "less developed regions". The value of β is backed out by using (6), by computing the steady-state capital-labor ratio that is compatible with an annual return of 6 percent in industrialized countries, and by setting $A = 1$ and $n = 0.1$ when computing λ in (9). Based on the reasoning in section 2.3 we chose the ratio $\left(A^F/A^H\right)$ to equal 2.5 – i.e. effective total factor in foreign firms is two and a half times as large as in domestic firms. This number is clearly smaller than the TFP differences at the national level that are reported by Hall and Jones (1999). Conversely, it surpasses the wage increases that are reported as a result of foreign takeovers.

Given the uncertainty about the exact size of the foreign productivity advantage, we believe that our choice is an acceptable compromise. Finally, we set ρ equal to one in the benchmark parameterization, thus assuming that political influence is a linear function of group size.

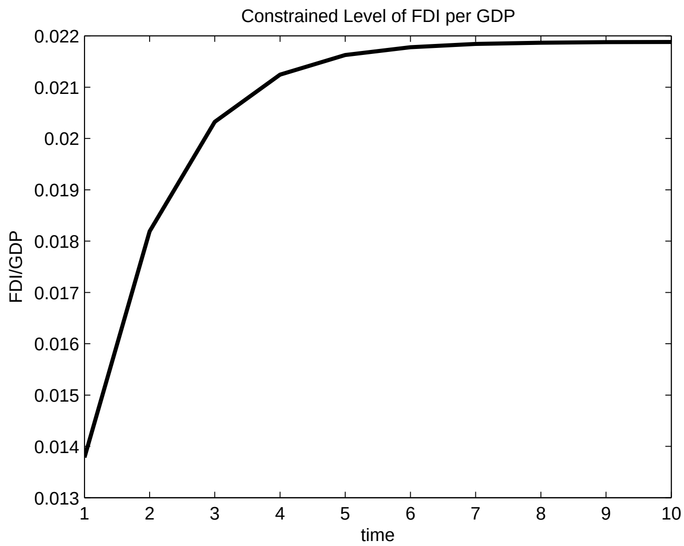

Figure 2: The constrained level of FDI relative to the host country's GDP

Figure 2 describes the constrained level of FDI relative to the host country's GDP for this choice of parameter values and illustrates the result stated in Lemma 5: given the risk of expropriation, the FDI/GDP ratio does not reach its steady state in period 2 but gradually converges to a steady state level which is slightly above 2 percent of GDP. This value is much lower than what would be realized in a world with secure property rights. It is, however, not too different from FDI flows (relative to GDP) that the average low-income country attracted in the recent past.[10]

Figure 3 illustrates the effect of a variation of ρ on the constrained level of FDI relative to GDP. A lower value of ρ raises the old generation's relative weight in the government's objective function. As the old generation prefers expropriation for any value of $\widetilde{b}$ it is not surprising that the government's incentive to expropriate increases as ρ decreases and that the host country receives a smaller volume of FDI relative to its GDP.

[10] Worldbank (2008) documents that, while FDI in low-income countries has picked up recently, the cross-country average of FDI net inflows relative to GDP between 1991 and 2006 was 1.97 percent.

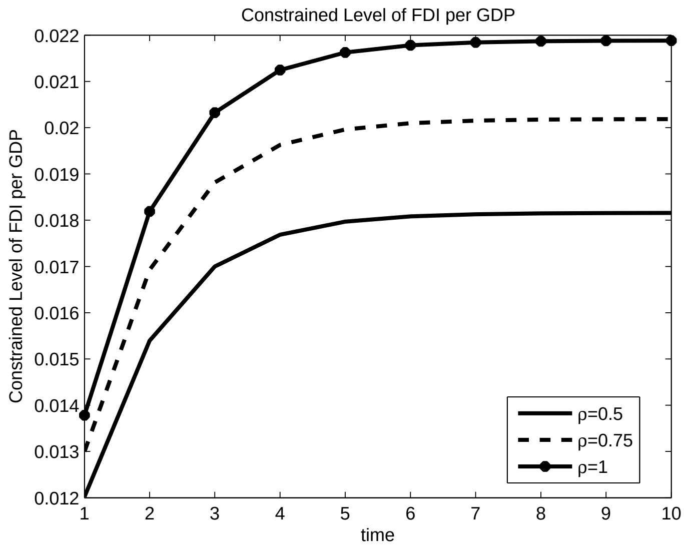

Figure 3: The effect of ρ on the constrained level of FDI relative to GDP

3.5 Population Growth and the Risk of Expropriation

In the preceding section we have identified the *constrained* level of foreign investment per worker ($\bar{k}^{F,c}_{t+j}$) as the volume of FDI that keeps the host-country government indifferent between expropriation and non-expropriation. How does the host country's population growth rate influence $\bar{k}^{F,c}_{t+j}$? We have shown that a higher value of n spurs foreign capital inflows if we abstract from expropriation risk since high population growth both reduces the host country's initial capital-labor ratio and raises the future supply of labor. Once we explicitly account for the possibility of redistributive expropriation, the role of n becomes more complex: on the one hand, we have to take into account that a high population growth rate slows down domestic capital accumulation. The lower domestic capital stock potentially reinforces the positive transfer and return effects and dampens the wage effect, thus making expropriation more attractive for the government. If this "*poverty effect*" dominated the government's decision a higher population growth rate would reduce the constrained volume of FDI. On the other hand, raising n increases the weight of the young generation in the government's objective function and thus raises the political costs of expropriation if $\rho > 0$. There is thus a "*political weight effect*" through which higher population growth strengthens the position of those who oppose expropriation. Finally, there is a simple "*dilution effect*" through which higher population growth reduces the per-capita transfer and thus reduces the attractiveness of expropriation.

The multi-faceted role of n makes it impossible to derive general results on how varying the population growth rate affects the time path of foreign investment. We therefore proceed by computing the constrained volume of FDI relative to GDP for different levels of n, using the parameter values specified in Table 1. Figure 4 describes the evolution of $\bar{k}^{F,c}_{t+j}/\bar{y}_{t+j}$ for n = 0.2, 0.25 and 0.3. The shift of the curve indicates that FDI relative to GDP *increases* in the population growth rate. Note, however, that this effect only materializes in the *long run* while the impact of varying n on FDI in the first periods after the elimination of investment barriers is close to zero. Apparently, the "poverty effect", the "political weight effect", and the "dilution effect" of a higher population growth rate offset each other in period $t+1$. This is intuitive: countries with a fast-growing population accumulate little capital in autarky, and they enter the post-liberalization period with a very small per-capita income. As a result, the constrained volume of FDI is small even if young workers have a strong influence on the government's decision. In the medium and long run, however, the presence of foreign capital and expertise results in higher wages, incomes and savings, and domestic capital accumulation picks up. The "poverty effect" gradually becomes less important as wages and incomes increase, and the "political weight effect" of raising n eventually dominates. Note, however, that for this development to materialize we need ρ to be sufficiently high: if a larger group size does not translate into greater political influence the "political weight effect" is suppressed by definition. In this case, *no* FDI takes place in equilibrium, regardless of the population growth rate.

In the preceding paragraphs we have focused on the level and evolution of constrained FDI relative to GDP and found that an increasing population growth rate raises $\bar{k}^{F,c}_{t+j}/\bar{y}_{t+j}$. By how much does constrained FDI differ from the volume that would be observed under secure property rights, how does this difference evolve over time, and how is it affected – if at all – by population growth? To answer these questions we define the "extent of expropriation risk" (μ_{t+j}) as:

$$\mu_{t+j} = 1 - \frac{\bar{k}^{F,c}_{t+j}}{\bar{k}^{F}_{t+j}} \tag{30}$$

If the non-expropriation constraint is binding, $\bar{k}^{F,c}_{t+j}$ is smaller than $\bar{k}^{F}_{t+j}$, and μ_{t+j} is smaller than one. Figure 5 demonstrates that, for our benchmark parameter values, μ_{t+j} is substantial: due to the possibility of expropriation, de-facto FDI inflows relative to GDP amount to less than ten percent of what would be obtained with secure property rights. Note, however, that μ_{t+j} decreases over time: the inflow of foreign capital – albeit slowly – raises the

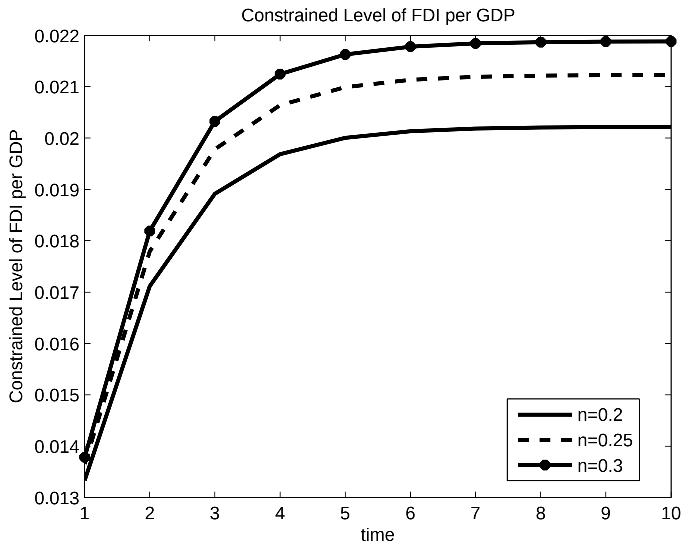

Figure 4: The effect of n on the constrained level of FDI relative to GDP

domestic wage level. A higher wage level allows for higher savings, a greater capital stock in the domestic sector, and still more FDI in subsequent periods. In the long run, however, diminishing returns to capital kick in, and μ_{t+j} converges to a steady-state level of approximately 91 percent. Figure 5 also documents that while raising n has no discernible effect on the extent of expropriation risk in the short run, it reduces this wedge in the long run. This mirrors the result illustrated by Figure 4: while countries with a high population growth suffer from their low capital intensity in the periods immediately following the elimination of investment barriers, domestic savings slowly pick up as time passes, and the "political weight effect" dominates the "poverty effect" of a high population growth rate. Note, again, that for this effect to materialize, group size has to be important in the political process. Hence, in a non-democratic system with $\rho = 0$ a larger value of n has no influence on the extent of expropriation risk.

4 Conclusions

There is a wide-spread presumption that shifting capital to countries with high population growth rates might contribute to preventing an "asset-price meltdown" in fast-aging industrialized countries. At the same time, those countries that seem to offer the highest scope for "demographic diversification" threaten foreign investors with bad institutions and insecure property

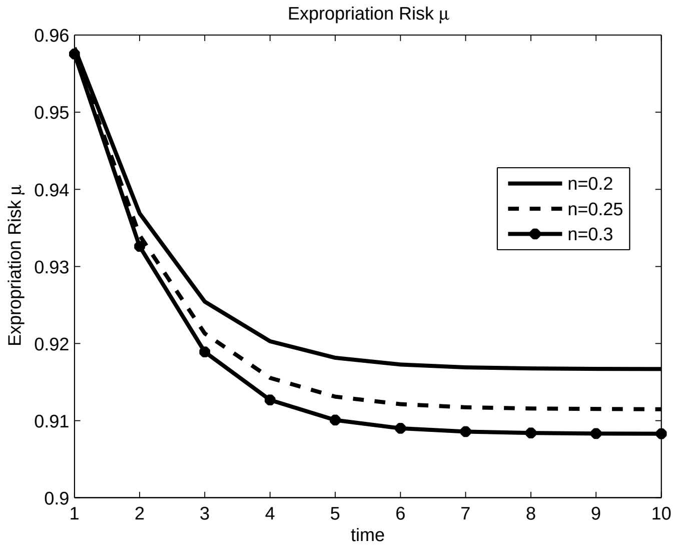

Figure 5: The effect of n on "Expropriation Risk"

rights. The goal of this paper was to augment an OLG model of a small open economy with a support-maximizing government's incentive to expropriate foreign investors, and to use this framework to analyze the impact of population growth on FDI inflows.

We have shown that, in a world with secure property rights, higher population growth in developing countries does, indeed, foster international investment. However, if we allow for the possibility of expropriation, FDI is potentially constrained by an upper boundary whose value is proportional to the domestic capital stock. We have discussed how various effects of expropriation – a *transfer* effect, a *return* effect and a *wage* effect – influence this boundary, and we have shown that although the constrained volume of FDI increases over time, the wedge between unconstrained and constrained FDI – the extent of "expropriation risk" – remains large. Finally, we have demonstrated that, in the long run, expropriation risk drops if the host country's population growth rate increases. The logic behind this result runs as follows: since young workers stand to lose from a withdrawal of foreign expertise they oppose expropriation. If a relatively large size of this cohort also translates into a greater weight in the government's objective function, higher population growth raises the political costs of expropriation. Conversely, if group size does *not* matter in the political process the "political support effect" is suppressed and population growth does not affect the risk of expropriation. Our theoretical model thus provides us with a clear and testable hypothesis: higher population growth should be associated with a lower risk of expropriation – but only in countries in which the political regime is sufficiently democratic for group size to matter in the political process. While testing this hypothesis is beyond the scope of this paper, our results provide important guidance on how to specify the appropriate empirical model.

From an economic-policy point of view, our analysis offers some important conclusions: first, the interests of young workers and foreign investors are aligned if the negative "wage effect" of expropriation dominates the positive "transfer effect". Whether this is the case depends on the relative productivity advantage of foreign firms. In countries in which foreign firms' productivity is dragged down by an unfavorable business climate, high corruption etc. or in which productivity gains are not passed on to domestic workers the temptation to expropriate is much higher. Second, our analysis suggests that a stabilizing role of population growth is conditional on a country's political institutions. It is the non-democratic nature of many developing countries' political regimes – rather than poverty and population growth per se - which gives rise to a bad investment climate. Accordingly, replacing established gerontocracies by systems in which young workers have a stronger voice is an important step in making countries more attractive to foreign investors. Our third conclusion is based on the observation that, even in democratic countries, the beneficial influence of high population growth only materializes in the medium and long run. This is due to the fact that, initially, a low domestic capital stock raises the incentive to expropriate and drags down foreign investment. As a consequence, it is important to design contractual arrangements which provide initial institutional support to a flow of foreign investment which, eventually, becomes self-sustaining.

A Appendix

A.1 Proof of Lemma 1

We derive the evolution of FDI per domestic worker for period $t+1$ (the *short run*) and all subsequent periods $t+j+1$ with $j \geq 1$ (the *long run*).

Combining (14) and (15) allows us to derive

$$\bar{k}^F_{t+j+1} = (1+\Lambda)\left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}} - \frac{\alpha\beta A^H \Lambda}{(1+n)\Omega}\left(1+\Omega b_{t+j}\right)^{\alpha}\left(\bar{k}^H_{t+j}\right)^{\alpha} \tag{31}$$

For period $t+1$, we substitute $\bar{k}^H_t = k$ as given by (9) into (31), taking into account that $b_t = 0$. This yields

$$\bar{k}^F_{t+1} = (1+\Lambda)\left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}} - \frac{\alpha\beta A^H \Lambda}{(1+n)\Omega}(\lambda)^{\frac{\alpha}{1-\alpha}}. \tag{32}$$

To derive the level of foreign investment relative to the domestic labor force in all subsequent periods, we solve (14) for b_{t+j} and substitute it into (31). This yields

$$\bar{k}^F_{t+j+1} = \left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}}\left[1+\Lambda\left(1-\frac{\beta R^*}{(1+n)\Omega}\right)\right] \tag{33}$$

for $j \geq 1$. Note that this expression is constant over time: in period $t+2$, the capital stock in the foreign sector (relative to the domestic labor force) has reached its steady state $\bar{k}^F$. Analogously we can derive the time path of $\bar{k}^H$ for the short and the long run. Using (9), (14) and (15) yields

$$\bar{k}^H_{t+1} = \frac{\alpha\beta A^H \Lambda}{1+n}(\lambda)^{\frac{\alpha}{1-\alpha}} - \Lambda\Omega\left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}}. \tag{34}$$

For subsequent periods ($j \geq 1$) we use (14) and (15) to derive

$$\bar{k}^H_{t+j+1} = \left(\frac{\alpha A^F}{R^*}\right)^{\frac{1}{1-\alpha}}\Lambda\Omega\left(\frac{\beta R^*}{(1+n)\Omega}-1\right) \tag{35}$$

which, again, is a constant value. The expressions in (32) and (33) are presented in Lemma 1, taking into account that $\bar{k}^F_{t+j} = \left(\alpha A^F/R^*\right)^{1/(1-\alpha)}$ whenever $\bar{k}^H_{t+j} = 0$, i.e. whenever the expressions in (34) and (35) are not strictly positive.

A.2 Proof of Lemma 2

From equation (14) we know, that FDI per worker ($\bar{k}^F_{t+j}$) *increases* in n if $\bar{k}^H_{t+j}$ *decreases* in n. We will therefore focus on the reaction of $\bar{k}^H_{t+j}$ on n. Using equations (34) and (35), it is easy to show that both $\bar{k}^H_{t+1}$ and $\bar{k}^H_{t+j+1}$ for $j \geq 1$ are decreasing in n as long as they are positive. However if the domestic capital stock per worker is already equal to zero, n doesn't affect it's volume and thus leaves the volume of FDI both per worker and as a share of the host country's GDP unchanged as well.

A.3 Proof of Lemma 3

The government's benefit from expropriation at time $t + j$ is given by

$$\Delta W_{t+j} = (N_{t+j-1})^{\rho} \Delta \ln(c^o_{t+j}) + (N_{t+j})^{\rho} \Delta U^y_{t+j}. \tag{36}$$

where $\Delta \ln(c^o_{t+j}) \equiv \ln(c^o_{t+j}(\xi_{t+j} = 1)) - \ln(c^o_{t+j}(\xi_{t+j} = 0))$ represents an old worker's utility gain from expropriation and $\Delta U^y_{t+j} \equiv U^y_{t+j}(\xi_{t+j} = 1) - U^y_{t+j}(\xi_{t+j} = 0)$ the respective young worker's utility gain from expropriation.

To analyze this expression, we start by substituting the consumption levels given by equations (23) – (25) into (36). Apparently, the capital-labor ratio in the domestic sector ($k^H_{t+j} \equiv K^H_{t+j}/L^H_{t+j}$) depends on the time path of expropriation. Table 2 introduces some useful shorthand notation:

Cap. intensity in the dom. sector	Expr. in $t + j - 1$	Expr. in $t + j$
$k^H_{t+j} = k^{NN}_{t+j}$	no	no
$k^H_{t+j} = k^{NE}_{t+j}$	no	yes
$k^H_{t+j} = k^{EN}_{t+j}$	yes	no

Table 2: Notation referring to the domestic sector's capital intensity

Using (12) and the fact that productivity in the foreign sector drops in case of expropriation we can show that

$$\frac{k^{NN}_{t+j}}{k^{NE}_{t+j}} = \frac{1 + \Omega b_{t+j}}{1 + b_{t+j}} \tag{37}$$

with the foreign sector's *productivity advantage* Ω and the foreign sector's *relative capital stock* b_{t+j} defined by (13) and (17), respectively. Note that K^F_{t+j} and K^H_{t+j} are predetermined in period $t + j$. For a given value of b_{t+j}, differences between k^{NN}_{t+j} and k^{NE}_{t+j} thus only arise from the (endogenous) reallocation of the labor force between the domestic and the foreign sector.

Two other results, which also go back to (12) and which will turn out to be useful are

$$\frac{K^F_{t+j}}{L_{t+j} k^{NN}_{t+j}} = \frac{b_{t+j}}{1 + \Omega b_{t+j}} \tag{38}$$

$$\frac{K^F_{t+j}}{L_{t+j} k^{NE}_{t+j}} = \frac{b_{t+j}}{1 + b_{t+j}} \tag{39}$$

Using the expressions for wages, capital returns and transfers in (5), (6) as well as (26) we can show that an old worker's benefit from expropriation in period $t + j$ is given by

$$\Delta \ln(c^o_{t+j}) = \ln \left[\left(\frac{k^{NN}_{t+j}}{k^{NE}_{t+j}} \right)^{1-\alpha} \frac{\alpha(1-\alpha)A^H \left(k^{NN}_{t+j-1}\right)^{\alpha} + (1-\alpha)k^{NE}_{t+j} + \alpha \frac{K^F_{t+j}}{L_{t+j}}}{\alpha(1-\alpha)A^H \left(k^{NN}_{t+j-1}\right)^{\alpha} + (1-\alpha)k^{NN}_{t+j}} \right]. \tag{40}$$

Using (37), (38) and (39) this can be transformed into

$$\Delta \ln(c^o_{t+j}) = \ln \left[\left(\frac{1+\Omega b_{t+j}}{1+b_{t+j}} \right)^{1-\alpha} \frac{\alpha A^H \frac{(k^{NN}_{t+j-1})^{\alpha}}{k^{NN}_{t+j}} + \frac{1+\frac{b_{t+j}}{(1-\alpha)}}{1+\Omega b_{t+j}}}{\alpha A^H \frac{(k^{NN}_{t+j-1})^{\alpha}}{k^{NN}_{t+j}} + 1} \right]. \tag{41}$$

Again using (5), (6) and (26) a young worker's benefit from expropriation is given by

$$\begin{aligned} \Delta U^y_{t+j} = \\ (1+n)\ln &\left[\frac{(1-\alpha)A^H \left(k^{NE}_{t+j}\right)^{\alpha} + \frac{1-\alpha}{\alpha} k^{EN}_{t+j+1} + \frac{K^F_{t+j}}{L_{t+j}} \alpha A^H \left(k^{NE}_{t+j}\right)^{\alpha-1}}{(1-\alpha)A^H \left(k^{NN}_{t+j}\right)^{\alpha} + \frac{1-\alpha}{\alpha} k^{NN}_{t+j+1}} \right] \\ +\beta \ln &\left[\left(\frac{k^{NN}_{t+j+1}}{k^{EN}_{t+j+1}} \right)^{1-\alpha} \frac{(1-\alpha)A^H \left(k^{NE}_{t+j}\right)^{\alpha} + \frac{(1-\alpha)}{\alpha} k^{EN}_{t+j+1} + \frac{K^F_{t+j}}{L_{t+j}} \alpha A^H \left(k^{NE}_{t+j}\right)^{\alpha-1}}{(1-\alpha)A^H \left(k^{NN}_{t+j}\right)^{\alpha} + \frac{(1-\alpha)}{\alpha} k^{NN}_{t+j+1}} \right]. \end{aligned} \tag{42}$$

To write this in a parsimonious fashion we define

$$f(b_{t+j}) = A^H \left(\frac{1+b_{t+j}}{1+\Omega b_{t+j}} \right)^{\alpha} \left((1-\alpha) + \frac{\alpha b_{t+j}}{1+b_{t+j}} \right). \tag{43}$$

Using this definition and (37) as well as (39), we can write

$$\begin{aligned} \Delta U^y_{t+j} = (1+n)\ln &\left[\frac{f(b_{t+j}) + \frac{(1-\alpha)}{\alpha} \frac{k^{EN}_{t+j+1}}{\left(k^{NN}_{t+j}\right)^{\alpha}}}{(1-\alpha)A^H + \frac{(1-\alpha)}{\alpha} \frac{k^{NN}_{t+j+1}}{\left(k^{NN}_{t+j}\right)^{\alpha}}} \right] \\ +\beta \ln &\left[\left(\frac{k^{NN}_{t+j+1}}{k^{EN}_{t+j+1}} \right)^{1-\alpha} \frac{f(b_{t+j}) + \frac{(1-\alpha)}{\alpha} \frac{k^{EN}_{t+j+1}}{\left(k^{NN}_{t+j}\right)^{\alpha}}}{(1-\alpha)A^H + \frac{(1-\alpha)}{\alpha} \frac{k^{NN}_{t+j+1}}{\left(k^{NN}_{t+j}\right)^{\alpha}}} \right] \end{aligned} \tag{44}$$

It follows from domestic capital accumulation $K^H_{t+j+1} = N_{t+j} \cdot s_{t+j}$, (5), (6), (7) as well as (12), (26) and (39) that we can write

$$K^{NN}_{t+j+1} = \frac{\frac{N_{t+j}}{1+n+\beta} \cdot \beta(1-\alpha)A^H \left(k^{NN}_{t+j}\right)^\alpha}{1+\Lambda\left(1+\Omega b_{t+j+1}\right)} \tag{45}$$

$$K^{EN}_{t+j+1} = \frac{\frac{N_{t+j}}{1+n+\beta} \cdot \beta\left[(1-\alpha)A^H + \alpha A^H\left(\frac{b_{t+j}}{1+b_{t+j}}\right)\right]\left(k^{NE}_{t+j}\right)^\alpha}{1+\Lambda\left(1+\Omega b_{t+j+1}\right)} \tag{46}$$

with Λ defined by (16). Using (12) and (37), equations (45) and (46) can be used to derive

$$\frac{k^{NN}_{t+j+1}}{\left(k^{NN}_{t+j}\right)^\alpha} = \frac{\frac{\alpha\Lambda}{1+n}\beta A^H}{\Lambda + \frac{1}{1+\Omega b_{t+j+1}}} \tag{47}$$

$$\frac{k^{EN}_{t+j+1}}{\left(k^{NN}_{t+j}\right)^\alpha} = \frac{\frac{\alpha\Lambda}{(1+n)(1-\alpha)}\beta f(b_{t+j})\left(\frac{1+b_{t+j}}{1+\Omega b_{t+j}}\right)^\alpha}{\Lambda + \frac{1}{1+\Omega b_{t+j+1}}} \tag{48}$$

$$\frac{k^{NN}_{t+j+1}}{k^{EN}_{t+j+1}} = \frac{(1-\alpha)A^H}{f(b_{t+j})} \tag{49}$$

where $f(b_{t+j})$ is defined in (43). Expressions (47), (48) and (49) can be substituted into (41) to get

$$\Delta\ln(c^o_{t+j}) = \ln\left[\left(\frac{1+\Omega b_{t+j}}{1+b_{t+j}}\right)^{1-\alpha}\frac{\frac{1+n}{\beta}\left[\Lambda(1+\Omega b_{t+j})+1\right]+\Lambda\left(1+\frac{b_{t+j}}{(1-\alpha)}\right)}{\frac{1+n}{\beta}\left[\Lambda(1+\Omega b_{t+j})+1\right]+\Lambda(1+\Omega b_{t+j})}\right]. \tag{50}$$

Note that $\Delta\ln(c^o_{t+j}) = 0$ if $b_{t+j} = 0$. Substituting (47), (48) and (49) into (44) we can also show that ΔU^y_{t+j} only depends on b_{t+j}:

$$\Delta U^y_{t+j} = (1+n+\beta\alpha)\ln\left[\frac{f(b_{t+j})}{(1-\alpha)A^H}\right]. \tag{51}$$

Note that these expressions apply to any $j \geq 0$. In a *non-expropriation equilibrium* we have

$$\Delta W_{t+j} = \left(\frac{1}{1+n}\right)^\rho \Delta\ln(c^o_{t+j}(b_{t+j})) + \Delta U^y_{t+j}(b_{t+j}) \leq 0. \tag{52}$$

The level of b_{t+j} where the government weakly prefers to refrain from expropriation – $\widetilde{b}$ – is thus implicitly defined by

$$\Delta W_{t+j} = \left(\frac{1}{1+n}\right)^\rho \Delta\ln(c^o_{t+j}(\widetilde{b})) + \Delta U^y_{t+j}(\widetilde{b}) = 0. \tag{53}$$

A.4 Proof of Lemma 4

Since $\Delta \ln c^o_{t+j} = 0$ and $\Delta U^y_{t+j} = 0$ for $b_{t+j} = 0$ there is a trivial non-expropriation equilibrium in which no FDI takes place. If $\Delta W_{t+j} > 0$ for all $b_{t+j} > 0$ this is the only non-expropriation equilibrium. Conversely, if $\Delta W_{t+j} < 0$ for all $b_{t+j} > 0$ the non-expropriation constraint is not binding. A non-expropriation equilibrium can be sustained by strictly positive values of b_{t+j} that do not exceed a threshold $\widetilde{b}$ if the following conditions are satisfied:

Condition 1

$$\frac{\partial \Delta W_{t+j}}{\partial b_{t+j}}|_{b_{t+j}=0} < 0$$

Condition 2

$$\lim_{b_{t+j}\to\infty} \Delta W_{t+j} > 0.$$

Using the results underlying Lemma 3 we can show that condition 1 is satisfied if

$$\Omega\left[\left(\frac{1}{1+n}\right)^{\rho}(1-\alpha-\gamma_1)-\alpha\left(1+n+\beta\alpha\right)\right] < \left(\frac{1}{1+n}\right)^{\rho}\left(1-\alpha-\frac{\gamma_1}{1-\alpha}\right)-\alpha\left(1+n+\beta\alpha\right)\left(1+\frac{1}{1-\alpha}\right) \tag{54}$$

where $\gamma_1 = \frac{\beta\Lambda}{(1+n)(1+\Lambda)+\beta\Lambda}$. Note first that the term in squared brackets on the left hand side is larger than the term on the right hand side. By rearranging terms it can be shown that the left hand side is negative if

$$\left(\frac{1}{1+n}\right)^{\rho}\frac{1-\alpha}{\alpha} < 1+n+\alpha\beta+\frac{\beta\Lambda(2+n+\alpha\beta)}{(1+n)(1+\Lambda)} \tag{55}$$

Assumption 1 is sufficient for (55) to hold. Hence, by dividing both sides in (54) by the term in squared brackets, we can establish the lower boundary Ω' which is greater than one and which Ω has to exceed for condition (1) to be satisfied.

Computing the limit of ΔW_{t+j} we can show that condition 2 is satisfied if

$$\Omega^{\alpha[1+(1+n)^{\rho}(1+n+\beta\alpha)]} < \frac{1}{(1-\alpha)\gamma_2}+\frac{1+n}{\beta\gamma_2}\Omega \tag{56}$$

where $\gamma_2 = \left(1+\frac{1+n}{\beta}\right)(1-\alpha)^{(1+n)^{\rho}(1+n+\beta\alpha)}$. If Assumption 1 is satisfied, the left-hand side (LHS) is an increasing and convex function in Ω with a zero intercept while the right-hand side (RHS) is a linear increasing function in Ω with a positive intercept. There is thus one point of intersection at which the LHS starts to be larger than the RHS. This establishes the upper boundary Ω'' which Ω must not exceed for condition 2 to be satisfied.

A.5 Proof of Lemma 5

After the elimination of barriers to foreign investment in period t, the constrained level of FDI per worker $\bar{k}^{F,c}_{t+j} \equiv \frac{K^{F,c}_{t+j}}{L_{t+j}}$ evolves according to the following difference equation:

$$\bar{k}^{F,c}_{t+j+1} = \frac{\frac{\alpha}{1+n}\beta A^H \Lambda \left(1+\Omega\tilde{b}\right)^{\alpha} \tilde{b}^{1-\alpha}}{1+\Lambda\left(1+\Omega\tilde{b}\right)} \left(\bar{k}^{F,c}_{t+j}\right)^{\alpha} \tag{57}$$

This easily follows from setting $b_{t+j} = \tilde{b}$ in (15) and using the fact that $\bar{k}^{F,c}_{t+j} = \bar{k}^{H}_{t+j} \cdot b_{t+j}$. It implies that $\bar{k}^{F,c}_{t+j}$ increases over time and converges to a constant level $\bar{k}^{F,c}$. Using the production functions (4) and (10) as well as (12) we can show that GDP per worker is given by:

$$\bar{y}_{t+j} = A^F \left(\bar{k}^{F,c}_{t+j}\right)^{\alpha} \left(\frac{\Omega b_{t+j}}{1+\Omega b_{t+j}}\right)^{1-\alpha} + A^H \left(\bar{k}^{H}_{t+j}\right)^{\alpha} \left(\frac{1}{1+\Omega b_{t+j}}\right)^{1-\alpha}. \tag{58}$$

Using the fact that $\bar{k}^{F,c}_{t+j} = \bar{k}^{H}_{t+j} \cdot b_{t+j}$ and $b_{t+j} = \tilde{b}$, (58) becomes

$$\bar{y}_{t+j} = A^H \left(\frac{\bar{k}^{F,c}_{t+j}}{\tilde{b}}\right)^{\alpha} \left(1+\Omega\tilde{b}\right)^{\alpha} \tag{59}$$

The constrained level of FDI relative to the host country's GDP is thus given by

$$\frac{\bar{k}^{F,c}_{t+j}}{\bar{y}_{t+j}} = \frac{\left(\bar{k}^{F,c}_{t+j}\right)^{1-\alpha} \left(\tilde{b}\right)^{\alpha}}{A^H \left(1+\Omega\tilde{b}\right)^{\alpha}} \tag{60}$$

Using equations (57) and (60) this ratio evolves as described in Lemma 5.

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