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Abstract

We generalize endogenous growth models, which often assume a closed-economy, to allow for international borrowing and lending. We incorporate a prominent feature of global financial markets, that the marginal cost of borrowing facing a small open economy is dependent on the "country risk" as perceived by international lenders. This interest rate premium is determined by the ratio between debts and country assets that can be used for debt collateral. Consequently, the cost of credit is jointly influenced by international financial parameters and by endogenous country policies and growth patterns. To highlight the implications of integrating international financial considerations into an otherwise real growth model, we first use the simplest (and arguably, the most popular) one-factor growth model, the *AK* one, and assume that all real factors of production can be used as collateral. The model yields long-run conditions under which the country becomes a borrower in international markets, remains closed or accumulates financial wealth. The model highlights the special conditions corresponding to the solution to an *AK* growth model, but the outcomes of the model are richer and perhaps more realistic than conventional endogenous growth solutions. However, extending the model to include another reproducible, non-collateral asset allows for transitional dynamics but does not change the basic insights derived using the simple one-factor model.

Kurzfassung

In der vorliegenden Studie werden endogene Wachstumsmodelle, welche oft eine geschlossene Wirtschaft zugrunde legen, verallgemeinert, um die Berücksichtigung internationaler Schuldenaufnahme und Kreditgewährung zu ermöglichen. Wir inkorporieren ein hervorstechendes Merkmal der globalen Finanzmärkte, nämlich dass die Grenzkosten der Schuldenaufnahme, mit denen eine kleine offene Wirtschaft konfrontiert wird, von der Einschätzung des „Länderrisikos" von Seiten der internationalen Kreditgeber abhängen. Dieser Zinssatzaufpreis wird bestimmt von dem Verhältnis zwischen den Schulden und den Vermögenswerten des Landes, die als Sicherheit hinterlegt werden können. Somit werden die Kreditkosten sowohl von internationalen Finanzparametern als auch von der endogenen Länderpolitik und Wachstumsmustern beeinflusst. Um die Auswirkungen der Integration von internationalen finanziellen Erwägungen in ein ansonsten reales Wachstumsmodell hervorzuheben, wenden wir zunächst das einfachste (und wohl gängigste) Ein-Faktor Wachstumsmodell, das *AK-Modell*, an und gehen von der Annahme aus, dass alle realen Produktionsfaktoren als Sicherheit genutzt werden können. Das Modell liefert langfristige Bedingungen, unter denen ein Land ein Kreditnehmer in internationalen Märkten wird, geschlossen bleibt oder finanziellen Wohlstand akkumuliert. Das Modell hebt die besonderen Bedingungen hervor, die der Lösung eines *AK*-Wachstumsmodells entsprechen. Die Resultate des Modells sind jedoch ergiebiger und vielleicht realistischer als die Ergebnisse konventioneller endogener Wachstumsmodelle. Die Ausweitung des Modells zur Einbeziehung eines weiteren reproduzierbaren, nicht als Sicherheit nutzbaren Vermögenswertes lässt zwar vorübergehende Dynamiken zu, ändert aber nicht die grundlegenden Einsichten, welche aus der Anwendung des einfachen Ein-Faktor Modells herrühren.

1 Introduction

Recent advances in modeling economic growth have largely been applied in the context of a closed-economy. Yet as Barro *et al.* (1995) have pointed out, the assumption of a closed economy is difficult to justify, given the presence of a world credit market that tends to equate real interest rates across economies. On the other hand, an open-economy model of growth that does allow for international borrowing and lending poses some problems for standard growth models developed for a closed economy. In this paper we adapt two popular versions of endogenous growth models for a small open economy that largely avoid the above problems associated with previous efforts. The insights derived from the models developed in this paper are especially applicable to high-productivity emerging economies that have become increasingly integrated in world financial markets.

Closed-economy endogenous growth models either lead to balanced growth that is independent of capital, and therefore unaffected by real interest rates, or predict differences in capital and thus in real interest rates across countries. The first set of models comprises typically the one-sector endogenous growth model without diminishing returns, with the simplest case being the AK model embodying a fixed technology parameter of Rebelo (1991). However, as the AK and similar models predict that balanced growth is independent of the capital stock, then for countries that are open to international credit market, differences in the marginal productivity of capital may cause all capital to migrate out of the low-A into the high-A countries. The second set of models is exemplified by the two-sector endogenous-growth model incorporating both physical and human capital, which allows for gradual transition to long-run balanced growth (Mulligan and Sala-I-Martin, 1993; Barro and Sala-I-Martin, 2004, ch. 5). However, such a model predicts that, if capital endowments differ across closed economies, so would real interest rates, and both such capital imbalances would vanish instantaneously if the economies were to open to a world credit market.

Similarly, Barro and Sala-I-Martin (2004, p. 161) demonstrate that modifying the neoclassical growth model *"to allow for an open economy leads to some paradoxical conclusions."* For example, if the world interest rate is higher than the steady-state interest rate in the closed economy, then if the latter opens it would eventually end up owning all the world's assets. If the world interest rate is equal or lower than the steady-state interest rate, then the marginal productivity of capital in the economy must converge instantly to the constant world interest rate when the economy opens. This suggests in turn that any capital imbalance between the domestic economy and the rest of the world must disappear instantaneously, implying immediate convergence to a balanced growth path.

Several approaches have attempted to preclude these rather unrealistic and paradoxical results that arise in an open-economy growth model with international borrowing and lending. Cohen and Sachs (1986) construct a model in which only a fraction of an economy's capital stock serves as collateral on foreign loans. In contrast, Barro and Sala-I-Martin (2004, ch. 3) and Barro *et al.* (1995) distinguish two types of capital, and assume that only one form is internationally mobile: borrowing in the world market is possible to finance accumulation of physical capital, but not human capital, and the interest rate on these loans is pegged at the world rate. This key assumption effectively imposes a credit-market constraint, as the amount of foreign debt incurred by an economy is necessarily limited by the quantity of physical capital accumulated.[1]

Our model is motivated by similar concerns as those expressed by Barro *et al.* (1995), Barro and Sala-I-Martin (2004, ch. 3) and Cohen and Sachs (1986). We focus on endogenous growth models rather than neoclassical models as the above works did. Also, in contrast to the latter models, we do not impose the assumption that the domestic interest rate (or marginal product of capital) is equalized to a single world interest rate. Although the economy may be fully integrated into the world financial markets, the domestic interest rate may diverge from the world rate and diverge across countries in long run equilibrium. We incorporate a prominent feature of international financial markets, which is the widespread use of country risk premium as assessed by banks and other international lenders (Agénor, 2004, ch. 16; Bulow, 2002; Reinhart *et al.*, 2003; Zoli, 2004).

The actual (marginal) cost of credit paid is, therefore, different across countries. More importantly, we explicitly allow for such a risk premium to be endogenously determined by the country's pattern of economic growth chosen, including the asset composition strategy followed. That is, the country-specific cost of credit faced by a small open economy is determined by both exogenous factors, including prime or base (risk-free) rates, by the parameters that international lenders used to evaluate country risks, and by the endogenous (over the long run) country policies and growth strategies followed. This means that a net debtor country faces an upward-sloping supply curve for capital.

That the marginal cost of borrowing facing a small open economy may depend on its "country risk" rating is a well-known feature of sovereign debt markets, especially for developing or "emerging market" country borrowers. For example, Bulow (2002, pp. 235-6)

[1]In the credit-constrained open economy model developed by Barro *et al.* (1995), the opportunity to borrow on world credit markets does affect the speed of convergence, and the authors find that the economy has a higher rate of convergence than if it remained closed. But this difference in the rate of convergence does not appear to be large for plausible parameter values. For example, Barro *et al.* (p. 112) note that "if a credit-constrained open economy can amass a foreign debt that is only about one-eighth of its total capital, then the convergence speed is very close to the value (0.014) that would apply if the economy were closed." However, the authors also acknowledge that "many developing countries are insufficiently productive to be credit-constrained and, second, that the collateral for international debt is likely to be substantially smaller than the quantity of physical capital" (p. 114). If this is the case and the borrowing constraint is not binding in the open economy model, then Barro *et al.* find that there are no transitional dynamics and instead the economy jumps immediately to its steady-state values.

maintains that *"in some respects developing-country debt resembles U.S. consumer debt more than corporate debt"*, and the former *"is characterized by competitive lending, high interest rates, and commensurably high default rates."* As remarked by Reinhart *et al.* (2003, p. 2), *"the idea that factors such as sound institutions and a history of good economic management affect the interest rate at which a country can borrow is well developed in the theoretical literature"*. Utilizing the sovereign debt ratings (IIR) reported by *Institutional Investor*, the authors demonstrate that the IIR "country risk" measure tends to rise with the stock of external debt, and this relationship may be nonlinear.[2] Following Bayoumi *et al.* (1995), Zoli (2004) develops a model illustrating that, for an emerging market economy, the cost of international borrowing is determined by the exogenous risk-free world interest rate and the country premium, which depends on the probability of default. Empirical application of the model confirms that the country premium paid by emerging economies on sovereign debt increases non-linearly with the amount of debt.[3]

To highlight as best as possible the "pure" implications of integrating such international financial considerations into conventional endogenous growth models that often focus exclusively on the "real" side of a closed economy, we first apply the analysis to a small open economy using the simplest (and, arguably, the most popular) endogenous growth model, the *AK* one. This means that there is only one factor of production and that this factor can be fully used as collateral. We find that growth in a small open economy may follow three alternative endogenously-determined patterns with dramatically different implications: (1) The economy may partially fund growth through borrowing internationally at various levels paying an endogenous marginal cost for it; (2) it could become a net lender in the world economy (the "capital flight" case); or (3) it could become self-sufficient in funding capital investment.

Outcome (3) is a special case that yields a solution identical to the standard closed-economy *AK* endogenous growth solution. This happens when the parameters are such that they permit the economy to exactly finance its own investment. However, in the context of a small open economy (free of capital controls) this outcome is a "knife-edge" solution for our more general growth problem; it occurs only by coincidence for a small open economy when the marginal productivity of capital and the base or risk-free world interest rate coincide by chance.

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[2] When examining various alternative measures of risk and country indebtedness, Reinhart *et al*. (2003) find further evidence of such a monotonic relationship. However, the authors also note (p. 18) that *"although the relationship between external debt and risk may be monotonic for emerging market economies, it is clearly not monotonic for the public debt of advanced economies; in those countries, relatively high levels of government debt can coexist with low levels of risk."* This result is not surprising if one assumes that the "risk-free" world interest rate is equal to the marginal product of capital prevailing in the few "giant" advanced economies, such as the USA, Japan and the European Union (EU), that almost completely dominate the world financial (and real) markets (World Bank 2000). In the context of our model, this is an important assumption, which implies that the rest of the world other than the advanced economies, and especially emerging market economies, must pay an interest rate premium above the risk-free rate and that the premium is essentially determined by the bankers in the dominant economies based on country credit ratings.

[3] This result that a net debtor country faces an upward-sloping supply curve for additional borrowing is robust across alternative specifications of the empirical model. In the basic version of the estimated model Zoli (2004) also finds that the curve tends to become vertical at a critical value for the debt level of a country.

Outcome (2), which happens in lower productivity countries (vis-à-vis the advanced economies that dictate the base interest rate), is likely to cause government capital controls to mitigate the possibility of capital flight, which effectively means that in practice such an outcome precludes full capital openness.[4] In this case consumption growth also follows the closed-economy *AK* model but the growth rate is lower than when the *AK* model solution arises (by chance) in the context of free capital flows.

Outcome (1) corresponds to the high-productivity open economy. Unlike the closed economy version of the *AK* model, in this case we have balanced growth rates that are not in general independent of the world interest rate. However, unlike existing open economy models of endogenous growth that assume binding quantitative borrowing restrictions, the rate of growth in our model is determined by *both* the base world interest rate (and other parameters considered by international lenders) *and* by domestic productivity features. We also show that the growth rate of the *AK* economy that is exactly self-sufficient in savings (and that of the lending economy whether subject to capital controls or not) is never higher than the growth rate of the economy that is a net borrower of international funds without government controls (outcome 1). That is, a country using international debt to finance part of its growth needs may grow faster than countries that do not rely on international debt, even though the debtor country faces a higher (and rising) marginal cost of capital. However, as our analysis makes clear, this positive association between debt or financial openness and the rate of economic growth does not necessarily mean that access to international debt *causes* more growth.

Because of the assumption of *AK* production technology, this version of our general growth model contains no transitional dynamics. Any capital imbalance between the domestic economy and the rest of the world disappears instantaneously; i.e., capital will flow immediately into the economy if it has sufficiently high productivity relative to that prevailing in the advanced economies though domestic interest rates will in general be permanently higher than the base rate prevailing in the dominant economies. Similarly, capital will flow out rapidly if the advanced, or “giant”, economies have higher productivity than that of the emerging economy up to the maximum capital outflow allowed by the government given its ability to monitor and control them.

As in Barro *et al.* (1995) and Barro and Sala-I-Martin (2004, ch. 3), we introduce an additional reproducible asset (“human capital”) that is non-tradable internationally and that cannot be used as a collateral to secure borrowing, as well as a more general production function. Although capital inflows or outflows still occur, in some cases the small open economy will adjust gradually to its long-run balanced growth path because human capital accumulation occurs more slowly. However, the basic long-run solutions derived from the simpler version of the model do not change significantly.

[4] No government is likely to permit the full migration of the country’s savings, so under these conditions capital flows are likely to become constrained by capital controls.

The outcome in which the economy is self-sufficient in financing its own investment now resembles the two-sector endogenous-growth model incorporating human and physical capital (Mulligan and Sala-I-Martin, 1993; Barro and Sala-I-Martin, 2004, ch. 5), but this outcome is still a knife-edge solution to our more general growth model.

By contrast, for any high-productivity economy a richer solution that integrates both external and domestic factors in determining consumption growth applies. As in the *AK* model, the rate of growth of a high-productivity economy that borrows on the international market to finance its capital investment is never less than in a non-borrowing economy whether closed, partially closed, or open to capital flows. The transitional dynamics arising from this model offer some important testable and seemingly counter-intuitive predictions: A superficial logic would lead us to believe that, for economies that are sufficiently productive to be able to borrow internationally, an economy that is relatively more scarce in the asset that can be used as debt collateral will adjust more quickly to its long-run equilibrium than an economy that is relatively more scarce in the asset that cannot be used as collateral. In fact, we show that exactly the opposite occurs, which suggests that this phenomenon is worth examining further empirically.

The outline of the paper is as follows. In the next section we develop our basic model of the small open economy that can borrow and lend in world financial markets. In a subsequent section we introduce the possibility that the economy has access to an additional reproducible asset, human capital, which does not serve as collateral for international borrowing and is non-tradable internationally. We conclude the paper with some final remarks on the implications of the models we have developed.

2 Borrowing and Lending in a Small Open Economy

As in Barro and Sala-I-Martin (2004, ch. 3) we assume a world that contains many small open economies.[5] We also assume that the base (or risk-free) international interest rate is set by a few giant economies (presumably, the USA, EU and Japan) and that the small economies individually or even as a group cannot affect the international base interest rate. We denote one country as the domestic economy and the remaining countries as foreign, which we refer to collectively as the rest of the world.

Output in the economy is represented by a single type of good, Q, which is produced using capital, K, and labor, L. Capital is freely mobile internationally but labor is not. We represent production as $Q = F(K, L)$, which has the standard concave properties with respect to its inputs and is homogeneous of degree one.

The domestic economy has the possibility of accumulating wealth, W, as a means to financing capital as a productive input, K, or alternatively, borrowing from the rest of the world to pay for this input. The two assets are assumed to be perfect substitutes as stores of value. The fact that the economy is open means that foreigners may obtain claims on K by lending to domestic borrowers (alternatively, nationals can have net claims on foreign capital by buying foreign bonds as well). If $K > W$, then $K - W$ are the net claims by the rest of the world on the domestic economy (the economy's debt); conversely, if $W > K$ then $W - K$ are the net claims by domestic residents on foreigners. The domestic economy's net debt to foreigners can be defined as $D = K - W$, and the debt-equity ratio of the domestic economy is:

$$\frac{D}{W} = \frac{K - W}{W}. \tag{1}$$

In contrast to Barro and Sala-I-Martin (2004), Barro *et al.* (1995) and Cohen and Sachs (1986), we assume that the world interest rate is not exogenously determined but is affected asymmetrically by the amount of borrowing by any country. That is, the cost of borrowing for the domestic economy will rise with its debt-equity ratio[6]. The theoretical foundation of this assumption was developed by Steigum (1983), and it has since been incorporated into empirical

[5] The "openness" of the economy refers to the capital flows. Since we only have one final good, free trade in that good plays no role in the analysis.

analyses of international borrowing by emerging market economies (Bayoumi *et al.*, 1995 and Zoli, 2004). In addition to being well-grounded theoretically, the idea that the cost of borrowing is affected by a country's stock of debt in relation to its wealth is highly intuitive and, under various specific formulas, is often used by banks and international financial analysts in assessing a country's credit worthiness and risk (Bulow, 2002; Reinhart *et al.*, 2003). Thus the marginal cost of borrowing in international credit markets to a country is:

$$\tilde{r} = r\left(1 + e\left(\frac{K - W}{W}\right)\right), \qquad e' > 0,\, e'' > 0 \text{ for } K > W, e\left(\cdot\right) = e'\left(\cdot\right) = 0 \text{ for } K \leq W \;, \qquad (2)$$

where r is the given base or risk-free international interest rate, $\left(K - W\right)/W$ is the economy's debt-equity ratio, and $e\left(\cdot\right) \geq 0$ is the interest-rate borrowing or risk premium function if the economy is indebted. The specific properties, including variables considered and parameters of this function are determined by the criteria of the large lending institutions in the dominant economies. Apart from assuming that e is strictly increasing, consistent with the empirical evidence (Zoli, 2004), we assume that e ( ) is also a strictly convex function. It follows from (2) that, if the domestic economy is self-sufficient in financing its investment, $K = W$, or is a net lender to the rest of the world, $K \leq W$,then it faces a world interest rate that is equal to the risk-free rate, i.e. $\tilde{r} = r$.

One interpretation of r is that it is equal to the marginal product of capital prevailing in the few advanced, or "giant", economies that almost completely dominate the world financial (and real) markets. One may argue that apart from the USA, Japan and the European Union (EU) few other countries in the world are able to play any important role in setting the base or risk-free interest rate.[7] Thus all other economies can be considered "small" in the sense that their productivities have a practically zero effect on the world base rate both individually and even perhaps as a group. These other economies are what we call "small economies". While the base rate is the market interest rate prevailing in the giant (risk-free) economies, the rest of the world open to financial international markets, and especially emerging market economies, must pay an interest rate premium above r that is associated with their country risk as perceived by the bankers in the dominant economies.

We assume that Equation (2) above is valid not only for the economy as a whole but also for each firm in the economy. The firm is fully aware that its borrowing and investment decisions may influence the cost of its credit. Moreover, we assume that the firm has perfect knowledge regarding the way in which such decisions affect the cost of credit, that is, they know

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[6] The "equity" that counts to international lenders is any asset that can be used as collateral and that can be easily transformed into a liquid asset. In this version of the model, we assume that the only factor of production, *K*, satisfies these conditions.

[7] According to the World Bank (2000) together these three major economies account for about two thirds of the world GDP and an even greater share of the world financial transactions.

the function, $e\,[(K-W)/W]$. This allows the firm to incorporate this knowledge in their profit maximizing decisions. Even firms under perfect competition still will make their capital demand decisions taking full consideration of the e function as long as they know it.

We assume that the risk premium function takes the form:

$$e = \left(\frac{K-W}{W}\right)^{g} \text{ for } K-W \geq 0 \text{ and } e = 0 \text{ otherwise.} \tag{3}$$

Moreover, the fact that e is strictly increasing and convex for $K-W \geq 0$ implies that the fixed parameter $g > 1$.

The budget constraint for the economy can be described as:

$$\dot{W} = F(K,L) + r\left(1+\varepsilon\left(\frac{K-W}{W}\right)\right)(W-K) - C,\ \ W(0) = W_0. \tag{4}$$

As indicated earlier if $W-K \leq 0$ then $e = 0$ and equation (4) changes correspondingly. In addition, we can assume that the government will not allow that all physical capital leaves the country so that the economy becomes a pure renter country. That is, a "capital flight constraint" through government regulation,

$$W - K \leq qW\ , \tag{4'}$$

where $0 \leq q \leq 1$ is the maximum proportion of the total wealth of the country that the government is effectively able to allow leaving the country given its capacity to monitor and control capital flows[8].

Finally, the objective of the social planner is to choose consumption, *C*, and capital, *K*, so as to maximize the following discounted utility function:

$$\int_0^{T\to\infty} e^{-\delta t} U(C)dt\ . \tag{5}$$

We assume that the utility function has the usual concave properties and that the elasticity of marginal utility is constant and defined as $s = -\frac{U''}{U'}C > 0$. The discount rate d is also constant.

[8] Many countries in Africa, Asia and Latin America, especially the poorest (presumably those that have the lowest levels of productivity), have had and still have tight capital flight regulations, including foreign exchange controls and other regulations affecting their capital markets.

The Basic Financial Wealth-Physical Capital Model: The AK Technology Case

The simplest version of the model uses the highly popular *AK* production model (Rebelo, 1991). Given the need to retain the assumption of competitive equilibrium, the production function has to be assumed to be linearly homogenous in *K* and *L*. This causes potential problems to standard models seeking endogenous or permanent growth as a solution because the linear homogeneity assumption implies that the marginal product of capital must be decreasing in *K* for a fixed labor force, *L*. The usual approach to obtain endogenous growth when the economy can invest in only one asset (in this case *K*) is to assume the existence of externalities so that increasing *K* causes labor-augmenting technical change as an *externality* to the firm. Under this assumption a Cobb-Douglas production function may become an *AK* function with a constant marginal product of capital and effective increasing returns to scale but still consistent with profit maximizing competitive firms.

As labor is constant, we normalize its units so that $L = 1$.[9] This allows us to depict aggregate output as $Q = F(K, L) = AK$. Following the discussion from the previous section, in the context of an *AK* model, $r = A^W$, where A^W is the marginal product of capital in the advanced, or "giant", economies that determine the "risk-free" base world interest rate. In general we assume that the productivity of the small open economy that we are considering can be greater, equal or lower from the capital productivity of the giant economies.

The current-value Hamiltonian of the social planner's maximization problem is

$$\mathrm{H} = U(C) + l\left[AK + r\left(1 + e\left(\frac{K - W}{W}\right)\right)(W - K) - C\right] - q(W - K - qW), \tag{6}$$

where ? is the co-state variable and the shadow value of wealth to the household and $q \geq 0$ is the multiplier of the capital flight control restriction (4').

The first-order conditions are (4) and:

$$U' = \lambda \tag{7}$$

$$A - r(1+e) - re'(\cdot)\frac{W-K}{W} + q/l = 0, \qquad (W - K - qW)q = 0\ , \tag{8}$$

$$\dot{l} = l\left(d - r\left[1 + e - e'\frac{K}{W}\frac{W-K}{W}\right] + \frac{(1-q)q}{l}\right) \tag{9}$$

[9] We may assume instead that *L* grows at a constant exponential rate, but the results would not be affected.

The corresponding transversality condition for this infinite time horizon problem is:

$$\lim_{t\to\infty}\left[l(t)W(t)\right]=0\,. \tag{10}$$

Using (3), Equations (8) and (9) can be rewritten as:

$$A-r[1+(1+g)e(\cdot)]+q/l=0,\qquad (W-K-qW)q=0 \tag{8'}$$

$$\dot{l}=l\left(d-r\left[1+e(\cdot)(1+g\frac{K}{W})\right]+\frac{(1-q)q}{l}\right). \tag{9'}$$

Now we consider the full range of possible outcomes including the cases where $K-W\leq 0$. Using (8') and (9'), there are three possible outcomes for this economy:

Case (i) Capital Flight Economy

If $A-r<0$ then $q>0$ and $K=(1-q)W$. That is, in this case the capital control regulation is binding because the domestic marginal productivity of capital is less than the minimum value of the interest rate (or, equivalently, is less than the capital productivity prevailing in the giant economies); therefore, the domestic return to capital in production is not competitive with financial returns. As a result, the economy would cease production and become a pure renter if were not for the capital flight controls. It is straightforward to show from (7) and (9') that the rate of growth in the economy is $\frac{\dot{C}}{C}=\frac{1}{s}\left[r-\frac{q}{l}d\right]$. Since $K<W$ in this case, we have that $e=0$ and, therefore, from (8') $\frac{q}{l}=r-A$, which means that the growth rate is in this case exactly like in the closed-economy *AK* model. This is hardly surprising because, though the economy is partly open to capital flows, at the margin it is not open due to the binding regulation. We refer to this solution as the "capital flight" model. That is, for countries which have a lower productivity than the advanced economies capital openness becomes less likely as they are more prone to impose capital (and foreign exchange) controls.[10]

Case (ii) AK Closed Economy

If $A=r$ then $K=W$, and we have a solution identical to the standard closed-economy case. In this case, any small debt incurred by the domestic economy would make the marginal cost of capital greater than its marginal productivity; therefore, the economy abstains from participating in the world financial market and is exactly self-sufficient in capital. This occurs despite the lack of any regulation that prevents capital flows. That is, if $A = r$ the economy naturally becomes closed even in the absence of capital controls. It is straightforward to show

[10] This outcome is confirmed by Taylor (1998), with the example of Argentina in the 20th century, who maintains that where the marginal productivity of capital in an open developing economy is less than in rich economies, regulations that restrict capital outflows and some capital flight, nonetheless, are inevitable.

that this case corresponds to the standard closed-economy *AK* growth model solution $\frac{\dot{C}}{C} = \frac{1}{s}[A - d] = \frac{1}{s}[r - d]$. In this case the rate of growth of the economy is greater than in the regulated economy simply because the level of productivity of this economy is higher than in the regulated economy. We refer to this solution as the *AK* unregulated closed-economy model (Rebelo, 1991; Barro and Sala-I-Martin, 2004). Both case (i) and case (ii) may result in a closed economy, but while in case (ii) the economy remains close for market reasons, an economy in case (i) may be closed only through forced regulations. That is, the standard closed-economy *AK* model is a market solution for a small open economy only by chance, when the productivity of the economy happens to be identical to that of the giant economies. Otherwise, it may describe a solution to a small economy that is forced to remain closed (or perhaps semi-closed) by government regulation. A prediction of case (ii) is that all economies grow at the same rate, certainly an implausible one.

Case (iii) WK Economy

If $A > r$ then the economy becomes open to capital inflows. This is probably the most important (and interesting) case not only because of how much richer is the solution but also because it may be relevant to a large number of high-productivity emerging economies that are able to grow faster than the advanced economies and are increasingly more integrated into world financial markets (e.g, South Korea, Chile, Malaysia, Singapore, Thailand, Mexico, Poland and many other fast growing emerging economies). Now the regulation is not binding and therefore $q = 0$. In this case

$$A = r[1 + (1 + g)e(\cdot)] \text{ with } K - W > 0. \tag{8”}$$

The latter condition implies that there exists a value of the *K/W* > 1 ratio at which (8’) holds with $q = 0$. It is optimal for the domestic economy to incur some debt, which is determined uniquely by (8’’). The growth solution arising in this case is fundamentally different than the solution with the standard *AK* model described in the previous two cases. Differentiating (7) with respect to time and substituting into (9’) yields the long run growth rate:

$$\frac{\dot{C}}{C} = \frac{1}{\sigma}\left[r\left[1 + \varepsilon(\cdot)\left(1 + \gamma\frac{K}{W}\right)\right] - \delta\right], \qquad K - W \geq 0. \tag{11}$$

That is, growth now depends on the composition of assets held by the household, *K/W*, as well as the characteristics of the financial market, which are represented here by the interest rate premium function, $e(\cdot)$, and the responsiveness of this premium to the debt ratio, ?. The *K/W* ratio is obviously endogenous and depends among other things on *A*, so the growth rate of the borrowing economy depends on a blend of international conditions as well as domestic conditions including capital productivity. We refer to this case as the “*WK*” (Financial Wealth-Physical Capital) model, and note that countries that conform to the conditions of this case are net borrowers and have higher levels of productivity, *ceteris paribus*, compared to economies conforming to the other two cases (the net borrowers and closed-economy cases) and higher productivity than the giant economies.

In case (iii), the optimal composition of assets held by the household, $(K/W)^*$ is derived from (8') to be:

$$\left(\frac{K}{W}\right)^* = \left(\frac{A-r}{(1+g)r}\right)^{\frac{1}{g}} + 1 \,. \tag{12}$$

The optimal *K/W* ratio is greater than one, which is the case since *A* > *r*. This ratio is increasing in *A*, but decreasing in *r* and ?. Using (12) in (11) and doing some algebraic manipulation we obtain:

$$\frac{\dot{C}}{C} = \frac{1}{s}\left[A + gr\left(\frac{A-r}{(1+g)r}\right)^{\frac{1+g}{g}} - d\right] \tag{13}$$

By partial differentiation of (13) it follows immediately that growth in the high-productivity *WK* countries is decreasing in *r* and in g and, naturally, increasing in its productivity level, *A*. That is, a tightening of international credit causes growth to slow down in high-productivity or net borrower countries. Also, not surprising, growth in high-productivity countries slows down when the sensitivity of the risk premium to the debt-equity ratio increases.

Proposition 1: (i) If $A \geq d$, which is a necessary and sufficient condition for growth to be non-negative in the capital flight and closed-economy AK cases, then growth is strictly positive in the borrowing countries (the WK countries) and is greater than in the other two cases. (ii) The rate of economic growth in the borrowing countries is decreasing in the base or risk-free international interest rate and in the sensitivity of international rates to country risk as measured by the debt-equity ratio and increasing in its domestic level of productivity. (iii) An identical, proportional increase of the country's productivity and of the base world interest rate **increases** the growth rate of the WK country.

Proof: The first part of Proposition 1 is self-evident from equation (13) and the definitions of the growth rates for cases (i) and (ii). If $A \geq d$ then $\dot{C}/C > 0$ in all three cases, and is higher in the *WK* case because in this case *A* > *r* and $gr\left(\frac{A-r}{(1+g)r}\right) > 0$.

Part (ii) follows directly by differentiating Equation (13) which is the rate of growth of the *WK* economy. Part (iii) follows from the fact that the first right-hand-side term of (13) is homogenous of degree one in *A* and *r*. ⊗

As in the closed-economy *AK* and "capital flight" models, there are no transitional dynamics in the *WK* model. Growth is constant, because $\left(\frac{K}{W}\right)^*$ is constant. From (4):

$$\frac{\dot{W}}{W} = A\left(\frac{K}{W}\right)^* + r\left(1+e(\cdot)^*\right)\left(1-\left(\frac{K}{W}\right)^*\right) - \frac{C}{W}. \qquad (14)$$

A constant $\dot{W}/W$ and *K/W* ratio implies that *C/W* must also be constant. Growth is therefore balanced, $\frac{\dot{C}}{C} = \frac{\dot{W}}{W} = \frac{\dot{K}}{K}$. Using (11) in (14), we solve for $\left(\frac{C}{W}\right)^*$:

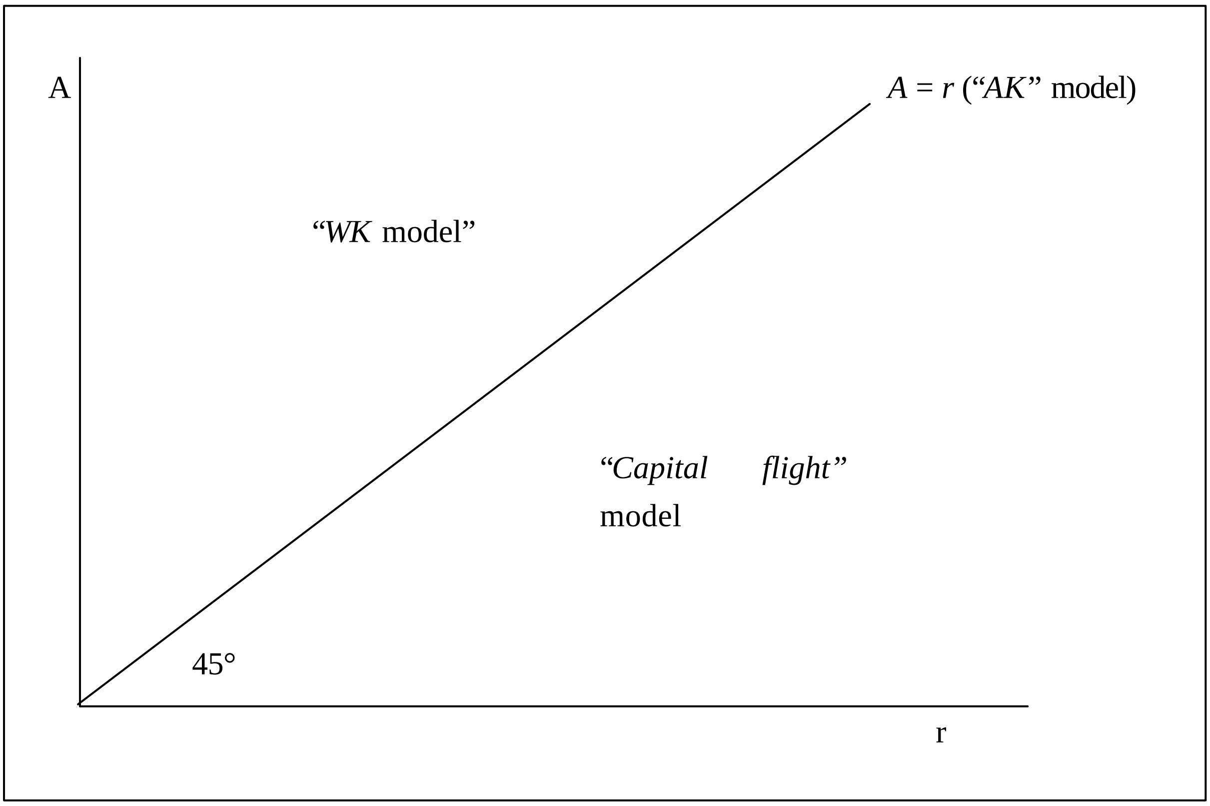
$$\left(\frac{C}{W}\right)^* = A\left(\frac{K}{W}\right)^* + r\left(1+e(\cdot)^*\right)\left(1-\left(\frac{K}{W}\right)^*\right) - \frac{1}{s}\left[r\left[1+e(\cdot)^*\left(1+g\left(\frac{K}{W}\right)^*\right)\right] - d\right]. \qquad (15)$$

Implications

The above extraordinarily simple model endogenously derives the conditions for an economy to become open to capital markets and is able to predict the particular way in which the economy may or may not enter the world financial market. More importantly, it shows that the standard *AK* closed-economy model is just one special-case solution among three possible outcomes for an open economy, or it may be relevant to low productivity economies that decide to limit capital flight through regulation. In fact, in the pure open economy case (in the absence of capital controls) the *AK* closed-economy solution is a "knife edge" case that occurs only by chance if certain particular conditions are satisfied.

The three possible growth models arising from the above framework are represented in Figure 1. While the *AK* closed-economy solution is a knife's edge case that occurs only if $A = r$ (both fixed parameters for a small open economy), the other two solutions may occur under broader conditions. The *WK* model in particular arises when the domestic economy is more productive than the rest of the world ($A > r$), in which case the economy is able to borrow in the world markets, but only up to a level at which the debt to wealth ratio is optimal. The "capital flight" solution occurs when the economy has lower productivity ($A < r$), in which case, in the absence of regulations that effectively close the economy at the margin, productive activities may shut off and the economy lives exclusively out of its interest income from capital invested abroad. In this case the economy may, however, choose to remain partially closed through imposing capital controls, in which case the closed-economy *AK* solution would still be valid whenever $A \leq A^W$ and effectively would not be a razor's edge solution. Needless to say, closing the economy when $A < r$ may enable the economy to retain positive growth of GDP but at the cost of slower growth of consumption as well as welfare losses.

Figure 1: Three Possible Growth Models for the Simple Open Economy



A *key testable prediction* of this simple model is that borrowing small countries grow faster than the giant economies and also faster than small fully open economies that nonetheless remain self-sufficient in savings. Countries that remain self-sufficient or semi self-sufficient as a consequence of restrictive regulations grow even slower. Moreover, within the high-productivity countries there will be no convergence over time as the richer countries (those that have a higher *A* and, therefore, higher output per capita) will tend to grow faster. Some support for the first part of this prediction is provided by Cohen (1994), who finds empirical evidence that, if the marginal productivity of capital in poorer countries is higher than in rich countries, then foreign debt financing raises growth in the poorer economies.[11] However, a more comprehensive empirical analysis of this prediction should also examine the possible influence of capital control regulations on growth.

The model described above integrates certain key financial variables into a growth model, a feature often neglected in standard growth models. In addition, it has the advantage of being simple and at the same time, unlike competing models, is able to endogenously predict when an economy may open to capital markets and become a net borrower. It has, however, two significant problems that make it less plausible: First, the model does not have transitional

[11] A more recent analysis by Lin and Sosin (2001) finds little evidence for an empirical relationship between foreign government debt and growth, except for African countries where a significant negative relationship is found. However, this analysis does not allow for the influence of capital controls across countries. In general, most recent empirical analyses have focused on the indirect influence of debt on growth via a negative correlation with investment. See Agénor (2004, ch. 16) for a review.

dynamics to a balanced growth path, thus being not useful to studying short-run adjustments. Second, while for highly productive economies ($A > r$) the balanced growth path is considerably richer than that of competing models, for low productivity economies (when $A < r$) growth of GDP (as opposed to consumption growth that may still be feasible) as an open economy is infeasible and induces us to assume that in this case the economy would use capital controls to restrict the outflow of capital.

One may suspect that the *AK* technology with a constant marginal product of capital is driving much of these latter results. The ensuing model corrects for this by introducing an additional non-tradable asset, human capital, which unlike K does not serve as collateral for international borrowing. Allowing a more flexible, non-linear and two-input production function in which the economy can invest generalizes the above results. While the resulting model has tractable transitional dynamics that permits to shed some light on the issue of convergence during the transitional process, surprisingly it confirms most of the *AK* model results. The standard solution obtained for long run growth in a closed economy (Barro and Sala-I-Martin, 2004, ch. 5) is still a knife-edge type of solution that happens under special conditions when the economy is free of capital controls. For high-productivity economies (where productivity is now measured more generally than in the *AK* model), long-run growth is still the result of both domestic and international financial conditions.

3 An Additional Reproducible Asset

We now assume that there are two productive assets, K and H in which the economy can invest. The key difference between the two is that K is internationally tradable (and "liquid") while H is not. This means that K serves as collateral for borrowing on world markets while H does not. For example, the additional asset could be human capital, in the form of the number of years invested in job training or education, in which case the asset accumulates with additional investment by households.[12] The aggregate production function, $Q = F(K, H)$, has the standard properties with respect to its two capital inputs: increasing, concave and linearly homogenous. We also assume that K and H are gross complements; the marginal product of K is non-decreasing in H and vice versa. Moreover, we assume that $F(\cdot)$ satisfies the Inada conditions; the marginal products of K and H approach infinity as K or H approaches zero, respectively.

We assume for notational simplicity that the stock H has a depreciation rate equal to zero and thus:

$$\dot{H} = I_H . \qquad H(0) = H_0, \tag{16}$$

where $I_H \geq 0$ is the investment in H. The economy is endowed with an initial amount of human capital, H_0. Aggregate investments in education, job training and other skill-enhancing activities, I_H, can increase the human capital stock.

Investments in human capital must be paid for out of income that is not consumed or used to pay off debt and accumulate wealth. State equation (4) is now modified to:

$$\dot{W} = F(K, H) + r\left(1 + \varepsilon\left(\frac{K - W}{W}\right)\right)(W - K) - C - I_H, \;\; W(0) = W_0, \;\; H(0) = H_o \tag{4'}$$

The new objective of the representative household is to choose consumption, C, capital, K, and the flow of human capital investment, I_H, so as to maximize the discounted flow of utility (5). The resulting current-value Hamiltonian of this problem is[13]:

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[12] As pointed out by Barro and Sala-I-Martin (2004, p. 168), one could alternatively consider the new asset to be any form of capital that cannot serve as collateral for borrowing on world capital markets: *"The key distinction…is not the physical nature of the capital but whether the cumulated goods serve as collateral for borrowing on world markets."*

[13] In this model we do not allow for the possibility of quantitative capital controls to save space, but the reader can easily check that such controls, by not affecting the marginal cost of capital, will have the same effects as in the *AK* model. The more general model with quantitative capital controls is available from the authors.

$$H = U(C) + l\left[F(K,H) + r\left(1 + e\left(\frac{K}{W} - 1\right)\right)(W - K) - C - I_H\right] + mI_H \tag{17}$$

The first-order conditions are (4'), (7), (9) and (17) plus the new conditions:

$$m - l \leq 0, \qquad I_H \geq 0 \tag{18}$$

$$F_K - r(1 + e) + \frac{W - K}{W} re' = 0 \tag{19}$$

$$\dot{m} = dm - lF_H \tag{20}$$

The new transversality condition is:

$$\lim_{t \to \infty}\left[\mu(t)H(t)\right] = 0\,. \tag{21}$$

Note that (19), despite abstracting from capital controls, always holds as an equality. This is of course due to the fact that $F(\cdot)$ satisfies the Inada conditions. Conditions (18) arises from the fact that $I_H \geq 0$. Note by contrast that the variable $\dot{W}$ has no restrictions on its sign. The rate of growth of the economy follows by differentiating with respect to time the first order condition shown in Equation (7), which is also valid now, $U'(C) = l$. Thus the rate of growth is,

$$\frac{\dot{C}}{C} = \frac{1}{s}\left[r\left(1 + (1 + g\,\frac{K}{W})e(\frac{K}{W} - 1)\right) - r\right]. \tag{11'}$$

Equation (11'), however, is not a "solution" for the growth rate of consumption as *K/W* is endogenous, which we determine below. Equation (11'), however, illustrates, as in the *AK* case, the apparent paradox that a more indebted economy (paying a higher marginal cost for capital) is able to grow faster than a less indebted one. This is explained by the fact that the countries that are willing and able to pay a higher cost for capital are those that have a higher productivity (in this case a higher marginal product of *K*).

Balanced Growth. We first consider the long-run or balanced growth equilibrium. Positive balanced growth is defined by the condition $\frac{\dot{W}}{W} > 0$ and *constant* over time. Using the budget constraint it can be easily seen that this means that *C/W, K/W, H/W* and *K/H* are all constant over the balanced or long-run growth equilibrium.

Positive balanced growth requires that both H and W (and, consequently K) be growing over time. That is, $I_H > 0$, $\dot{W} > 0$ and consequently, $\lambda = \mu$ (that is, condition (18) applies over the long-run equilibrium). The latter condition implies that $\dot{\lambda} = \dot{\mu}$ and that (9), therefore, equals (20). Using the explicit function for the interest rate premium, $\varepsilon(\cdot)$, the expression equating (9) and (20) becomes:

$$F_H\left(\frac{K}{H},1\right) = r\left[1 + (1 + g\,\frac{K}{W})e\,(\frac{K}{W} - 1)\right] \equiv rh \qquad (22)$$

It is also convenient to rewrite condition (19) as:

$$F_K\left(\frac{K}{H},1\right) = r\left[1 + \varepsilon\left(\frac{K}{W} - 1\right)(1+\gamma)\right] \equiv r\Omega\,, \qquad (23)$$

where we have explicitly used the homogeneity condition of $F(\cdot)$, which means that F_K and F_H are both homogenous of degree zero in K and H. Of course, while (23) holds at all points in time, equation (22) is only valid in the long-run equilibrium. Note that both h and Ω are greater than one. [14]

Equations (22) and (23) provide a simultaneous solution for the long-run equilibrium levels of K/H and K/W. Figure 2 shows the long-run equilibrium of this economy. The line KK represents all the combinations of K/H and K/W that satisfy equation (23) while HH represents the combinations of the same variables that satisfy equation (22). Given the properties of $F(\cdot)$ and $\varepsilon(\cdot)$, it is easy to see that, for values of $K/W \geq 1$, KK must be downward-sloping and HH upward-sloping. At $K/W \leq 1$ the equations (22) and (23) change as the value of e becomes zero, so that we have $F_K = r$ and $F_H = r$ with solutions $(K/H)^k$ and $(K/H)^h$, respectively. That is, for $K/W \leq 1$ the levels of K/H that satisfy these conditions become independent of W.

The lines KK and HH intersect at a point in the space above $K/W > 1$ if $(K/H)^h < (K/H)^k$. If this condition is satisfied a simultaneous solution such as the one labeled $(K/W)^*$ and $(K/H)^*$ in Figure 2 is possible. In particular, if we assume that $F(\cdot)$ is a Cobb-Douglas production function of the form $F = AK^{\alpha}H^{1-\alpha}$, where A is a positive productivity factor and $0 \leq \alpha \leq 1$ is a fixed parameter, then we obtain the following lemma:

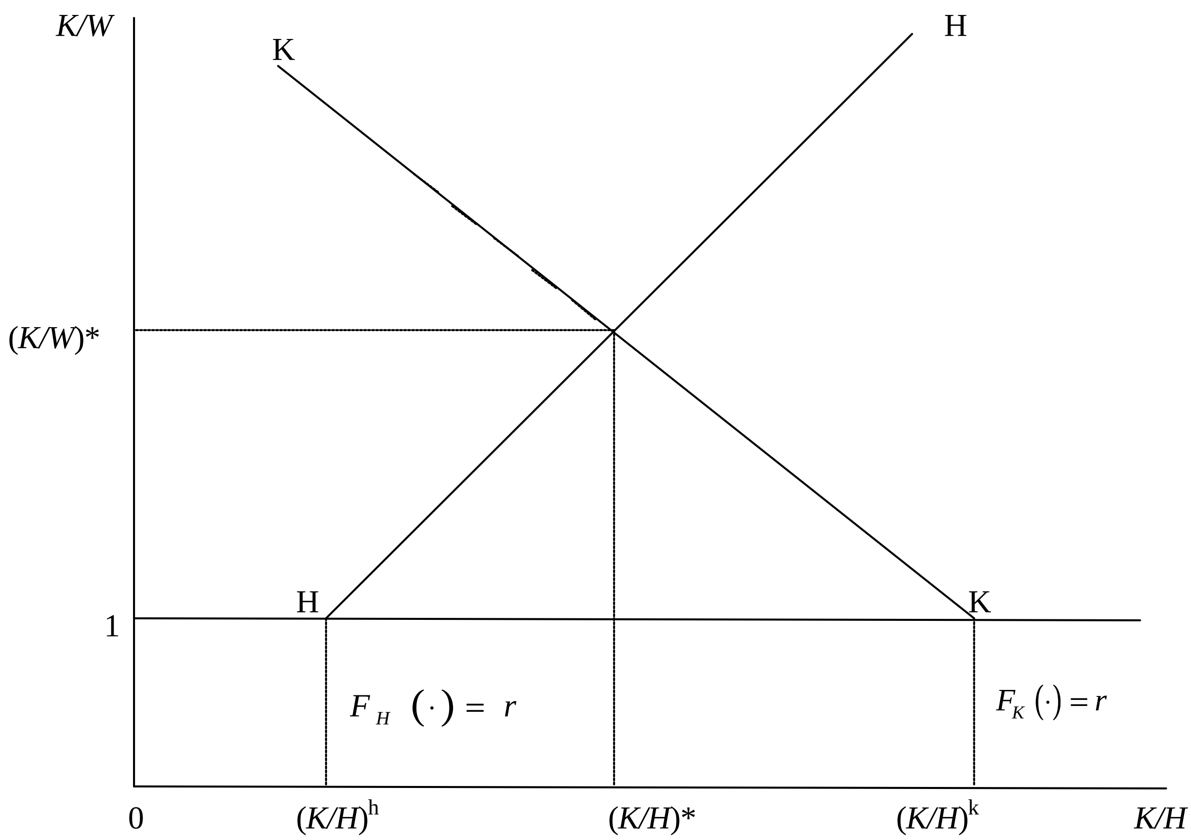
[14] Note that dividing (22) by (23) we obtain the Barro and Sala-I-Martin model's long run solution for the closed economy (when K/W = 1), yielding $F_k(K/H,1) = F_H(K/H,1)$, which solves uniquely for the long-run level of K/H.

Lemma 1. The long-run equilibrium levels (K/W)* ≥ 1 and (K/H)*, with $(K/H)^k \geq$(K/H)*$\geq (K/H)^h$, are feasible simultaneous solutions to Equations (22) and (23) if and only if $r \leq (1-a)^a a^{1-a}$.

Proof: (See appendix).

Lemma 1 says that as the share of capital, a, approaches either of its extreme values (1 or 0) and the base interest rate r is higher, it is less likely that in the long-run equilibrium the economy will become a borrower in international markets, and instead, it must depend purely on its own savings to grow.

Figure 2: Growth in the Small Open Economy with an Additional Reproducible Asset



Consider the marginal products of K and H as a function of the *K/H* ratio. Denote by $(K/H)^{\propto}$ the physical to human capital ratio at which the marginal products of each factor are equalized. Then we have:

Proposition 2: (i) If $F_K\left((K/H)^*,1\right) > r$ and $F_H\left((K/H)^*,1\right) > r$ (the high productivity economy), then the economy will become a borrower in the international markets over the long-run; that is, K/W > 1 and the condition of Lemma 1 is satisfied and the equilibrium depicted in Figure 2 is valid.

(ii) If $F_K\left((K/H)^\infty\right) = F_H\left((K/H)^\infty\right) = r$ *, then we have the close economy case, where the economy neither borrows nor lends to the outside world in the long run. The closed-economy case is of course a razor's edge solution that can happen only by chance.*

(iii) If $F_K\left((K/H)^\infty\right) = F_H\left((K/H)^\infty\right) < r$ *,(the low productivity economy) then the condition for Lemma 1 is not satisfied. A solution would lead to K/W < 1, which means that the opportunity cost of capital is just r. The economy, in the absence of capital control regulations, only accumulates financial wealth.*

Proof: From Figure 2 it is clear that, if the level of K/H at which the schedule HH cuts the line *K/W* = 1 is lower than the level of *K/H* at which the KK schedule does the same, then the two schedules may cross at a level of *K/W* > 1. That is, if $(K/H)^h < (K/H)^k$ then the economy is able to become a borrower in the world markets and thus complement domestic savings with foreign savings to finance growth. Since h and Ω are both greater than one, it follows that when evaluated at $(K/H)^*$ both F_K and F_H are greater than r. Thus case (i) follows. If, however, $(K/H)^k < (K/H)^h$ then as can be seen in Figure 2 the KK and HH schedules do not intersect at a level of $K/W \geq 1$, which means that the economy does not borrow in world markets. Such a long-run equilibrium where investment relies purely on domestic savings would imply that $F_K((K/H)^\infty) = F_H((K/H)^\infty) < r$. That is, in this case the economy's rate of return on assets is not large enough to allow domestic investment to compete with the returns on world assets. The economy becomes a lender in world markets and closes down domestic production (case iii). Finally if by coincidence $F_K((K/H)^\infty) = F_H((K/H)^\infty) = r$, then the economy does not participate in world financial markets leading to a closed-economy equilibrium as in Barro and Sala-I-Martin (2004, chapter 5) and in Mulligan and Sala-I-Martin (1993). This is case (ii). ⊗

Corollary to Proposition 2. The physical to human capital ratio of a closed-economy cannot be higher than that of an open economy that borrows internationally, i.e. $(K/H)^\infty \leq (K/H)^*$. In addition, since in the steady state $\frac{\dot{C}}{C} = \frac{1}{s}\left[F_H\left((K/H)^*,1\right) - d\right]$ and $F_K\left((K/H)^\infty,1\right) = F_H((K/H)^\infty,1) = r < F_H\left((K/H)^*,1\right) > r$ by Proposition 2 we have that the rate of growth over the long run is higher in the borrowing economy than in the closed-economy (and in the capital flight economy).

Thus, the existence of a second (non-collateral) asset that can be adjusted only gradually, and the use of a more general production function, does not fundamentally alter the results shown in Proposition 1 which assumes an *AK* production model. In Proposition 2, the long-run equilibrium sets a fixed level of the marginal product of capital. If this level is above the base rate or, equivalently, higher than the marginal product of capital in the developed countries, the domestic economy becomes open and grows faster than the giant economies despite that the small economy must pay an interest rate premium (case(i)). If the marginal product of capital when evaluated at the long-run equilibrium *K/H* ratio is by chance equal to r then the economy without intervention is self-sufficient in savings and grows as the closed-economy endogenous growth model would predict (case (ii)). Finally, if the economy's marginal product of capital is lower when evaluated at the equilibrium *K/H* ratio, we have that the production sector can survive only via capital controls that prevent the economy from being fully open.

These results are fundamentally similar to those for the one-factor open economy growth model. What does change is that now there are transitional dynamics. We turn to this issue next.

Transitional dynamics. Consider Figure 2; assume that initially $\left(\frac{K}{H}\right)^0 > \left(\frac{K}{H}\right)^*$ and that $\left(\frac{K}{H}\right)^0 < \left(\frac{K}{H}\right)^k$. That is the economy has too little *H* and too much *W*. Therefore, condition (18) applies, $m = l$ and $I_H > 0$. In this case, the economy instantaneously adjusts to the long run equilibrium level and there is no transitional dynamics. The reasons are that $\dot{W}$ and I_H are perfect substitutes and that $\dot{W}$ is unrestricted in sign. Investment in *H* can always be increased to whatever level of *H* is optimal by reducing $\dot{W}$, even to negative levels without affecting the consumption choice (thus avoiding the cost of reducing consumption smoothing that strict concavity of preferences would have otherwise caused). By contrast, if initially $\left(\frac{K}{H}\right)^0 < \left(\frac{K}{H}\right)^*$ and $\left(\frac{K}{H}\right)^0 > \left(\frac{K}{H}\right)^h$, then $m < l$ and we *do have transitional dynamics*. In this case convergence requires $\frac{\dot{m}}{m} > \frac{\dot{l}}{l}$, which means that $F_H\left(\frac{K}{H},1\right) < rh$. The intuitive explanation is that too low an initial *K/H* ratio means that the economy needs to expand *W* to allow for increasing *K* and therefore to increase *K/H* to its long run level. But since $I_H \geq 0$, increasing $\dot{W}$ can be done at the expense of I_H only up to the point at which the non-negativity constraint for I_H becomes binding. Any further increase in $\dot{W}$ can occur only through reducing consumption smoothing over time, which is increasingly costly. Thus there is a need for a gradual adjustment of *W* and hence of *K* (and of the *K/H* ratio). Transitional dynamics in this two-asset version of the model is therefore *asymmetric*; it exists when the economy is initially wealth-poor but not when it is initially human capital-poor.

Thus the transitional dynamics of this model are simple. Even over the short run the economy must be on the KK schedule (Figure 2). If the initial capital endowment ratio of the economy is $(K/H)^0$, which is lower than its steady state level $(K/H)^*$, then the economy chooses an initial ratio $(K/W)^0 > (K/W)^*$ along the KK schedule and gradually follows it until it reaches $(K/H)^*$. If *K/H* is initially higher than the steady state ratio, the economy instantaneously adjusts to its long-run equilibrium.

The model makes *two potentially testable predictions* regarding the adjustment or transitional dynamics for an economy that is sufficiently productive ($(K/H)^h < (K/H)^k$):

First, if the economy initially has a relative shortage of human capital vis-à-vis physical capital, it will increase its international debt over time (*K/W* increases) to whatever levels are needed to raise *H* to reach long-run equilibrium instantaneously.[15] Or, equivalently, building the human capital base will increase the marginal productivity of *K* which, in turn, allows the economy to afford a higher marginal cost of capital thus increasing its international borrowing. By contrast, a high-productivity economy that initially has a relative shortage of physical capital will grow over by gradually reducing its debt-to-equity ratio and its marginal financial costs.

Second, an economy initially scarce in human capital is able to expand *K/W* to its long-run equilibrium levels as soon as the investment in I_H matures. That is, an economy with a shortage of human capital will greatly increase its debt in the short run and *speed up* its rate of economic growth to its long-run equilibrium as quickly as possible. By contrast, the transition for an economy initially relatively scarce in physical capital is associated with a gradual reduction of the rate of growth over time as *K/W* falls. This prediction is in contrast with the closed-economy two-sector growth model (Barro and Sala-I-Martin, 2004, Ch. 5), which predicts that over the transitional period the rate of economic growth is *always* decreasing over time whether the economy's *K/H* ratio is initially too high or too low vis-à-vis the steady state level of *K/H*.

[15] If we interpret *H* literally as human capital, this does not mean that the economy will in fact reach long-run equilibrium levels instantaneously because of the time that needs to elapse between investing in human capital (e.g. through educational expenses, job training, etc.) and the actual increase in *H*.

4 Conclusion

Many of the important innovations in growth theory in recent years have been based on the assumption of a closed-economy. Endogenous growth models remain unrealistic in one important respect: they fail to account for the influences of a world credit market and the diversity of conditions that especially developing countries face in the international financial markets, in particular the great disparities of country risk premiums affecting their borrowing costs. Yet, recent theoretical and empirical investigations of international borrowing suggest that increasing marginal costs of borrowing for indebted developing countries is a prevalent feature in financial markets, and that the growth rates of emerging economies are especially affected by international financial conditions. (Agénor, 2004, ch.16; Bayoumi *et al.*, 1995; Reinhart *et al.*, 2003; Zoli, 2004).

The main aim of this paper has been to correct for this omission. Existing approaches derive an open-economy growth model with international borrowing and lending which have focused primarily on neoclassical growth models (Barro and Sala-I-Martin, 2004; Barro *et al.*, 1995; Cohen and Sachs, 1986). We have focused instead on endogenous growth models for open small economies. The key innovation that distinguishes our model is that we explicitly integrate endogenous country risk premiums that affect the marginal cost of borrowing on world financial markets. The country risk premium is a feature of great practical relevance among international banks in determining what effective interest rates to demand from specific countries (Agénor, 2004, ch.16; Bulow, 2002; Reinhart *et al.*, 2003). More importantly, the country risk premium is determined by both the international financial environment and responsiveness of banks to perceived country risks as well as by specific country developments that can be endogenously influenced by the country's pattern of growth at least over the long run.

Several important results emerge from this approach. First, we demonstrate that the standard endogenous growth outcome of the typical closed-economy *AK* model corresponds to a knife-edge solution to our more general growth problem, which occurs only by coincidence for a small open economy when the marginal productivity of capital and the base world interest rate are equal by chance. This suggests that the advantage of an open economy growth model such as the one we have developed in this paper is that it allows for more robust and varied outcomes than a closed-economy growth model.

Second, the latter result has an interesting implication for the relationship between debt and growth. We find that growth in the economy that is a net borrower of international funds is higher than growth in either the closed-economy case or the "capital flight" economy (whether subject to capital controls or not), even though the debtor economy faces a rising marginal cost from its increased international borrowing. That is, in order to borrow internationally, countries must be highly productive, and thus the international financial community essentially rewards these highly productive countries by lending them additional funds for domestic investment. This result suggests that the often-cited empirical finding that countries more open to capital markets tend to grow faster may provide little practical guidance for policy (Agénor, 2004; Greenaway *et al.*, 1998; Harrison and Hanson, 1999). Countries that are more open may attract more financial investment and grow faster than countries that are less open simply because the former economies are more productive in the first place and not necessarily because their greater openness increases their productivity. That is, the empirical result that correlates greater openness with growth may not necessarily mean that more capital openness causes faster growth, as is often interpreted. On the other hand, however, for a low productivity economy tighter capital controls will *cause* consumption or welfare to grow at a slower rate, although real domestic GDP may be allowed to grow as a consequence of capital controls.

Moreover, a key assumption of our model is that the base world rate is the market interest rate prevailing in the handful of "giant" (risk-free) advanced economies, whereas the rest of the world open to financial international markets must pay an interest rate premium above such a rate that is associated with their country risk. To survive, the "small" economies (the rest of the world) must have a higher productivity than the capital productivity prevailing in the giant countries if they choose to become open. The result is that high-productivity small open economies that borrow can grow even faster than the "giant" advanced economies. Alternatively, if the productivity of small open economies is lower than in the giant economies, then the former must retain restrictions to capital flows, e.g., to remain as closed or semi-closed economies. For such a low productivity economy, where its productivity is below the capital productivity prevailing in the dominant economies and therefore lower than the base risk-free world interest rate, will experience see its domestic savings migrate rapidly to other countries - the so-called "capital flight" phenomenon – if the economy remains open. According to Taylor (1998), low capital productivity in Argentina relative to rich economies triggered exactly this phenomenon during periods of the 20th century.

Third, we also find that the rate of growth in high-productivity debtor countries decreases both with the base world interest rate and with the sensitivity of marginal borrowing costs to country risk as measured by the debt-equity ratio of the country. This implies that growth in debtor countries is particularly vulnerable not only to world financial crises that raise world interest rates but also to changes in the "mood" of leading world lenders that may influence their responsiveness to perceived country risks.

Finally, we demonstrate that our model is sufficiently robust to allow it to be extended to include an additional reproducible asset, "human capital" that cannot be used as debt collateral. Such an extension eliminates the problem in the simple version of our open economy model of instantaneous capital inflow and outflow adjustments and thus the lack of transitional dynamics to a balanced growth path. However, the basic insights from the simpler version of the model do not change; in the long run under different conditions the economy can be a borrower in international markets, remain closed or simply accumulates financial wealth. In the latter two cases, the closed-economy outcome in which the economy is self-sufficient in financing its own investment now resembles the two-sector endogenous-growth model with physical and human capital (Barro and Sala-I-Martin, 2004, chapter 5; Mulligan and Sala-I-Martin, 1993). Yet this outcome also is a coincidental knife-edge solution, and what is more, we demonstrate that in the long run the physical to human capital ratio in the closed-economy cannot exceed that of the open economy that borrows internationally. For this economy, borrowing allows it to adjust its capital stock freely, and gradual accumulation of human capital will allow the economy to adjust its human to physical capital as well as its physical capital to wealth ratios to achieve optimal long-run growth. Once again, under the right circumstances debt can be “good for growth”.

The transitional dynamics of the two-factor model also yield important testable predictions. During their transition phase, and provided that they remain highly productive relative to the “giant” advanced economies, small open economies that are initially relatively scarce in the asset that can be used as debt collateral adjust slowly to their long-run equilibrium levels, while economies that have less of the asset that cannot be used as collateral adjust instantaneously to their long-run levels.

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Appendix: Proof of Lemma 1

First, we note that if *K/W* = 1 then along the KK schedule $F_K\left((K/H)^k\right) = r$, and along the HH schedule $F_H\left((K/H))^h\right) = r$. For *K/W* ≥ 1 (so that the KK and HH schedules in Figure 1 cross at *K/W* ≥ 1) we need that $F_K\left((K/H)^k\right) \geq F_H\left((K/H)^h\right)$. Assuming that $F(\cdot)$ is a Cobb-Douglas production function of the form $F = AK^{\alpha}H^{1-\alpha}$, then $F_K((K/H)^k) \geq F_H((K/H)^h)$ if and only if $\left(\frac{r}{1-\alpha}\right)^{\alpha} \leq \left(\frac{r}{\alpha}\right)^{1-\alpha}$, which means that $r \leq (1-a)^a a^{1-a}$. Suppose now that $r > (1-a)^a a^{1-a}$, then $F_K((K/H)^k) < F_H((K/H)^h)$ and, therefore, the KK and HH schedules cross at levels *K/W* < 1 and *K/H* < $(K/H)^h$ (see Figure 1).

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