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Capital Mobility and Poverty Traps in a Convex Model of Growth

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Abstract

We employ a convex model of growth, nesting both a neoclassical and endogenous growth regimes, as a framework for studying the contributions of capital accumulation to the widely documented divergence of international growth experiences. In particular, we study the importance of effective (physical) capital mobility in this respect. We show the conditions under which such mobility can give rise to what may be termed relative and absolute poverty traps. Greater effective capital mobility helps to deliver a greater global growth rate; but if unequally developed across countries, it can also help generate both relative and absolute poverty traps.

• **JEL Classification numbers:** E22, E23

• **Key Words:** Poverty traps, growth, international capital mobility, foreign direct investment

I. Introduction

A. International income disparities in the data and theory

The emergence of poverty traps has recently begun to be the focus of both public awareness and interest in the literature. Baumol (1986) may be one of the first to emphasise that less developed economies have not shared the convergence

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in productivity and standards of living that industrialised economies have experienced among themselves in the last 100 years - a phenomenon he termed “club convergence”. Jones (1997) notes the remarkable tendency between 1960 and 1988 of the frequency distribution of countries to become more bi-modal, a situation called “twin peaks”, following Quah (1993, 1996a, 1996b). A less well-known fact is also highlighted by Jones (1997), namely the absolute stagnation experienced by 11% of the economies, whose GDP per worker actually fell in the same period; several of those are in sub-Saharan Africa (see also Rodrik, 1999, p. 106).[1]

The point therefore is both that “club convergence” is the norm and not the exception in recent international experience, and also that considerable stagnation if not downright regression has co-existed with growing affluence in most parts of the planet. We may call the former situation, whereby all countries grow but at unequal rates so that their relative standards of living diverge over time, a relative poverty trap, and the latter situation, of plain stagnation or even regression, an absolute poverty trap.

These findings have generated some interest in the theoretical literature, where various possible causes of poverty traps have been highlighted. Azariadis and Drazen (1991) builds a model where the returns to education are higher if human capital exceeds a certain threshold; obviously, more advanced economies have then a tendency to grow faster. Galor and Zeira (1993) similarly focus on human capital and skill acquisition. Azariadis (1996) investigates a variety of factors such as imperfections and distortions in financial markets, consumption, international trade, and human capital formation. Durlauf and Johnson (1996) and Duffy and Papageorgiou (2000) highlight the role of the elasticity of substitution between capital and labour in generating possible multiple steady states in overlapping generations models. Graham and Temple (2001) assesses the empirical relevance of models with multiple steady states and finds that such multiple steady states go quite a lot of but not all the way towards a full explanation. So, while a number of potentially fruitful avenues have been explored, there does not seem to emerge any consensus in the literature; nor is it obvious whether the models can account simultaneously for both relative and absolute poverty traps.

[1]Based on a World Bank study, the *The* Guardian (19 June 2002, p. 24) asserts that in fact the 49 least developed countries have seen their standards of living fall in the last 30 years. The article is titled, “100m more must survive on ≤ 1 a day”.

B. International capital mobility

Capital mobility may play an important role in generating (or not) international convergence of living standards. In neoclassical growth models of open economies, Barro, Mankiw and Sala-I-Martin (1995) find that, compared to closed economy models, imperfect capital mobility can increase the convergence rate, if only marginally. In contrast, under perfect capital mobility, economies converge immediately to their steady states. Hence, if anything, capital mobility should generate more, not less, uniformity of growth experiences. Similar theoretical conclusions are reached by Quah (1996b) in the context of an endogenous growth model. For convergence however to occur, as these models imply, there should be capital flowing from developed to less developed economies, a suggestion at odds with the stylised fact that foreign direct investment (FDI) flows mostly between developed economies (Feenstra, 1999).[2] Thus, it appears that capital mobility merits more attention than hitherto it has received. The pattern of FDI flows mentioned above suggests that the flow of capital may somehow be related to the emergence of poverty traps.

Before proceeding to set the objectives of this paper, we should mention that in order to be more sharply focused, this paper narrows down the concept of capital mobility by making two important distinctions. Firstly, it distinguishes between capital flows related to physical capital accumulation, on the one hand, and the rest, which may be more speculative in nature. As Eichengreen and Leblang (2003) argue, the often negative effects of wider capital mobility may originate more from the speculative flows, whereas FDI may be associated more with positive, resource allocation-related effects. Physical capital mobility, or FDI, seems to be the focus of the growth papers mentioned above and is also our focus here - the terms may be used interchangeably.[3,4]

Second, while the legal freedom of capital to move may be high, in practice

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[2]More than 85% of total outflows originated in developed economies in the 1980s and 90s, and more than 60% of total inflows were received by those countries.

[3]Edwards (1999) demonstrates, with reference to the Latin American experience, that FDI-related capital flows bear little relation to overall capital flows.

[4]FDI is usually defined as those flows that result in the acquisition of more than 10% of the equity of a foreign firm. International capital mobility in the wider sense includes FDI and also equity acquisition on a smaller scale, capital movements related to currency or financial instruments speculation, account transfers, etc.

there may exist informal impediments. Such impediments include lack of familiarity with foreign business and administrative practices, red tape, corruption, or simply the well-documented home portfolio bias (see Obstfeld, 1995). In other words, the legal and effective degrees of international capital mobility are conceptually separate (Edwards, 1999). Our subject here is the latter, and in particular the extent to which foreign capital receives the same effective treatment in the host country as the native capital (see the parameter H below). Henceforth, capital mobility is exclusively taken to be the effective (as just defined) degree of physical capital mobility.[5]

C. Objectives and structure of the paper

Prompted by the observed parallel between the emergence of poverty traps and lack of physical capital flows in parts of the less developed world, this paper builds a framework for understanding the emergence of poverty traps and investigates theoretically whether capital mobility (in the sense defined above) is related to them. The effective capital stock employed in an economy consists of the home-owned, home-employed one, plus the foreign-owned, home-employed one, appropriately weighted by its effective degree of integration in the home economy and ability to confer profit opportunities to its owner; this is captured by H below, an index of the effective degree of physical capital mobility. This parameterisation is the first analytical innovation of this paper.

The model builds upon the convex model of growth investigated in Jones and Manuelli (1990) and suggests that nesting a neoclassical and an endogenous growth ("AK) model may provide a fruitful framework of analysis to capture the diverse growth experiences that have been observed. This is a second analytical innovation.[6] This nesting can provide a crucial threshold for differentiating growth experiences, as the former is associated with endogenous growth while the latter is not, because of diminishing returns to capital.

The paper is organised as follows. We introduce in section 2 the specification of

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[5]In talking about capital mobility, physical or otherwise, a useful distinction can be made between *ex ante* mobility, i.e. the freedom (legal or effective) of capital to move, and *ex post* mobility, i.e. the resulting capital flows. While conceptually distinct, however, the two are in practice closely linked; see Results 1 and 2 below. Hence, we talk generically about (effective) capital mobility.

[6]Indeed, that nesting may be an asset of the model, bridging much of the cross-country empirical work on growth (largely based on the Solow model) with the purely theoretical endogenous growth literature.

effective physical capital mobility. We proceed in section 3 to introduce the complete model, based on consumer intertemporal optimisation. A third analytical device we employ (this time borrowed from Aoki, 1980) is the separation of the system into averages and differences and the concomitant analysis of steady states in sections 4 and 5. Section 6 investigates poverty traps. A number of results are highlighted along the way, and are summarised in Section 7 which draws policy conclusions. A longer version of this paper, available on the web (http://www.econ.lgu.ac.uk/~tsoukis/poverty traps.pdf), discusses several of the points in more detail and allows us to concentrate on the key results here.

II. Production function, capital stock(s) and capital mobility

We begin by introducing our production function, which takes the form:

$$Y = \tilde{K}^{\beta}(\phi A^{\gamma} + (1+\phi)L^{\gamma})^{(1-\beta)\gamma}, \qquad 0 < \phi,\ \beta,\ \gamma < 1$$

Y is output, K is capital (and the tilde indicates the effective capital stock, defined below), A is technology and L labour (which is assumed identical to population). This is very similar to the standard neoclassical production function, except that technology and labour are substitutes. Productivity can be labour-augmenting or labour-saving, depending on γ (> or < 0). In this way, constant returns to all factors, including A, are maintained. The marginal product of capital would not fall to zero, even asymptotically, guaranteeing perpetual growth.[7]

Furthermore, this can be simplified in a tractable way. Consider $A = \tilde{K}$ (the simplest statement of the fact that technology may grow at the rate of physical capital growth and may indeed be embodied in it); there are various reasons why physical capital may be linked to productivity, including externalities from learning-by-doing, the existence of capital-embodied technical progress, and government services that are proportional to private output. We also normalise labour units such that:

$$Y = \Phi\tilde{K} + \tilde{K}^{\beta}L^{1-\beta}, \qquad \Phi \equiv [\phi/(1-\phi)]^{(1-\beta)/\gamma} \tag{1}$$

This provides a rationale for the specification used by Jones and Manuelli (1990), provided one is interested (like here) in capital deepening and not long-term technical progress as such. The importance of the (potentially) endogenous growth

[7]Moreover, it would not depend on the level of population or labour, thus avoiding controversial scale effects (asymptotically).

Table 1. Types of capital stock

Ownership	Domestic employment	Foreign employment	Total
Domestic	K	K_*	$\bar{K} \equiv K + K_*$
Foreign	K^*	K_*^*	$\overline{K^*} \equiv K^* + K_*^*$

component of the production function increases with the importance of technology, and (if $\phi < 1/2$) with the importance of physical capital and with the degree of substitutability of technology and labour (the lower this is, i.e. the more labour-saving technology, the better for endogenous growth). Implicitly, F also increases with any (once-and-for-all, exogenous) improvements in productivity.

The exact counterpart of (1) applies for the foreign economy - foreign variables (and equations) will be indicated by *:

$$Y^* = \Phi\tilde{K}^* + \tilde{K}^{*\beta}L^{*1-\beta} \tag{1*}$$

Time subscripts are not used, as continuous time techniques will be employed. For tractability, foreign technological (but not institutional) parameters are assumed identical to the domestic ones. Apart from convenience, this assumption will serve to highlight the fact that country differences in growth rates and other key variables can emerge as a result of differences in capital mobility even under completely symmetric technology.

There are two types of capital stock available, owned by domestic and by foreign firms. We assume that the two are imperfectly substitutable - see equation (2) below, so that both types of capital are employed domestically and abroad.[8] Hence, the following grid of capital stocks emerges, where star subscripts or superscripts indicate foreign employment or ownership, respectively:

Importantly, each type of capital stock (domestically or foreign-owned) is the same whether employed at home or abroad. The effective aggregate capital stock in the production of each economy (which appears in 1) is defined as,

$$\tilde{K} \equiv (K^{\rho} + H^{\rho}K^{*\rho})^{1/\rho}, \quad 0 \le \rho < 1,\ 0 \le H \le 1. \tag{2}$$

K is home-owned, home-employed capital and K* is foreign-owned capital employed domestically. The function above aggregates over the two different types of capital, so r is closely linked to the elasticity of substitution between the

[8]We may think of all projects in the economy as joint ventures, involving the somewhat different capital and firms of both countries.

two capital inputs.[9] H is the effectiveness of foreign capital and the index of the *effective* (as opposed to legal) degree of capital mobility, as analysed. The limits of (2) are K when there is no mobility (so any foreign capital employed here is completely unproductive and irrelevant for the effective capital stock) and the standard CES aggregate $(K^{\rho} + K^{*\rho})$ in the case of perfect capital mobility (H=1). As mentioned, the foreign equation exhibits symmetry in its rate of` substitution but not effective capital mobility:[10]

$$\tilde{K} \equiv (K_*^{*\rho} + H^{*\rho} K_*{}^{\rho})^{1/\rho} \tag{2*}$$

How much of the domestically-owned capital will be employed here and how much abroad? Elimination of all profit opportunities by firms equalises the marginal products of capital employed here and abroad (adjusted by the exchange rate). (As mentioned, this condition rests on the premises that each type of capital is the same stock, whether employed at home or abroad, so that their price and the interest rate they face are common.) Formally,

$$\frac{\partial Y}{\partial K} = E\frac{\partial Y^*}{\partial K_*}, \tag{3}$$

where starred output is the foreign one and E is the real exchange rate (foreign price level over the domestic, both in home currency units). Similarly for the foreign firm:

$$\frac{\partial Y}{\partial K_*}E^{-1} = \frac{\partial Y^*}{\partial K_*^*} \tag{3*}$$

Substituting from (1) and (2) into (3) and (3*), dividing by sides and taking logs we have:

$$\frac{x + x^*}{2} \equiv x^A = \frac{\rho\eta^A}{1-\rho} = z^A \equiv \frac{z + z^*}{2} \tag{4^A}$$

Where, $X \equiv K^*/K,\ X^* \equiv K_*/K_*^*$; and, $Z \equiv K_*/K,\ Z^* \equiv K^*/K_*^*$ show the ratios of

[9]The relation between the elasticity of substitution between different types of capital ψ and ρ is ρ=(ψ-1)/ψ, ψ≥1. The limits of ρ are 0 (the lowest possible degree of substitution) and 1 (capital goods infinitely substitutable, i.e. virtually the same stock. We shall assume that substitutability is quite high, therefore the approximations that follow will be taken around ρ=1.

[10]As with variables, foreign equations are indicated with a *. Later on, when the distinction between averages and differences emerges, the equations are going to be labelled accordingly.

immigrant and emigrant stock of capital relative to the home owned and employed one. As is standard, logs are indicated by lower-case letters (with respect to both variables and parameters, so that e.g. $\eta \equiv \log H$). As indicated above, in the averages (i.e., a closed) system, immigrant and emigrant stocks are equal. Both increase with effective capital mobility (less impediments to capital). They decrease with greater substitutability between the two types of capital (because $\eta^A \leq 0$). In the polar cases of complete discrimination against foreign capital (H=0) and/or low substitutability between types of capital (ρ=0), there is no outflow of capital. In the case of perfect capital mobility (H=1), each country deploys the capital under its ownership at home and abroad in equal measure. We can summarise as:

Result 1a: Better effective treatment of foreign capital generates a greater degree of participation of foreign capital in the capital stock.

As mentioned, we are going to work with the averages-differences method of arranging our system (see Aoki, 1980). Accordingly, the equations will be arranged along the (A-D) dual form. The differences counterpart of (4^A) is obtained by logging (3, 3*), using (2, 2*), and adding by sides; furthermore, by utilising the approximation (around $Z=Z^*=Z^A$, $H=H^*=H^A$). This allows us to log-linearise the effective-to-domestic capital ratio,

$$\Lambda \equiv \tilde{K}/K = (1 + (HX)^{\rho})^{1/\rho}, \tag{5}$$

as follows:

$$\log\Lambda = (1/\rho)\log(1 + H^{\rho}X^{\rho}) \approx \omega/\rho + \frac{\omega(\eta^D + x^D)}{2(1+\omega)},$$

so that,

$$(\log\Lambda)^D \approx \frac{\omega(\eta^D + x^D)}{(1+\omega)} \tag{6}$$

where $\omega \equiv (HX)^{A\rho}$. Similarly for all the other terms appearing in when spelling out (3, 3*) fully. Hence, we obtain:

$$x^D \equiv x - x^* = \frac{2\beta K^D - 2e + (1-\Omega)\eta^D}{\Omega} \tag{4^D}$$

$$1 > \Omega \equiv \frac{(1-\rho)(1-\omega)}{(1+\omega)} > 0$$

We will find it useful to work with a "grand ratio" that will play a prominent part in our analysis, indicated by the (Greek letter) $K \equiv (\tilde{K}/L)^{\beta-1}$. This labour-capital ratio can be interpreted as the productivity of capital. The quantity Ω decreases as product substitutability and (global average) capital mobility increase; it vanishes for perfect integration of foreign capital (H=1, so that X=1, too) and perfect substitutability of capital (ρ=1). Thus, we need to restrict those parameter values accordingly, so that the denominator be strictly positive. Hence we have:

<u>Result 1b:</u> The inflow of capital increases with its productivity at the host country, with its better integration there (H) and decreases as the host country's currency weakens (because the proceeds of foreign investment are valued less). It can be checked easily that all of these effects intensify as the capitals become closer substitutes ($\rho \to 1$) and as the integration and quantity of foreign capital in the average economy improves ($\omega \to 1$).

III. The full model

Having described the production function, the specification of capital mobility and derived the foreign capital shares, we now turn attention to the full model along the more traditional lines of consumer and producer optimisation. While the focus is not on labour mobility, we employ a simple population growth specification to see its influence on the effects of capital mobility. Population growth will be assumed exogenous in the averages system (i.e., globally), but it will be purely endogenous (i.e., immigration) when differences between countries are concerned.

The backbone of the model is a consumption growth equation of the standard "Keynes-Ramsey" form. At the beginning of history (or on arrival), each individual plans for him/herself, without caring for others. The evolution of *per capita* consumption is given by:

$$\dot{C}/C - g_L = \sigma(r^C - \theta) - g_L \tag{7}$$

r^C is the consumption-based real interest rate; in contrast to the pure rate, the consumption-based rate is common across countries and equals the average pure real interest rate. σ is the inverse of the intertemporal rate of substitution in consumption and θ the rate of time preference. g_L is the population and employment growth rate.

The model is closed by firms' equating of their marginal product of capital with the interest rate:

$$r = (\Phi + \beta K)\Lambda^{1-\rho} \tag{8}$$

By (3), this is also equal to the marginal product of the capital employed abroad.

As stated, we shall employ Aoki's technique of compartmentalising the system into aggregates and differences. Let $y^A \equiv (y + y^*)/2$ and $y^D \equiv y - y^*$, for any variable y, be the average and difference of *y*. Section 4 analyses the averages and section 5 the differences system. The original variables are recovered by $y = y^A + y^D/2$ and $y^* = y^A - y^D/2$. As is customary in the growth literature, we focus on steady states, whereby case consumption growth equals general output growth. When endogenous growth is involved and capital and output are growing faster than labour, the labour-capital ratio will be perpetually falling; for this reason, we focus on asymptotic steady states, when this ratio is zero.

IV. The averages system

Our averages system consists of the averages equations for (7) and (8) with $r^{CA}=r^A$ and $\Lambda^A \equiv \tilde{K}^A/K^A = (1 + H^{A\rho}X^{A\rho})^{1/\rho}$. We note that Λ^A is a constant (cf. 4^A). With the understanding that in this section we are dealing with averages, superscripts are from now on dropped. Combining (7) with (8) to substitute r out, we have in the steady state:

$$g = \sigma[\Lambda^{1-\rho}(\Phi + \beta K) - \theta] - g_L \tag{9^A}$$

Where g is per capita growth rate of consumption, capital and output.

Two regimes emerge in the asymptotic steady state (around which all the discussion centers), and we now turn to their analysis. The first arises if the terms on the RHS of (9^A) add up to a positive amount with K=0; the per capita growth term on the LHS is positive, which would in turn generate the asymptotic steady state with K=0 described above. In this case, the world economy finds itself in a regime of perpetually growing per capita capital, output and living standards: The endogenous growth (EG) regime. If, on the other hand, the LHS is negative, then the capital-labour ratio growth rate will be temporarily negative, restoring K (essentially the labour-capital ratio) to a finite value, so as so make the RHS equal to zero. In this case, the world economy finds itself with constant per capita capital and output and stagnation in its living standards. This is the neoclassical (N) regime.[11]

Hence, two regimes naturally arise in the model that form a continuum. A necessary and sufficient condition for EG to emerge is:

$$\sigma[\Phi\Lambda^{1-\rho} - \theta] - g_L > 0\,, \tag{10A}$$

Accordingly, endogenous growth emerges if the marginal productivity and importance of the broad capital stock, adjusted for cross-border capital mobility, is high enough, and in particular higher than the standard benchmark of time preference plus population growth. On the other hand, the labour-capital ratio in the N-regime can be derived from (9^A) with g=0.

The effects of international capital mobility (we take Λ to be the relevant index, as in the averages system it depends directly on H), are as follows:

$$\left.\frac{\partial g}{\partial \Lambda}\right|_{EG} = (1-\rho)\sigma\Phi\Lambda^{1-\rho} > 0$$
$$\left.\frac{\partial K}{\partial \Lambda}\right|_{N} = -(1-\rho)\frac{\theta + g_L/\sigma}{\beta\Lambda^{2-\rho}} < 0 \tag{11}$$

(Real, effective) Capital mobility enhances per capita growth, but only if the global economy finds itself in the EG regime. Such mobility also benefits living standards in the N regime, but only in a step-wise and not permanent fashion. In other words, we have:

<u>Result 2:</u> The Endogenous Growth and Neoclassical regimes form a continuum. There is a threshold given by,

$$\Lambda = ((\theta + g_L/\sigma)/\Phi)^{1/(1-\rho)} \tag{12}$$

that separates the two regimes and allows for stagnation or not of living standards. Better treatment of foreign capital results in a higher growth rate, but only after having reached this threshold.

V. Differences system

We shall now re-introduce average-difference superscripts because both emerge

[11] Perpetually falling living standards (g<0) is not admissible, because that will augment K on the RHS, bring the RHS to zero and restore the N regime. Strictly speaking, absolute impoverishment in the sense of continuously falling living standards cannot be generated, but would make little sense in the real world, anyway. As mentioned in the Introduction, we call perpetual stagnation an absolute poverty trap.

in this system. (7) now becomes:

$$\dot{c}^D = \sigma(r^C - r^{C*}) \tag{7^D}$$

where the consumption real interest rate is hypothesised to be related as follows to real interest rate depreciation:

$$r^C = r + \mu\dot{e}\,,\ r^{C*} = r^* - \mu^*\dot{e}\,,\quad \Rightarrow r^{C,D} = r^D + \bar{\mu}\dot{e}\,, \tag{13}$$

$$\mu,\ \mu^* > 0\,,\ \bar{\mu} \equiv \mu + \mu^*$$

From the firm's problem, we also have:

$$r^C = \sigma(\Lambda^{1-\rho}(\Phi + \beta K))^D \tag{8^D}$$

Now combining (7^D) and (8^D) in the steady state, using (13), we obtain,

$$g^D = (\Lambda^{1-\rho}(\Phi + \beta K))^D - g_L^D + \bar{\mu}\dot{e}\,, \tag{14}$$

where it should be reminded that g is per capita growth.

Real exchange rate depreciation has been introduced above to relate the consumption-based and the GDP-based real interest rates. In order to avoid augmenting the dimensions of our system, we invoke the well-known Balassa-Samuelson empirical regularity, whereby the countries with higher physical capitalisation also become more expensive over time. Hence, the country with the fastest-growing labour/capital ratio is depreciating in real terms, so that we can write,

$$e = \varepsilon K^D\,,\ \varepsilon > 0\,. \tag{15}$$

Furthermore, the difference in population growth is endogenous in this system, reflecting labour mobility (as the pure population growth differential is assumed zero); this is for simplicity assumed to respond to the difference in wage (the marginal product of labour) enjoyed in the two countries, if that is static, or else in the difference in the growth rates of the capital-labour ratios. We therefore assume:

$$g_L^D = -\lambda(K^D - g^D)\,,\ \lambda > 0 \tag{16}$$

An increase in λ, the responsiveness of mobility to the real wage, would be a natural measure of greater integration and labour mobility. We can also linearise:

$$\dot{K}^D \approx (\beta - 1)g^D\,. \tag{17}$$

Thus, we obtain:

$$g^D = \sigma\Lambda^{A,1-\rho}\beta K^D + \sigma\Lambda^{D,1-\rho}(\Phi + \beta K^A) + \lambda(K^D - g^D) + \bar{\mu}\varepsilon(\beta - 1)g^D \quad (18)$$

(18) must be complemented by (6) and (4^D) derived in Section (2).

The global economy may now find itself in one of four regimes, listed below. It must be stressed that all the outcomes refer to (asymptotic) steady states:

1. (Convergence) Both economies may be in the endogenous growth regime (so that $K=K^*=K^D=0$), with equal growth rates ($g^D \neq 0$). This regime arises if the two economies are identical in all respects, technologically but also in terms of treatment of foreign capital. They will thus converge to the same living standards regardless of their starting point in terms of the initial labour capital ratio, which is the standard neoclassical result.

2. (Relative poverty trap) Again, both countries are in EG mode, but with persistent differences in the growth rates of the capital-labour ratio: $g^D \neq 0$.

3. (Absolute poverty trap) One of the countries may be having endogenous growth, with the other being in the Neoclassical regime, implying a conspicuous divergence in living standards. The world economy is in this case in an endogenous growth regime (since at least parts of it are perpetually growing), which however masks absolute stagnation in some quarters. In this case, we have (with Home being the one in EG mode for simplicity): $g=g^D=g^A/2 > 0$, $g^*=0$, $K=0$, $K^* = -K^D > 0$. We note also that, as the global capital stock is increasing, we will have, $K^A=0$.

4. (Universal stagnation) Both economies are in the N regime, $g=g^*=0$, with equal or unequal capital-labour ratios.

Regimes 1 and 4 may be discarded as uninteresting for our purposes. Regimes 2 and 3 serve as organising principles for the discussion below.

VI. Poverty traps

A. Relative poverty traps and "twin peaks"

Even with identical technology, the model gives rise to relative poverty traps or "twin peaks" in international income distribution in the terminology of Jones (1997) and Quah (1996a), if growth rates differ as a result of differences in the treatment of foreign capital. Specifically, persistent changes in endogenous growth rates will arise so long as the world economy is in the endogenous growth regime

(K^A=0) and g^D≠0 with K^D=0 are admissible in the system above; in other words, if

$$(1 + \lambda + \sigma\varepsilon\bar{\mu}(1 - \beta))g^D = \sigma\Phi\frac{1 + \omega(1 + \eta^D + x^D)}{1 + \omega} \neq 0\,. \tag{19}$$

Home (Foreign) is the one that grows faster if g^D>0 (g^D<0). In this light, the role of capital mobility is crucial in generating endogenous growth differences. More formally (let it be remembered that K^A=0):

$$\frac{\partial g^D}{\partial \eta^D} = \frac{\sigma\Phi\omega}{(1 + \lambda + \sigma(1 - \beta)\bar{\mu}\varepsilon)(1 - \omega)(1 - \rho)} > 0\,. \tag{20}$$

The average mobility (implicit in the effectiveness and extent of foreign capital in the global economy as captured by ω) exacerbates the effect a certain asymmetry in H (H/H*) has on the growth rate. We thus have:

Result 3: *Ceteris paribus*, increasing *average* world-wide capital mobility exacerbates the differences in growth rates.

B. Countries spanning the two regimes (absolute poverty traps)

This is the case whereby one country's living standards are growing, when another one is stagnating. A prerequisite for that is that the world is in EG regime. In this case, from (18), the growth differential becomes:

$$(1 + \lambda + \sigma\varepsilon\bar{\mu}(1 - \beta))g^D = \sigma\Lambda^{A,1-\rho}\beta K^D + \sigma\Phi\omega(\eta^D + x^D)/(1 + \omega) + \lambda K^D \tag{21}$$

If it happens that $|g^D|<2g^A$, both countries experience perpetual growth, albeit at different rates, so that we are in the case of a relative poverty trap, analysed above. In this case, K^D=0 and (21) boils down to (18). If, on the other hand, $|g^D|>2g^A$, then one of the growth rates is negative, tending to produce a finite K, which will raise the marginal product in that country, restoring zero growth in the steady state. The only other possibility is therefore $|g^D|=2g^A$, which entails one country growing and the other stagnating - an absolute poverty trap. The stagnating country will, *ceteris paribus*, be the one with the worst treatment of foreign capital. From now on, and without loss of generality, let us assume that Home is the strongest economy, so that $g=g^D=2g^A$. It is also obvious that in this case, we shall end up with sgn(K^D)≠sgn(g^D). The living standards of the stagnating economy will depend (inversely) on the labour-capital ratio, which can then be obtained from (21) (noting that $K^*=-K^D$).

In the light of this argument, the necessary and sufficient condition under which this type of trap emerges can be formalised as (without loss of generality),

$$g^D \geq 2g^A \text{ when } K^D=0 \text{ in (21).} \tag{22}$$

Using (6) and (10^A), this implies:

$$\sigma\Phi\frac{1+\omega\eta^D(1-\omega)(1-\rho)}{(1+\lambda+\sigma\bar{\mu}\varepsilon(1-\beta))} \geq 2\sigma((1+\omega)^{(1-\rho)/\rho}\Phi-\theta)-2g_L^A \tag{22'}$$

with $\omega \equiv (HX)^{A\rho}$.

Some further information can be gleaned about the effects of advancing globalisation. Maintaining a given ratio of domestic to foreign effectiveness (H/H*), advancing X^A and ω changes as follows the two sides of the above:

$$\frac{\eta^D}{(1+\omega)^2(1-\rho)(1+\lambda+\sigma\bar{\mu}\varepsilon(1-\beta))} vs \frac{2(1-\rho)}{\rho}(1+\omega)^{(1-2\rho)/\rho}. \tag{23}$$

The LHS is likely to be the smallest of the two at least when capital market integration and product substitutability are low. Hence, when international capital market integration (in the sense employed here) is low, changes in it are unlikely to produce regime differences. However, after a point, further changes will be working towards exceeding the threshold (22') which produces such regime differences, i.e. the country lagging behind is pushed over to the Neoclassical regime and stagnates.

Result 4: Physical capital mobility and FDI may be important for the emergence of poverty traps in a dual way. First, differences between countries in this respect may, *ceteris paribus*, produce differences in regimes (one country in EG, the other in N). Second, the more this mobility has proceeded worldwide, given individual country differences, the more likely it is that such asymmetries emerge.

VII. Conclusions

This paper studies the role of physical capital mobility in the growth process and in particular in the emergence of poverty traps. The motivating point is a number of parallel observations: First, both absolute and relative (“twin peaks”) poverty traps seem to be emerging in the world economy, in the midst of unprecedented and growing affluence for many, perhaps most, countries. At the same time, capital flows, in particular those directly related to physical investment, also exhibit this dual quality: Overwhelmingly, such flows occur among industrialised economies. As a result, the question arises whether the two (poverty traps and limited foreign direct investment) are related.

The paper builds a convex model of growth, which nests both a neoclassical and an endogenous growth regime. This at once both unifies these two strands of growth theory and generates a crucial threshold to account for diverging growth experiences. A second analytical innovation is the incorporation of effective (as distinct from official) physical capital mobility in growth analysis, captured by H - an index of the treatment foreign capital receives. This definition of capital mobility is well-defined yet rich enough: To the extent that international capital market integration and financial liberalisation entail foreign capital tending to have the same opportunities as native capital, such developments are generally implied by our definition here of capital mobility.

A number of results emerge: Real capital flows (or FDI) rise (both on average and between individual countries) when foreign capital is better treated in recipient countries. More importantly, as a result of the nesting described above, various conditions emerge that determine whether the global economy, or more crucially individual countries, get locked into poverty traps of some kind. Differences in capital mobility (in the sense described above) can play a crucial role here. Additionally, these individual differences are shown to have more powerful effects when global capital mobility is more advanced.

In other words, international capital mobility, and in particular the treatment of foreign physical capital by its recipient country, plays an important role in the process of growth and rising living standards. Most strikingly, such capital mobility emerges as a double-edged sword, in that it can confer huge benefits to average growth in the world economy; however, it also increases the danger of generating huge asymmetries in the growth experiences. These results may be interpreted as not boding well for the future world income distribution. This has obvious policy implications for policy-makers, who should try and discriminate *in practice* against foreign physical capital as least they can. To the extent that it works towards this goal, financial liberalisation should also be welcome.

References

Aoki, M. (1980), *Dynamic Analysis of Open Economies*, New York: Academic Press.

Azariadis, C. (1996), The Economics of Poverty Traps: Part One: Complete Markets, *Joural of Economic Growth*, 1, 4 (December), 449-96.

__________ and A. Drazen (1990), Threshold Externalities in Economic Development, *quarterly Journal of Economics*, May, 501-25.

Barro, R.J., N.G. Mankiw and X. Sala-i-Martin (1995), Capital Mobility in Neoclassical Models of Growth, *American Economic Review*, 85, 1 (March), 103-115.

Baumol, W. (1986), Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show, *American Economic Review*, 76, 5 (December), 1072-85.

Duffy, J. and C. Papageorgiou (2000), A Cross-Country Empirical Investigation of the Aggregate Production Function Specification, *Journal of Economic Growth*, 5, March, 87-120.

Durlauf, S.N. and P.A. Johnson (1995), Multiple Regimes and Cross-Country Growth Behaviour, *Journal of Applied Econometrics*, 10, 365-84.

Edwards, S. (1999), Capital Flows to Latin America: A Stop-Go Story?, Chapter 1.1, in Feldstein (1999).

Eichengreen, B. and D. Leblang (2003), Capital Account Liberalization and Growth, National Bureau of Economic Research WP #w9427.

Feenstra, R.C. (1999), Facts and Fallacies about Foreign Direct Investment, Chapter 6.2 on Feldstein (1999).

Feldstein, M. (1999), *International Capital Flows*, Chicago: Chicago University Press for the National Bureau of Economic Research.

Galor, O. (1996), Convergence? Inference from Theoretical Models, *Economic Journal*, 106 (July), 1056-69.

________ and J. Zeira (1993), Income Distribution and Macroeconomics, *Review of Economic Studies*, 60, 35-52.

Graham, B.S. and J. Temple (2201), Rich nations, poor nations: how much can multiple equilibria explain? University of Bristol, mimeo, September.

Jones, C.I. (1997), On the Evolution of the World Income Distribution, *Journal of Economic Perspectives*, 11, 3 (September), 19-36.

_________ and R. Manuelli (1990), A Convex Model of Equilibrium Growth: Theory and Policy Implications, *Journal of Political Economy*, 98, 5(1), 1008-38.

Obstfeld, M. (1995), International Capital Mobility in the 1990s, in P. Kenen (ed.), *Understanding Interdependence*, Princeton: Princeton UP.201-61.

Quah, D.T. (1996a), Convergence Empirics Across Economies with (Some) Capital Mobility, *Journal of Economic Growth*, 1 (March), 95-104.

Quah, D.T. (1996b), Twin Peaks: Growth and Convergence in Models of Distribution Dynamics, *Economic Journal*, 106 (July), 1045-55.

_________ (2001), Cross-Country Growth Comparison: Theory to Empirics, Chapter 16 in, J. Dreze (ed): *Advances in Macroeconomic Theory, Proceedings of the Twelfth World Congress of the International Economic Association*, vol.1, London: Palgrave.

Rodrick, D. (1999): *The New Global Economy and Developing Countries: Making Openness Work*, Washington DC: Overseas Development Institute *Policy Essay* No. 24.