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**Working Paper**

## Two-gap models: Post-keynesian death and neoclassical rebirth

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**Dieter Bender**  
**Wilhelm Löwenstein**

# **Two – Gap Models: Post-Keynesian Death and Neoclassical Rebirth**

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Dieter Bender  
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Two-Gap Models:  
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and Neoclassical Rebirth

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## **Part I: Two-Gap Models: Post-Keynesian Death**

### **1 Introduction**

Two-Gap Models of development are essentially rooted in the Post-Keynesian growth models for closed economies as designed by Harrod (1939) and Domar (1946) who tried to identify the pre-conditions which needed in order to enable an industrialized economy, in this case the U.S., to reach a steady-state equilibrium of growth. As the analysis shows the steady state in a Harrod-Domar world is always challenged by short-term instabilities which are triggered off by changes in aggregate demand and which materialize in boom times through cyclical inflation, and in times of recession through cyclical unemployment. In the early 1960s the Harrod-Domar approaches were adapted to open economies in the so-called Third World (Little (1960), Chenery and Bruno (1962), McKinnon (1964), Chenery and Strout (1966)).

In the Third-World context the fight against cyclical unemployment caused by a "labor demand gap" lost most of its importance in the light of unlimited supplies of labor assumed to be prevalent in developing countries (Lewis (1954), Bliss (1989)). The labor demand gap was replaced by a savings gap and by a foreign currency gap as a consequence of the diagnosis that, for realising a given growth target, first, domestic savings are low to finance the investment needed (savings gap) and, secondly, the inflows of foreign exchange are too small to finance the imports of capital goods needed (foreign currency gap). Both gaps, as proposed by the Two-Gap Model, can be bridged by foreign aid or by net capital imports, respectively, so that, if applied to a specific country, it is very easy to calculate the necessary inflow of aid or net-capital imports to reach a pre-defined growth target for a given country. This simplicity explains, why even today, a big percentage of World Bank country desk officers apply Two-Gap Models for projecting financing needs and why the models still belong to the standard tool box of Regional Development Banks and of the IMF (Easterly (1999)).

In current academic debates focusing on more modern growth theories Two-Gap Models are marginalized as a result of the following model-inherent assumptions.

#### **Two-Gap Models**

- solely focus on the availability of savings and foreign exchange, fail to identify the allocation of savings and foreign currency as a central theme and, consequently, neglect the importance of an efficient use of these resources for fuelling growth. As a result these models assume a 1 to 1 relation between aid inflows or capital imports and investment and exclude all other potential uses of the resources;

- assume the capital-output ratio to be constant which in turn means a constant average and marginal productivity of capital;
- take production factors as non-substitutable.

These assumptions prove to be highly unrealistic if Two-Gap Models are applied to explain long-term growth dynamics in developing countries. However, if applied to short-term growth projections as it is done by International Finance Institutions (IMI) much of this criticism, but not the one on the postulated 1 to 1 relation, is put into perspective again which might excuse the IMIs from using outdated economic models for their back of the envelope projections. From this starting point a popular version of the Two-Gap Models is thoroughly analysed for model-inherent inconsistencies in chapter 2 of this first part of the paper. Chapter 3 is devoted to a short presentation of some empirical evidence and includes some concluding remarks on this first part.

## 2 Why the Post-Keynesian Two-Gap Model is a One-Gap Model

Starting from the equality of investment (I) and savings (S) and distinguishing investment and savings with respect to their origin one gets

$$I = I_d + I_f = S_d + KIM = S \quad (1)$$

with index 'd' denoting developing country variables (domestic), index 'f' indicating variables of foreign origin and KIM the developing country's net-capital imports (new debts minus repayment of old debts) from the industrialised world.

(1) shows that if the sum of planned investment is split up into investment goods of domestic origin and into imported investment goods exceeds domestic savings then this savings gap can be bridged by net-borrowing from abroad. It goes without saying that this savings gap cannot be larger than the available capital imports:

$$\frac{I_d}{Y} + \frac{I_f}{Y} - \frac{S_d}{Y} \leq \frac{KIM}{Y} \quad \text{with } Y: \text{ domestic GDP} \quad (2)$$

As (3) shows is the investment rate which can be realised in the developing country restricted by the sum of the domestic savings rate ( $s = S_d/Y$ ) and the capital import ratio ( $kim = KIM/Y$ ):

$$\frac{I}{Y} = \frac{I_d}{Y} + \frac{I_f}{Y} \leq s + kim \quad (3)$$

If one augments both sides of (3) by  $dY/dY$  and considers that  $dY/Y$  is the country's GDP growth rate ( $gY$ ) and that the identity of aggregate investment and change in the capital stock ( $I_d = dK_d$  and  $I_f = dK_f$ ) holds one gets the growth rate of GDP restricted by the availability of savings ( $s$ ). (4))

$$gY \leq \frac{1}{dK_d/dY + dK_f/dY} \cdot (s + kim) = \frac{1}{k_d + k_f} \cdot (s + kim) \quad (4)$$

with the constant average (= marginal) capital-output ratio  $k_d$  for the capital stock of domestic and  $k_f$  for the capital stock of foreign origin assuming  $k_d < k_f$ . From (4) can be concluded that the scope for economic growth can be widened by either a reduction of domestic consumption, i.e. by an increase of  $s$ , or by the further accumulation of foreign debt, i.e. by increasing  $kim$ .

The savings restriction on the GDP growth rate as defined by (4) can be drawn as a linear function which is increasing in  $kim$  (s. fig. 1).

The developing country's capacity to import (IM) consumer goods (index 'C'), intermediate inputs (index 'ii') and capital goods (index 'K') is, in the absence of a foreign currency reserve, restricted by the country's exports (EX). This restriction is expanded through net-capital imports which can be used to supplement export earnings for the financing of imports:

$$IM_C + IM_K + IM_{ii} \leq EX + KIM \quad (5)$$

Defining  $EX - IM_C - IM_{ii} = PTA$ , the primary trade account balance, and considering that the import of capital goods ( $IM_K$ ) can be rewritten as  $I_f$ , following the notation in equation (1), one can solve (5) for  $I_f$  which discovers that a country's capacity to realise a given import ratio for capital goods is restricted by the sum of the country's primary trade balance ratio and capital import ratio:

$$\frac{I_f}{Y} = \frac{dK_f}{Y} \leq \frac{EX}{Y} - \frac{IM_C}{Y} - \frac{IM_{ZW}}{Y} + \frac{KIM}{Y} = pta + kim \quad (6)$$

As the identities of  $dK_f/Y$ ,  $dK_f/dY \cdot dY/Y$  and  $dK_f/dY \cdot gY$  hold we can express (6) as the growth rate of GDP restricted by the availability of foreign currency:

$$gY \leq \frac{1}{k_f} \cdot (pta + kim) \quad (7)$$

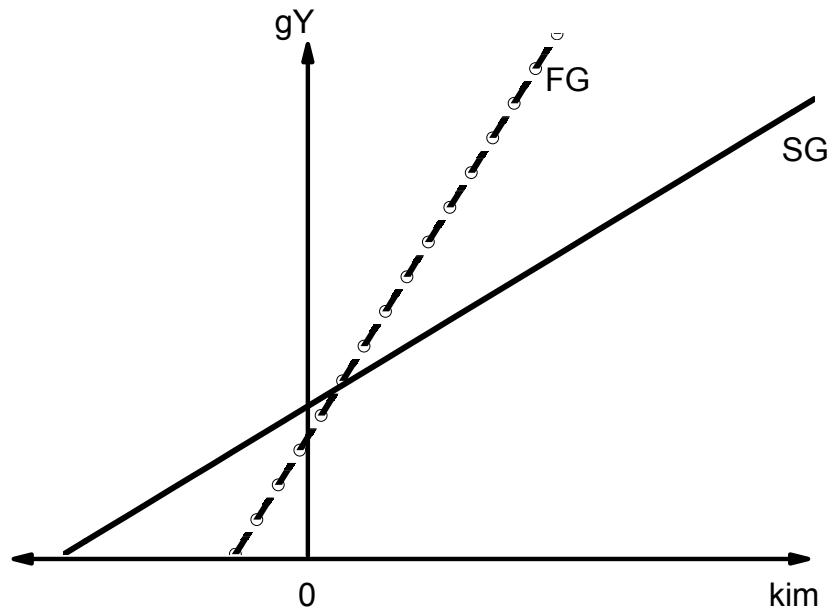
As well as the savings restriction on the GDP growth rate [(SG), see equation (4)] we can also draw the foreign currency restriction on the GDP growth rate [(FG), see equation (7)] as a linear function which is increasing in  $kim$  (s. fig. 1). In textbooks SG and FG are usually drawn for capital import ratios equal or bigger than zero. For the sake of the following arguments we are drawing the full picture, i.e. integrating negative capital imports into our graph.

As can be seen from fig. 1 both, SG and FG, allow for a positive growth rate of GDP even if  $kim$  equals zero. This requires for SG (FG) that the savings rate  $s$  (the primary trade account balance ratio  $pta$ ) of the country in view is non-negative. Comparing (4) and (7) makes clear that the savings restricted GDP growth rate in a  $gY$ - $kim$ -



diagram has a slope which is smaller than the one of the foreign currency restricted GDP growth rate as  $k_d$ , which is an argument in (4) but not in (7), is bigger than zero. Hence, SG, the curve representing all combinations of  $gY$  and  $kim$  which satisfy the savings restriction on growth (4), is flatter than FG, the curve representing all combinations of  $gY$  and  $kim$  which satisfy the foreign currency restriction (7).

Fig. 1: GDP growth rate restricted by savings (SG) and by foreign currency (FG) and capital import ratio



As both restrictions are to be satisfied simultaneously one usually concludes from fig. 1 that at lower GDP growth rates first FG is binding. Exceeding a certain capital import ratio, i.e. beyond the intersection of both curves, FG becomes redundant and SG becomes the binding restriction to GDP growth. What lessons can be learnt from the model behind fig. 1?

1. It teaches that development financing from foreign debt closes the savings gap as well as the foreign currency gap and widens the scope for growth according to (4) and (7), i.e. walking along SG and FG in fig. 1.
2. It shows that reducing consumption supports economic growth (see (4)), i.e. an upward shift of SG.
3. Improving the primary account trade balance by reducing the imports of consumer goods and intermediate inputs (import substitution) and/or increasing exports (export diversification) in accordance to (7) widens the foreign currency restriction on GDP growth, i.e. an upward shift of FG.
4. A debt service which is reducing net capital imports and which rises in response to the accumulation of foreign debt compromises GDP-growth as more and more of the country's foreign currency is absorbed by the debt

service which is no longer available for the imports of highly productive capital goods from abroad (see (7)), i.e. a downward shift of FG.

Despite the fact that most of these lessons are common sense among economists some of them are wrong, as we will show in part II of this paper, and most of them rely on a chimaera.

To show the inherent inconsistencies of the Two-Gap Model it is useful to analyse the axis intercept of SG and FG on the abscissa. There, it holds that  $gY = 0$  and it automatically follows from (4) that  $-kim = s$  and from (7) that  $-kim = pta$  if (4) and (7) are satisfied simultaneously. In consequence it must hold that if  $gY = 0$  that  $-kim = s = pta$  which means nothing else than a sharing of the same abscissa intercept by SG and FG. As a consequence we have to redraw figure 1.

Fig. 2: A Two-Gap Model which is a One-Gap Model

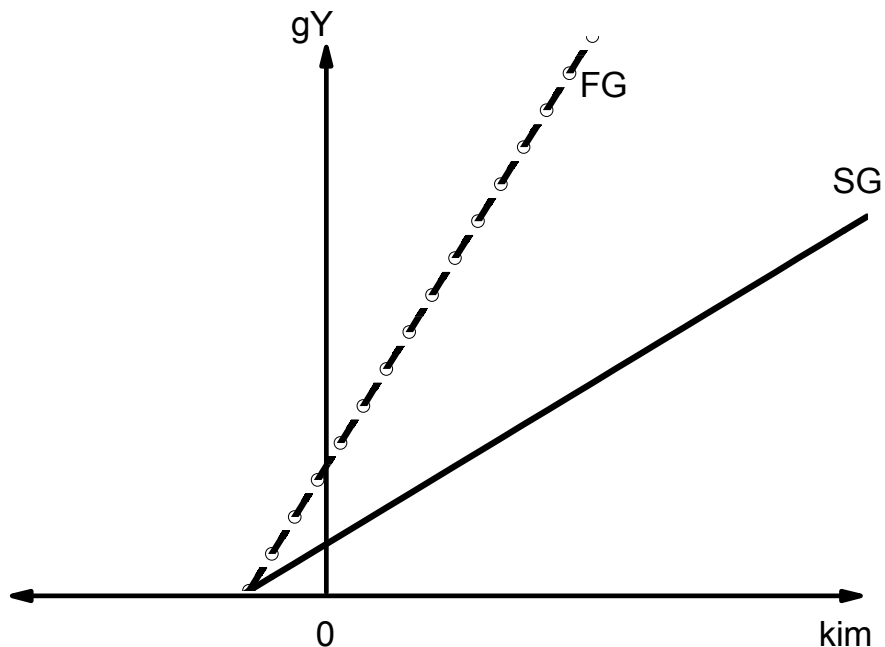


Figure 2 indicates that there are still two restrictions on growth, FG and SG. But as both curves share the same abscissa intercept and FG has a slope steeper than that of SG the foreign currency restriction on growth is never binding: FG always runs above SG (Löwenstein (2004)).

At the abscissa intercept the GDP of the country in view is growing with a rate of zero and the country is net exporter of capital ( $kim < 0$ ). This net export of capital is financed by domestic savings ( $-kim = s$ ) and materialises through the country's primary trade account balance ( $-kim = pta$ ).

With the capital import ratio approaching zero the country's GDP grows with increasing rates

- as there are more and more domestic savings available which are used to realise more and more investment ( $\Delta I_d > 0$ ),
- as more and more capital goods can be imported ( $\Delta I_f > 0$ ).

At given values for  $s = pta$  the growth of GDP and the increases in  $I_d$  and  $I_f$ , as triggered off by a negative capital import ratio approaching zero, guarantee that the capital output ratios,  $k_d$  and  $k_f$ , remain constant. Any increase of  $kim$  will bring about a savings rate restricted GDP growth rate which is rising by  $1/(k_d + k_f)\Delta kim$  and a foreign currency restricted GDP growth rate which is rising by  $1/k_f\Delta kim$ . The latter is always smaller than the former, hence, the latter is binding.

Obviously, the availability of domestic savings supplemented by capital imports is now imposing the only binding restriction on the growth dynamics. The country's GDP will at maximum grow in accordance to SG as defined by equation (4). The so-called Two-Gap Model only proves to be based on one gap so that the underlying approach corresponds to a Harrod-Domar Model that is explicitly augmented by capital imports. The lessons that can be drawn from this model do not differ from those of a traditional Harrod-Domar Model: increasing the savings rate 's', no matter whether financed by a domestic reduction of consumption ( $\Delta s > 0$ ) or by a reduction of consumption abroad ( $\Delta kim > 0$ ) leads to an increasing growth rate of GDP (see lessons 1 and 2, above). We have demonstrated that the Two-Gap Model does not add any further insights in addition to those already offered by the Harrod-Domar Model so that it merits its death even in the Post-Keynesian world.

### **3 Empirical Evidence and Concluding Remarks**

In this chapter we are testing a dead model to find out whether Two-Gap Models at least can demonstrate some empirical appeal. In this section we largely borrow from Löwenstein (2004). We are estimating the savings and the foreign currency restricted growth rate of GDP (see equations (4) and (7) with equalities in place of inequalities) for 67 low and middle income countries from the tropical belt for the period from 1980 to 1999. The estimations of SG and FG are designed as linear OLS-type regressions which are mis-specified as including a constant. We did so to allow for an interpretation of our statistical results which in the case of excluding the constant would differ sharply from those obtained from standard OLS-estimates. Both approaches regress the GDP growth rate on one independent variable each, i.e. the sum of  $s$  and  $kim$  for testing SG and the sum of  $pta$  and  $kim$  for testing FG. The data sets used are taken from the World Bank's World Development Indicators 2001. The

variable 's' is calculated as the fraction of gross national savings over GDP. kim is the yearly change in debt (plus the negligible inflows of foreign direct investments to the tropical countries) over GDP. pta =  $IM_k/Y$  is the share of imports of manufactures in percent of GDP.

The coefficient of the savings restricted GDP growth rate in (4) which is  $(1/(k_d + k_f))$  is the reciprocal value of the sum of the capital output ratios of domestically produced ( $k_d$ ) and imported capital goods ( $k_f$ ). With respect to  $k_f$  literature reports a bandwidth between 2.5 and 6.5 (Bender (1995), World Bank (1996a), World Bank (1996b), Fadel (2002) and NEAC). Assuming that the capital coefficient of imported investment goods equals 1.5 the size of the regression coefficient is expected to be found in a bandwidth between 0.125 und 0.25. Such expectations on the bandwidth of the regression coefficient can also be expressed for the estimate of FG. With  $k_f$  between 2.5 and 6.5 we expect for the regression coefficient of FG  $0,15 < 1/k_f < 0.4$ . In addition the variables in both approaches, i.e. (s+kim) in SG and (pta+kim) in FG are expected to positively affect the growth rate of GDP.

Tab. 1: Savings gap (SG) and foreign currency gap (FG)  
in a long term cross-country analysis

Approach	Constant	t-statistics (constant)	Coefficient		t-statistics (coefficient)	R <sup>2</sup> (in %)	Observations (years)
			$1/(k_d+k_f)$	$1/k_f$			
SG	0.654	1.856	+0.149		7.559	46.8	67
FG	2.961	1.774		-0.00064	-0.031	0.0016	67

Table 1 supports our theoretical findings that the foreign currency restriction on GDP growth is not binding. The availability of foreign currency earned from exports of goods and from capital imports only explains 0.0016% of the variation of the 67 countries' GDP growth rates.

The case of savings restriction on GDP growth is different. The estimate of SG explains 46.8% of GDP growth rate variation and proves to be efficient under the F-Test. Furthermore, the estimate of the regression coefficient brings about a result which is located within the expected bandwidth and which proves its significance under the t-test.

Unfortunately, this statistically highly efficient estimate is not to be taken for granted as it explains long term growth dynamics based on a One-Gap Harrod-Domar-type model which, as illustrated by the above cited neoclassical criticism, might only be valid for short term projections. Such short term projections can be based on regression analyses of time series from single countries. As here the short term impact of the independent variable on the GDP growth rate matters we have to

consider a time lag (Easterly 1999). As a consequence, we specify (4) as  $gY_t = 1/(k_d+k_f) * (s + k_m)_{t-2}$ . Table 1 shows the results of estimating SG for 21 countries in the tropics on the basis of time series with a length of at least 20 years.

Tab. 2: Savings gap (SG) in an analysis of time series

Countries	Constant	t-statistics (constant)	$1/(k_d+k_f)$	t-statistics ( $1/(k_d+k_f)$ )	R <sup>2</sup> (in %)	Observations (years)
Bolivia	2,855	0,985	-0,086	-2,055	17,43	22
Botswana	7,178	1,821	0,029	0,288	0,39	23
Brazil	3,005	0,776	-0,015	-0,057	0,02	23
Cameroon	7,787	1,073	-0,238	-1,252	5,90	27
Colombia	4,282	1,731	-0,033	-0,185	0,14	27
Cote d'Ivoire	2,186	0,474	-0,029	-0,587	1,62	23
Ecuador	2,404	0,599	0,004	0,056	0,02	22
El Salvador	5,623	1,108	-0,317	-1,547	10,69	22
Ghana	3,118	0,774	-0,004	-0,039	0,01	23
India	6,474	2,087	-0,064	-0,204	0,17	27
Jamaica	0,751	0,232	0,034	0,782	2,97	22
Malaysia	9,770	2,347	-0,090	-0,968	4,08	24
Nicaragua	0,312	0,044	-0,040	-1,687	13,02	21
Nigeria	1,450	0,267	0,042	0,660	2,24	21
Paraguay	-0,011	-0,003	0,266	2,473	19,65	27
Philippines	1,360	0,344	0,058	0,479	1,19	21
Senegal	2,611	0,559	0,028	0,310	0,44	24
Sri Lanka	5,807	4,326	-0,049	-0,900	3,71	23
Thailand	12,508	2,671	-0,207	-1,621	11,12	23
Trinidad and Tobago	-1,298	-0,291	0,159	2,418	21,78	23
Venezuela, RB	3,211	0,685	-0,054	-0,794	2,46	27

In contrast to the specification from (4) our regression approach underlying the results presented in tab. 2 is again and for the above reasons mis-specified as including a constant. Evaluating tab. 2 indicates that the estimates of the constant for 18 out of the 21 countries proves to be insignificant from zero which is in line with equation (4). As noted above the regression coefficient  $1/(k_d+k_f)$  is either expected to show a positive sign under the regression and a size of the coefficient in a bandwidth between 0.25 und 0.125. Table 2 shows that the expectations with respect to the coefficient's sign are only met by the estimates for eight out of the 21 countries. From these eight estimates of the regression coefficient only two, those for Paraguay and for Trinidad and Tobago, show a size close to the anticipated bandwidth and prove to be statistically efficient in the light of the F- and the t-test.

The empirical test of the savings restriction on GDP growth brings about disillusioning results: the regression approaches prove to be statistically efficient for

long term estimates for which the theoretical fundament is very weak and they are statistically inefficient for short term projections for which the theoretical basis is a little stronger.

This statistical inefficiency might be caused by the wrong assumption of a 1 to 1 relation between capital imports and investment (= savings) as postulated by equation (4) which would add empirical evidence to the general neoclassical criticism of this Post-Keynesian model.

It is well-known that neoclassical models of economic growth challenge the Post-Keynesian view on the effects of increasing  $s$  and  $k_{im}$  on GDP growth. In a neoclassical world these increases only result in a higher GDP growth rate in times of transition towards a new steady state. There, the country finds itself with a higher per capita income but with a growth rate of GDP which has fallen back to the rate of population growth. In part II of this paper we argue that these findings only hold for increases in the savings rate and we show that increasing  $k_{im}$  by lending abroad in general does not result in a higher but in a lower per capita income and, therefore, we are speaking of "Immiserizing Capital Flows to Developing Countries" in part II.

## **Part II: Two-Gap Models: Neoclassical Rebirth**

### **1 Introduction**

Most of the Solow-type models of economic growth focus on closed economies. They do not show if or how opening up an economy will affect the rates of growth of GDP and per capita income over the short, medium and long term. Exceptions are e.g. Tyler (1981), Feder (1982), Kavoussi (1984), Ram (1987), Moschos (1989), Chanthunya and Murinde (1998) who focus on positive externalities and economies of scale brought about by the production of export goods.

Linkages between openness and growth have more recently been analyzed by the younger generation of endogenous growth models (s. Rivera-Batiz and Romer (1991), Rebelo (1992), Fisher (1995), Lee (1995)). Most of these models concentrate on the effects of trade liberalization on economic growth.

Dismantling barriers to trade and integration into world markets for goods is one important and indispensable part of a development strategy of (joining) globalization. Furthermore, those “new globalizers” also have to decide how far to open the capital account, too, by eliminating controls of international capital flows and integrating into international financial markets. Compared to growth theoretical studies of trade deregulation, relatively few studies address the question of how international capital flows after opening up the capital account will affect economic growth (Eicher and Turnovsky (1994), Dalgaard, Hansen and Tarp (2004)).

Our study addresses this relatively neglected chapter of growth dynamics in open economies under the framework of a traditional Solow-type neoclassical model. This open economy Solow-Model will be applied to a low income developing country (LIC) where low savings restrain the potential for investment-driven growth (savings gap). Opening up to the international financial markets may pave the way out of a poverty trap in which a number of LICs are caught. If domestic investors (via domestic commercial banks) gain access to world financial markets, the savings gap could be overcome by financing domestic (excess) investment out of the savings from high income countries (HICs) i.e. by capital imports. These capital imports can take the form of commercial or – in the case of a LIC – concessional lending abroad, foreign direct investment (FDI) inflows and portfolio investment by foreigners. Our study focuses on investment financing through foreign loans (from international capital markets and financial aid). The effects of these capital imports are analysed with a “two gap version” of a neoclassical Solow-Model of a small, open LIC-economy whose second gap coming from opening up is the shortage of foreign exchange needed to finance imports of goods (foreign exchange gap).

Two or even three gap models of economic development (Chenery and Bruno (1962), McKinnon (1964), Chenery and Strout (1966), Bacha (1990), Taylor (1994)) have lost much of their attractiveness to development economists after becoming discredited by their Harrod-Domar-type modelling of growth dynamics under the assumptions of an always constant capital output ratio and non-substitutable factors of production. Although still the favourite model used in International Financial Institutions (such as the World Bank, and the IMF) for projections of capital import requirements and the realization of growth targets, this “Financial Gap Model” advocates two propositions which are not supported by evidence: (1) Capital imports will flow into investment one by one and (2) at least in the short run there will be a fixed linear relationship between investment and growth (Easterly (1999, 2003)).

In our study, the best case scenario of proposition (1) shall be maintained and proposition (2) is lifted. Extending this familiar neoclassical approach to an augmented financial gap model, it will be shown that this allows a simultaneous analysis of the interactions between growth and debt dynamics. With this framework which overcomes the weaknesses of Harrod-Domar-type development gap models, it will be demonstrated that even if foreign loans go into investment one by one this can lead to a lower level of per capital income and does not provide a way out of poverty traps as is commonly believed. Such cases of “immiserizing capital inflows” are no exception from the rule, but rather the rule than the exception.

The proof is developed in the following three chapters. Chapter 2 models the growth dynamics in a small open LIC which finances development by borrowing abroad. Chapter 3 models the debt dynamics following these capital imports. Chapter 4 brings both of these adjustment processes together in a “LIC growth-cum-debt model”, which reveals the conditions for the case of immiserizing capital inflows. Chapter 5 presents the empirical evidence.

## **2 Growth Dynamics**

This model is an extension of a structural closed economy one-sector neoclassical growth model which will be applied to a small open LIC where the growth potential is highly restrained by too low domestic savings and by foreign exchange shortages. GDP consists only of consumption goods produced for the domestic market and for export. There is no domestic production of capital goods. Expenditures for equipment investment flow into imports of capital goods (Hendricks (2000)). Investment-driven growth of potential output will only be possible, if the imports of capital goods and thus investment outlays can be financed out of foreign exchange earnings. Foreign exchange inflows are earned from exports of consumption goods (EX). Foreign



exchange outflows are equal to the sum of expenditures on imports of consumption goods ( $IM_C$ ) and capital goods ( $IM_K = I$ ).

This LIC produces a GDP of  $Y = C + I + EX - IM_C - IM_K = C + EX - IM_C$ . Now the trade account balance ( $TA = EX - IM_C - IM_K$ ) is split up into the primary trade account balance or balance of trade in consumption goods ( $PTA = EX - IM_C$ ) and the balance of trade in capital goods which is negative ( $-IM_K = -I$ ). The current account balance ( $CA = PTA - I - iD$ ) is smaller (larger) than the trade account balance if interest payments on the stock of foreign debts (assets) are flowing out (in) the case of  $D > 0$  ( $D < 0$ ).

The rate of interest ( $i$ ) is exogenous and constant as long as the implicit assumption of an infinitely elastic loan supply curve holds for the small LIC that is a price taker on world markets for goods and financial assets.

Gross domestic product which can be written

$$Y = C + PTA$$

is used for consumption ( $C$ ) and gross savings ( $S$ ):

$$Y = C + S$$

and gross savings are used for financing domestic investment and interest payments on foreign debt. From these definitions therefore

$$Y - C = S = PTA$$

follows. Over the long term, the savings ratio ( $s = S/Y$ ), consumption goods import ratio ( $im = IM_C/Y$ ) and export ratio ( $ex = EX/Y$ ) are assumed to be constant and are exogenously given;  $S = sY$ ,  $IM_C = imY$ ,  $EX = exY$ .

The LIC's growth potential is restricted by two gaps. One the one hand a savings gap restrains domestic investment:

$$S - iD < I \quad \text{or} \quad S < iD + I \quad (SG1)$$

Domestic savings after deducting interest payments (net savings) are smaller than planned investment. Planned investment will be realized if the savings gap can be bridged by net capital imports (new debt minus repayment of old debt):

$$KIM = \dot{D} = I - (S - iD) \quad (SG2)$$

(a dot above a variable indicates the change of that variable over time).

On the other hand, a foreign exchange gap limits imports of capital goods:

$$PTA - iD < I, \quad (FG1)$$

if net inflows of foreign exchange ( $PTA - iD$ ) do not cover the outflows caused by planned investment ( $I = IM_K$ ).

Planned investment will only be realized if the condition

$$KIM = \dot{D} = I - (PTA - iD) \quad (FG2)$$

is met. Since by definition the primary trade account balance is equal to gross savings ( $PTA = S$ ), conditions (SG2) and (FG2) are identical. If net foreign borrowing covers the savings gap, the foreign exchange gap is bridged, too.

Therefore, the investment ratio ( $I/Y$ ) can be derived from either (SG2) or (FG2) which is divided through  $Y$  (all of the other variables defined as a percentage of GDP are written in small letters):

$$\frac{I}{Y} = s + kim - id = pta + kim - id. \quad (8)$$

If the rate of interest, debt ratio ( $d = D/Y$ ), interest burden ratio ( $id = iD/Y$ ) and savings ratio would be given and constant, there would exist a one-to-one relationship between the capital import ratio ( $kim = KIM/Y$ ) and the investment ratio ( $I/Y$ ): if capital imports of 5 percent of GDP could be realized, the investment ratio would be 5 percentage points higher than under a closed capital account. But this reasoning is, of course, incorrect because  $kim > 0$  (after opening the capital account) leads to an increasing debt and interest burden ratio. Therefore, net savings (in percent of GDP) decline. The interaction of growth and debt dynamics makes the debt ratio and the net savings ratio become endogenous variables.

The rates of growth of GDP and per capita income are derived in the conventional way from the neoclassical production function

$$Y = K^\alpha L^{1-\alpha} \quad (0 < \alpha < 1), \quad K : \text{physical capital stock}, L : \text{labor input} \quad (9)$$

and the per capita version

$$y = \frac{Y}{L} = K^\alpha L^{-\alpha} = k^\alpha \quad k = \frac{K}{L} : \text{capital-labor-ratio}. \quad (10)$$

GDP grows at a rate of ( $g$  indicates the rate of change of a variable)

$$gY = \alpha gK + (1 - \alpha)gL.$$

Assuming that  $gL$  is determined by the rate of population growth ( $n$ ), i.e. a constant percentage of the population is employed, the growth equation yields:

$$gY = n + \alpha(gK - n) \quad (11.1)$$

$$gy = gY - n = \alpha(gK - n) = \alpha gk \quad (12)$$

The rate of growth of the capital stock is determined by the investment ratio and the capital output ratio ( $v \equiv K/Y$ ):

$$gK = \frac{I}{K} = \frac{I}{Y} \frac{Y}{K} = \frac{I/Y}{v} \quad (13)$$

The capital output ratio is an increasing function of the capital labor ratio:

$$v = \frac{K}{Y} = K K^{-\alpha} L^{-(1-\alpha)} = k^{(1-\alpha)}.$$

Inserting (15) in (13) yields

$$gK = \frac{s + kim - id}{v} = (s + kim - id) k^{-(1-\alpha)}$$

and therefore

$$\begin{aligned} gY &= n + \alpha \left[ \frac{s + kim - id}{v} - n \right] \\ &= n + \alpha [(s + kim - id) k^{-(1-\alpha)} - n] \end{aligned} \quad (11.2)$$

The reformulation of (11.1) demonstrates that the rates of growth of capital stock and GDP will decline, whenever the capital labour ratio or the debt ratio increases. Therefore, an increase in the capital import ratio ( $\Delta kim$ ) has a much weaker effect on economic growth than an increased savings ratio ( $\Delta s = \Delta kim$ ), because  $\Delta kim > 0$  leads to  $\Delta d > 0$ . Without integrating these debt dynamics into the LIC growth model, nothing can be said about the transitory and long-term effects of capital imports on per capita income and foreign indebtedness cannot be ascertained.

### 3 Debt Dynamics

The change of the debt ratio over time is

$$\dot{d} = \frac{\dot{D}Y - \dot{Y}D}{Y^2} = \frac{\dot{D}}{Y} - \frac{D}{Y} \frac{\dot{Y}}{Y} = \frac{\dot{D}}{Y} - dgY.$$

Inserting (SG2) or (FG2) delivers

$$\dot{d} = \frac{I - S + iD}{Y} - dgY = \frac{I - PTA + iD}{Y} - dgY.$$

Therefore, debt dynamics are shown by

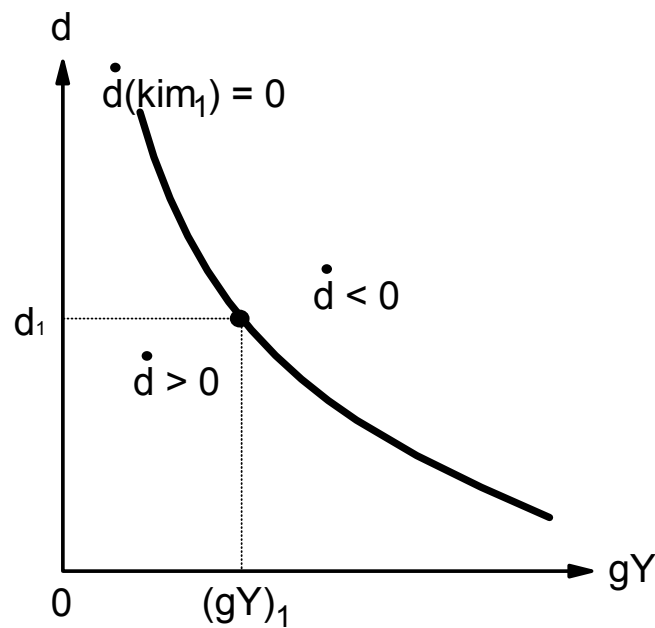
$$\dot{d} = \frac{I}{Y} - pta - (gY - i)d = kim - dgY. \quad (14)$$

Debt ratios are increasing ( $\dot{d} > 0$ ) as long as the existing debt ratio weighted by the GDP growth rate is smaller than the capital import ratio ( $dgY < kim$ ). If  $dgY > kim$ , debt ratios are declining ( $\dot{d} < 0$ ). Since  $\dot{d} = 0$  if  $dgY = kim$ , the condition for a stable debt ratio:

$$d\left(\dot{d} = 0\right) = \frac{kim}{gY} \quad (15)$$

can be represented in a  $gY$ - $d$ -diagram (s. fig. 3).

Fig. 3: Equilibrium debt ratio and GDP-growth



The hyperbola in figure 3 resulting from (15) indicates all combinations of GDP growth rates and debt ratios, where, for a given capital import ratio, the debt ratio remains unchanged. This Iso Debt Curve assigns an equilibrium debt ratio to any rate of GDP-growth. The higher  $gY$ , the lower will be the debt ratio which is accumulated out of a given  $kim$ . Higher (lower) levels of an Iso Debt Curve represent higher (lower) capital import ratios. Points above (below) an Iso Debt Curve show that the debt ratio lies above (below) the equilibrium level of indebtedness and, therefore, from  $d > kim/gY$  ( $d < kim/gY$ ) it follows that  $\dot{d} < 0$  ( $\dot{d} > 0$ ). If  $d$  is higher (lower) than the equilibrium value, it will fall (rise) and converge to a (stable) debt equilibrium where  $gD = gY$  and  $\dot{d} = 0$ .

#### 4 Growth and Debt Dynamics

As is well-known, neoclassical models distinguish the growth stages of transition and steady state. During transition, the rates of change of endogenous variables ( $gK$ ,  $gY$ ,

$gD, gk, gv, gy, gd$ ) follow an upward or downward trend. All of these trends approach the steady state where all of these rates of change stay constant:  $gK = gY = gD = n$ ;  $gk = gv = gy = gd = 0$ .

It follows from (11.2) that growth dynamics are in the stage of transition as long as  $(s + kim - id)k^{-(1-\alpha)} \neq n$ . If  $(s + kim - id)k^{-(1-\alpha)} > n$ , then  $gK > n, gk > 0, gY > n, gy > 0$  and from  $gk > 0$  it follows that  $gK, gY, gk, gy$  must decline until the steady state equilibrium condition  $(s + kim - id)k^{-(1-\alpha)} = n$  is met.

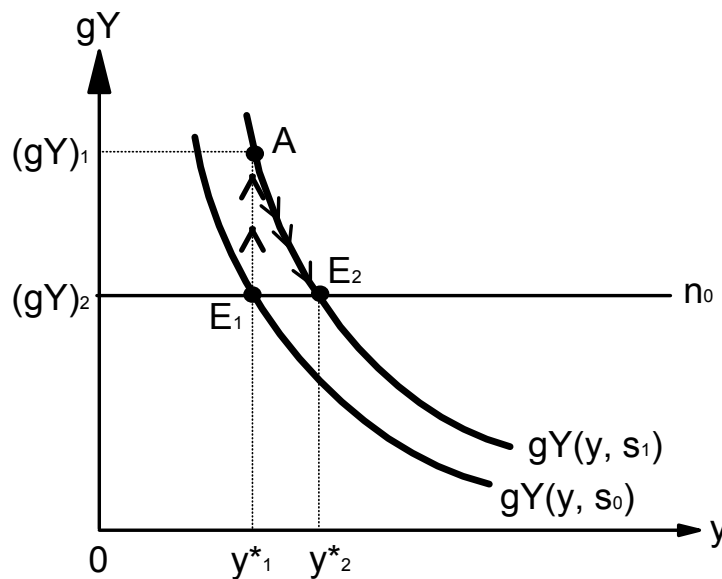
(15) indicates that the downward trend of the GDP growth rate during transition is accompanied by an upward trend of the debt ratio ( $\dot{d} > 0$ ) and therefore by  $gD > gY$ . These debt dynamics are transitory, too, as a decreasing  $gY$  which converges to the steady state growth  $gY = n = \text{const.}$  implies that the debt ratio also converges to a steady state equilibrium level of  $d = kim/n$  (for  $kim = \text{const.}$ ).

The transitional and steady state dynamics of GDP growth can be represented in a  $gY$ - $y$ -diagram (s. fig. 4). The graph shows the Growth Curve  $gY(y, s_1, kim_1, d_1)$  that can be derived by inserting the inverse of (10):  $k = y^{1/\alpha}$  into (11.2). This results in

$$gY = n + \alpha \left[ (s + kim - id)y^{-\frac{(1-\alpha)}{\alpha}} - n \right]. \quad (16)$$

Equation (16) demonstrates that (for given values of  $s, kim, d$  and  $n$ )  $gY$  is higher when  $y$  is lower (conditional convergence).

Fig. 4: GDP-growth dynamics in transition and in the steady state



The Growth Curve is shifted to the right by an increase in the savings rate, the export ratio or the capital import ratio and by a decrease in the import ratio, debt ratio or interest rate.

The steady state is determined by the intersection point  $E_1$  where the equilibrium rate of GDP growth is  $gY = n$  and GDP per capita is  $y = y^*_1$  (asterisks indicate steady state equilibrium values). The growth dynamics are shown by movements along the Growth Curve which come to a halt at point  $E_1$ . Every point on the Growth Curve other than  $E_1$  exhibits transitional growth dynamics. An increase in the savings rate from  $s_1$  to  $s_2$  shifts the Growth Curve upwards by the same amount as an increase in the capital import ratio by  $\Delta kim = s_1 - s_0$ . However, the long-term effects of these shocks differ. The transitional acceleration of growth and the increase in the level of GDP per capita created by the higher savings ratio is shown by the adjustment path  $E_1 \rightarrow A \rightarrow E_2$ , whereas the higher capital import ratio leads to rising debt ratios (downward shifts of the Growth Curve) and therefore to a different adjustment path from A to an E-point which lies on the  $n_0$ -line on the left of  $E_2$ .

This observation holds true as in contrast to the mobilisation of domestic savings the acquisition of capital imports translates into foreign debt which sets off interest payments. As a result, the investment ratio which was boosted by capital imports will go down (downward shift of the Growth Curve) and the new steady state equilibrium will be found on the  $n_0$ -Curve, again, but at a lower steady state PCI than was initially realised which can be shown easily.

As is already known the Growth Curve can be written as

$$gY = n + \alpha \left[ (s + kim - id)y^{-\frac{(1-\alpha)}{\alpha}} - n \right]. \quad (16)$$

The Iso Debt Curve is defined according to equation (15)

$$d = \frac{kim}{gY} \quad (15)$$

As in the steady state  $gY$  equals  $gK$  and  $n$ , the steady state debt ratio is

$$d^* = \frac{kim}{n} \quad (17)$$

Inserting (17) into (16) determines the steady state growth rate of GDP

$$gY = n = n + \alpha \left[ \left( s + kim - \frac{i}{n} kim \right) y^{*- \frac{(1-\alpha)}{\alpha}} - n \right], \quad (18)$$

where, in (18), the condition  $[...] = 0$  must be fulfilled.

As the equality of  $gY$  and  $n$  holds, the steady state per capita income can be calculated as follows:

$$n = \left[ s + \left( 1 - \frac{i}{n} \right) kim \right] y^{*- \frac{(1-\alpha)}{\alpha}} \Rightarrow ny^{* \frac{1-\alpha}{\alpha}} = s + \left( 1 - \frac{i}{n} \right) kim.$$

Considering that (18) holds, the steady state PCI is

$$y^* = \left[ \frac{s + \left(1 - \frac{i}{n}\right)kim}{n} \right]^{\frac{\alpha}{1-\alpha}} = \left[ \frac{s}{n} - \frac{i-n}{n^2}kim \right]^{\frac{\alpha}{1-\alpha}} = \left[ \frac{s}{n} - \frac{i-n}{n}d^* \right]^{\frac{\alpha}{1-\alpha}} > 0 \quad (19)$$

The effects of capital imports on the steady state PCI can be discovered by the first derivative of (19) for kim:

$$\frac{\partial y^*}{\partial kim} = \frac{\alpha}{1-\alpha} \left[ \frac{s}{n} - \frac{i-n}{n^2}kim \right]^{\frac{2\alpha-1}{1-\alpha}} \left( -\frac{i-n}{n^2} \right) \quad (20)$$

from which can be concluded that

$$\begin{aligned} &> 0 \quad i < n \\ \frac{\partial y^*}{\partial kim} &= 0 \quad \text{if } i = n \\ &< 0 \quad i > n \end{aligned} \quad (21)$$

(21) together with (19) can be used to compare the new steady state PCI (with net borrowing abroad (index D) and foreign indebtedness:  $d > 0$ ) and the initial steady state PCI without foreign borrowing (index ND) and no foreign debt ( $d = 0$ ) under the different preconditions as specified by (21):

For  $kim = 0$  (no foreign borrowing and no foreign debt:  $d = 0$ ):  $y_{ND}^* = \left[ \frac{s}{n} \right]^{\frac{\alpha}{1-\alpha}}$ ,

for any  $kim > 0$  (net borrowing abroad and foreign indebtedness ( $d > 0$ )) it holds

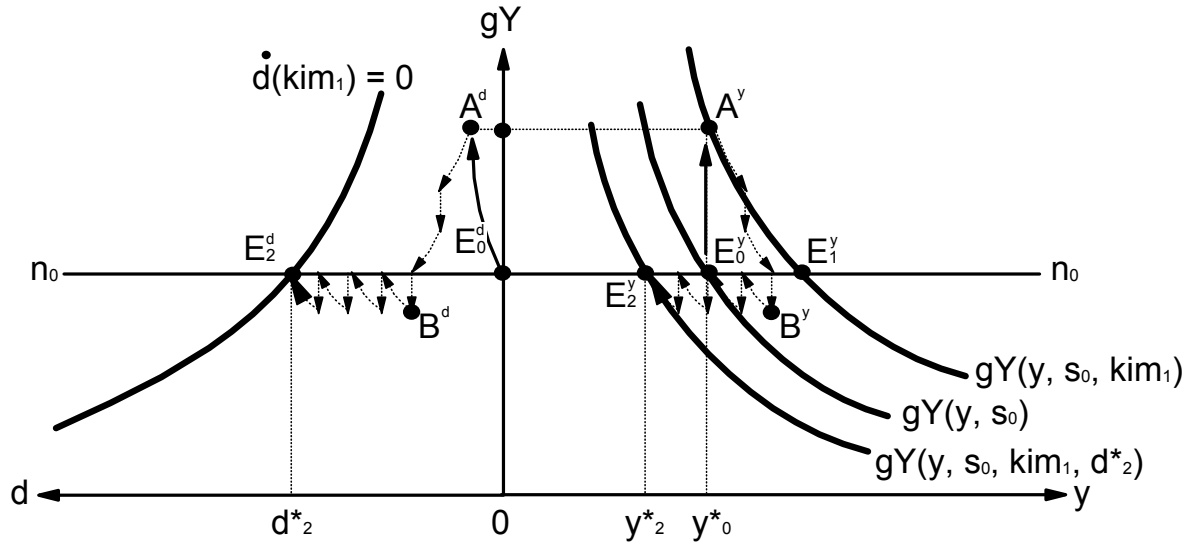
$$\begin{aligned} y_D^* &> y_{ND}^* \quad \text{if } i < n, \\ y_D^* &= y_{ND}^* \quad \text{if } i = n \quad \text{and} \\ y_D^* &< y_{ND}^* \quad \text{if } i > n. \end{aligned}$$

Considering that the normal case will be  $i > n$ , development strategies relying on net borrowing abroad will lead to a position of sustainable foreign indebtedness (provided that all capital imports are used for investment financing) but turn out to be immiserizing.

Fig. 5 shows these growth and debt dynamics (for  $i > n$ ) by bringing together figures 3 and 4. To summarise the results beforehand: net-capital imports  $kim = kim_1$  lead to a stable debt ratio  $d^*_2$ , a sustainable interest burden  $id^*_2$  and a loss in per capita income of  $y^*_0 - y^*_2$ , as expected.

Fig. 5: Capital Imports, GDP-Growth and the development of Debt and PCI

5a: Capital imports and debt ratio      5b: Capital imports, GDP-growth and PCI



The analysis starts with the steady state equilibrium ( $E_0^d$  in fig. 5a,  $E_0^y$  in fig. 5b) which is characterised by  $gY_0 = n_0$ ,  $s = s_0$ , and  $d_0 = kim_0 = 0$ . If the country now realizes and maintains a capital import ratio  $kim_1 > 0$ , then the country's potential to grow economically will rise. The transition process towards the new steady state set up by the import of capital is characterised by two different simultaneous effects (shifts of and movements along growth curves) which are presented in a stylized manner in figure 5. With a continuous realisation of the capital import ratio  $kim_1$  the Growth Curve first shifts upwards (by  $(\alpha/v)kim_1$ , see fig. 5b) towards  $A^y$ . From there,  $y$  rises and  $gY$  falls along a given Growth Curve towards  $E_1^y$  attracted by the magnetism of  $n_0$  in this neoclassical growth-model. Nevertheless  $E_1^y$  is never reached because the Growth Curve shifts downwards (by  $(\alpha/v)id$ ) as the maintained yearly capital import ratio ( $kim_1$ ) contributes to the accumulation of foreign debt ( $D$ ) on which interest ( $i$ ) is to be paid.

Hence, the transition process consists of declining  $gY$  and rising  $y$  along one Growth Curve, downward shift of this Growth Curve along which  $gY$  is going down and  $y$  going up, followed by a downward shift, etc., as indicated by the dotted arrows in fig. 5b, until point  $B^y$  is reached. At  $B^y$  the economy has reached a PCI bigger than that of the initial steady state ( $y^*_0$ ) and realises a growth rate of GDP smaller than  $n_0$ . Again, the magnetism of  $n_0$  becomes effective as  $gY$  now rises and  $y$  falls along a given Growth Curve. As a consequence of the still ongoing accumulation of foreign debt,  $kim_1$  is maintained, the downward shifts of the Growth Curve continue and the transition process takes the form as indicated in fig. 5b. Inevitably the transition process in fig. 5a follows the same pattern.



These dynamics of growth, income and debt come to an end in the new steady state  $E_2$  (s.  $E_2^d$  in fig. 5a,  $E_2^y$  in fig. 5b) which represents a simultaneous growth-debt-equilibrium. The debt ratio has risen from 0 to  $d_2^*$ , all the relevant variables are growing with the rate  $n_0$  ( $= gK = gKIM = gD$ ), and provided that  $i > n$  holds PCI decreased from its initial level  $y_0^*$  to  $y_2^*$ .

Nevertheless, there are two ways to get to or near to the equilibrium point  $E_1^y$ . Either the capital import ratio is gradually reduced while the rate of savings together with the primary-trade-balance ratio are raised at the same speed. In such a case development financing by foreign loans is only a temporary option that buys time for the necessary and efficient measures to be taken. Or the capital import ratio is increased in a way that the increasing interest payments on existing foreign debt are financed by new loans. In this scenario, foreign debt financing is effective with regard to the long-run target of a higher GDP per capita (in fig. 5b: steady state point  $E_1^y$  can be realised) but leads to an increasing foreign indebtedness (in fig. 5a: continuous leftward shifts of the Iso Debt Curve) which becomes unsustainable. Expectations of an unsustainable debt position lead to a breakdown of net inflows of capital and eventually a debt crisis where the LIC-government has to declare the country's inability to service the debt anymore. The LIC becomes a HIPC (Highly Indebted Poor Country) candidate for debt relief.

Thus, either development financing by foreign loans is ineffective but foreign debts are sustainable, or the effectiveness is bought at the price of growing into a unsustainable debt position. The first option is stable but counterproductive. The second option is effective but unstable. The solution to this dilemma is well-known: channelling capital inflows into financing of export-diversifying and/or import substituting investments which result in  $\Delta ex > 0$ ,  $\Delta im < 0$ , therefore  $\Delta pta > 0$ . Efficient use of  $kim > 0$  means substituting  $\Delta s = \Delta pta$  for  $kim$  and getting to a steady state with a current account equilibrium.

Hence, importing interest-bearing capital and using it wisely may make contributions to solving the problem of low per capita income. But our model shows that this type of capital imports does not automatically contribute to the solution but may aggravate the problem.

In general, capital imports can strengthen LICs' efforts to speed-up economic development if it is granted in the form of official development assistance (ODA) with heavily subsidised interest rates. If accompanied with the conditionality of using this inflow of resources wisely interest free credit is a very effective tool for increasing the per capita income in low income countries. In this case increasing the capital import ratio does not affect the interest burden ratio ( $id$ ) and brings about the same positive transitional and long-term growth effects as a respective increase of the

savings rate. In this scenario, the interest burden, i.e. the opportunity costs of capital, is paid by the (richer) donor countries and financed out of their savings.

Our argument against a general promotion of useless or damaging capital imports and in favour of a performance-oriented financial aid policy is strengthened if potential foreign creditors already perceive a country's debt ratio ( $d$ ) as critical before it reaches its steady state level  $d^*$ . The country's rating goes down and the creditors will add a risk premium which increases the interest rate on foreign debt. If a debt threshold such as  $d_T < d^*$  exists at which the interest rate rises with an increasing debt ratio ( $i = i(d)$ ,  $\delta i / \delta d > 0$ ) then the potentially positive growth effects of capital imports will be further weakened and the immiserizing effects will be strengthened.

## 5 Empirical Evidence

For confronting our model with reality, data for the period between 1970 and 1999 is used from a set of 64 countries located in the tropical belt. Following the World Bank classification from 1999 34 of these 64 countries belong to the group of low income countries, 19 are lower-middle income countries, and 11 are upper-middle income countries. 29 countries out of this set are classified as highly indebted poor countries in accordance with the Paris-Club definitions (s. Paris Club (2005)) and 23 are least developed countries.

For this group of countries we explain the steady state per capita income which is taken to be the one realised in 1999 according to equation (12) as depending on the savings rate, the capital import ratio and the population-growth rate, each realised between 1970 and 1999. The interest rate on foreign debt ( $i$ ) which is also one of the arguments in (12) is excluded from this empirical test as for ' $i$ ' there is only a proxy available. Table 1 summarises the results (for the full data set s. annex 1).

The dependent variable (PCI99) used in the regressions is the countries' per capita income realised in 1999 expressed in US-\$ of 1995. ' $s$ ' is the countries' average savings rate (in %) over a period from 1970 to 1999 calculated as  $(GDP-C)/GDP$ . ' $kim$ ' is the countries' average (net-)capital import ratio (in % of GDP) for 1971 till 1999 calculated as  $(D_t - D_{t-1})/GDP_t$ . ' $n$ ' is the countries' average growth rate of population for 1970 to 1999 (for the definition of variables, see annex 2). All data is taken from the World Development Indicators 2001 (World Bank, 2001).

We estimate equation (19) with OLS-type regression approaches which differ in terms of the assumed functional relation between the dependent variable 'steady state per capita income ( $y^*$ )' and the independent variables ' $s$ ', ' $kim$ ' and ' $n$ '. First, (19) is tested assuming linearity. Second, we use a log-linear approach where the

natural logarithm of  $y^*$  is explained by the natural logarithms of  $s$ ,  $kim$  and  $n$ . The results of these two regressions are presented in the first two rows of table 3.

Tab. 3: Regression results<sup>a</sup>

Row	OLS-approach, functional form	R <sup>2</sup>	Constant	Coefficients	s	kim	n
1	PCI = f(s, kim, n), linear	50% (0.000)	1151.13 (0.07)	Coefficient	101.23 (0.000)	-9.34 (0.74)	-539.09 (0.006)
				Standardized coefficient	0.581	-0.034	-0.266
					<b>ln s</b>	<b>ln kim</b>	<b>ln n</b>
2	lnPCI = f(ln s, ln kim, ln n), log-linear	49.1% (0.000)	5.355 (0.000)	Coefficient	0.866 (0.000)	-0.389 (0.056)	-0.396 (0.021)
				Standardized coefficient	0.515	-0.196	-0.226
3	lnPCI = f(ln s) log-linear	39.2% (0.000)	3.919 (0.000)	Coefficient	1.053 (0.000)		
				Standardized coefficient	0.626		
4	lnPCI = f(ln kim) log-linear	19.1% (0.000)	8.076 (0.000)	Coefficient		-0.868 (0.000)	
				Standardized coefficient		-0.437	
5	lnPCI = f(ln n) log-linear	13.4% (0.003)	7.153 (0.000)	Coefficient			-0.641 (0.003)
				Standardized coefficient			-0.366

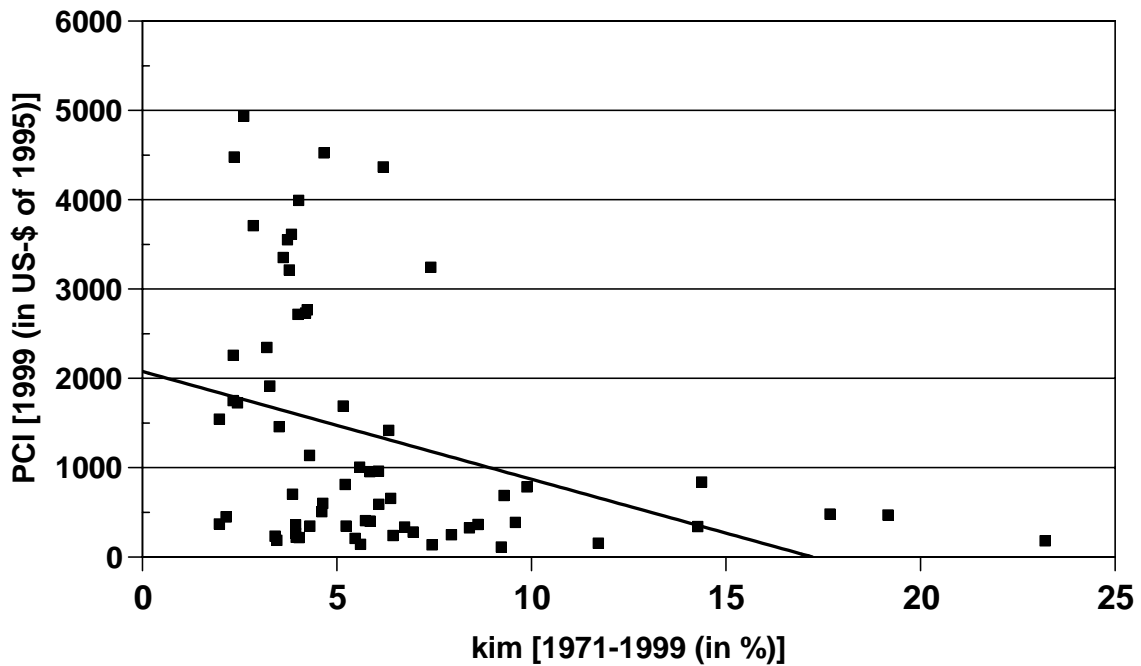
<sup>a</sup>: P-values in parentheses

In contrast to (19) all regressions run include a constant to explicitly capture the systematic influence on the steady state per capita income of variables which are not included in (19). This constant proves to be significant from zero at the 10%-level under all the regressions.

With determination coefficients between 49.1% and 50% the two multiple regressions are quite efficient in explaining the tropical countries' per capita income realised in 1999. Unfortunately, the testing of the linear regression model (s. row 1, tab. 3) suggests heteroscedasticity from which follows that the assumed linear relation between PCI and independent variables is not correctly specified and that in turn the reported P-values are biased. Figure 6 illustrates heteroscedasticity at the example of the partial PCI-kim scatter plot of the linear version of (19).

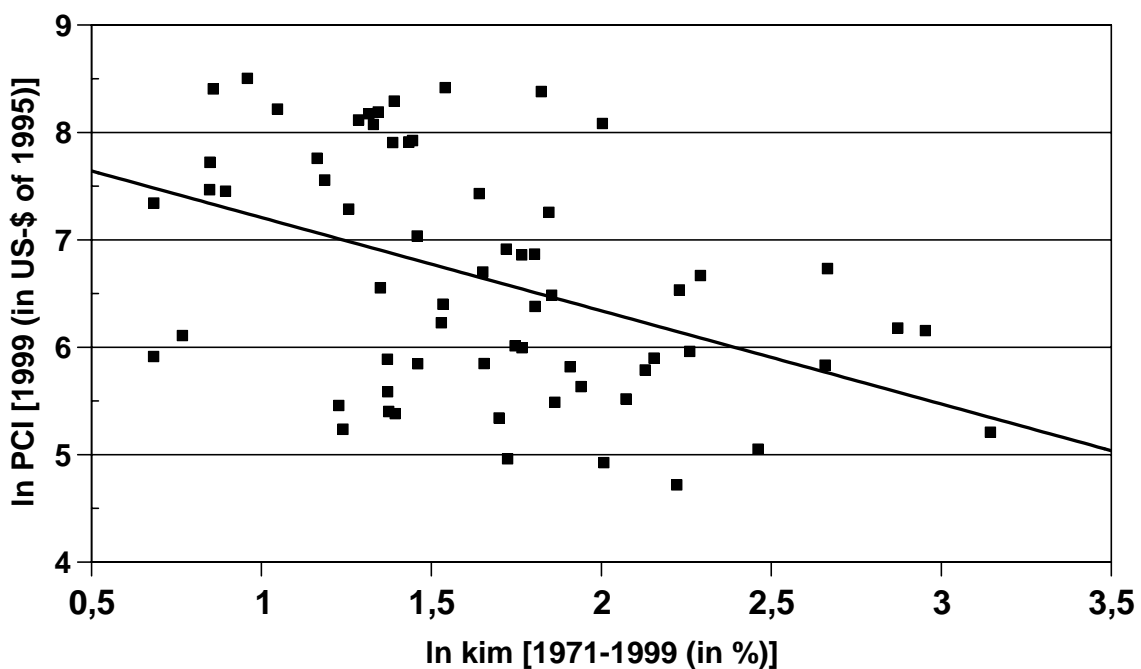
Fig. 6 indicates that the linear version of (19) produces a variation of the error term which is not homogenous but varies with PCI: the smaller PCI the smaller the variation of the error term. In contrast, the log-linear estimate of (19) indicates homoscedasticity as the corresponding partial scatter plot of PCI against kim demonstrates (s. fig. 7).

Fig. 6: Steady state PCI and kim, linear version



The regression output for the estimate of (19) based on natural logarithms (see row 2, tab. 3) demonstrates that all independent variables show the expected signs as predicted by (19): the PCI in 1999 which is taken to represent the steady state PCI is the higher the higher the savings rate and the lower population growth in the past. The coefficient of the capital import ratio also shows the expected negative sign which is supporting our model-based hypothesis of the potential immiserizing effects of capital imports.

Fig. 7: Steady state PCI and kim, log-linear version



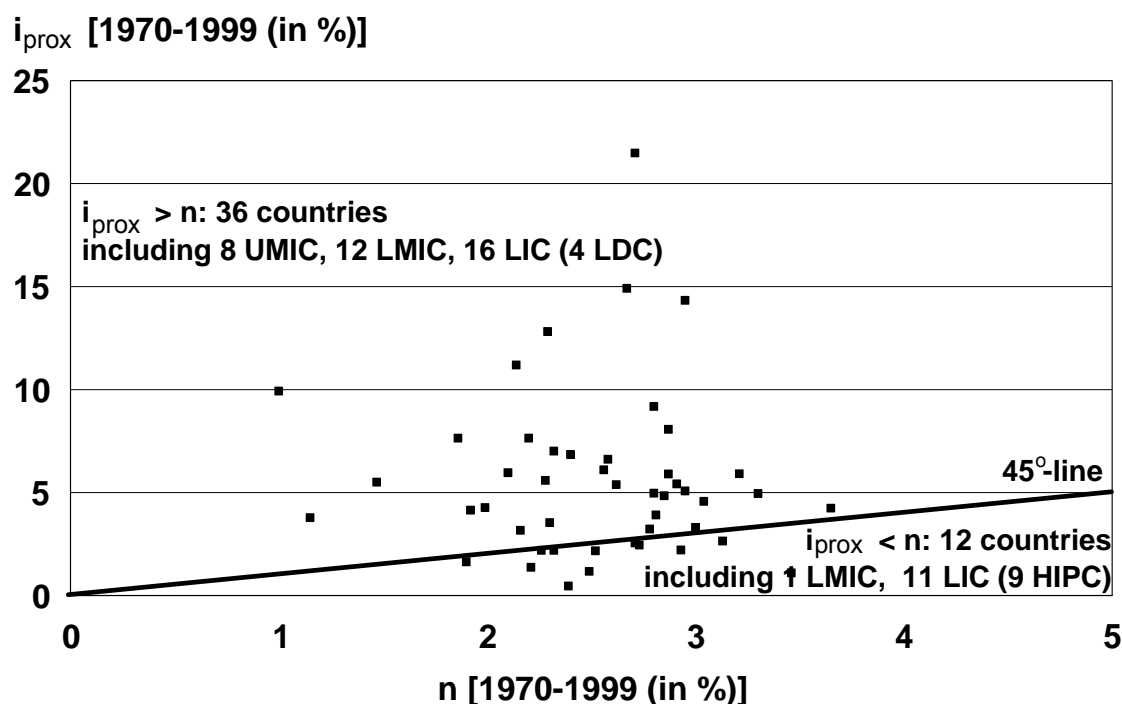
In contrast to the constant and to the coefficients of  $s$  and  $n$  the one of the capital import ratio is only significant from zero at the 10%-level so that one can conclude that the data at least is not contradictory to our theoretical findings.

In addition we run three log-linear simple OLS-type regressions to test for the individual impact of each of the independent variables on the steady state per capita income, again including a constant. All three approaches (s. rows 3 to 5 in tab. 3) prove their efficiency under the F-test. The coefficients show the expected signs. The t-test gives evidence for the significance of all three coefficients from zero. With respect to our theoretical findings the check for the individual impact of the capital import ratio confirms our hypothesis as demonstrated by the partial scatter plot of  $\ln \text{PCI}$  against  $\ln \text{kim}$  (s. fig. 7).

The preconditions to be met for the negative impact of the capital import ratio on the steady state PCI as shown in fig. 7 can be taken from equation (21): There is an interest rate to be paid on foreign debt which exceeds the population growth rate.

As a proxy for the interest rate on foreign debt we are using the interest rate that the countries' central governments are paying on domestic and on foreign debt. Fig. 8 confronts the mean values of the available entries of  $i_{\text{prox}}$  and of  $n$  of 48 tropical countries for a period between 1970 and 1999.

Fig. 8: Comparing interest rate and population growth



The 45°-line in fig. 8 shows the geometrical locations where  $i_{\text{prox}}$  equals  $n$ . Above that line 36 countries can be found where  $i_{\text{prox}}$  is bigger than  $n$ , below the line 12

countries are located with  $i_{prox}$  smaller than  $n$ . Correlating  $i_{prox}$  with the per capita income realised in 1999 brings about a highly significant Pearson's correlation-coefficient of +0.464 which confirms the visual impression given by fig. 8: the poorer a country the bigger are the grant elements of foreign credits and the smaller the resulting average interest rate paid on total debt.

This observation is confirmed by analysing the status of the 12 countries below the 45°-line. 10 out of these 12 countries are classified as least developed countries (LDC), and 9 are highly indebted poor countries (HIPC). The LDC- and the HIPC-status qualifies them for the cheap credits offered by the International Development Agency (IDA), by the regional development banks and others who follow the IDA-rules.

Fig. 8 shows that the number of countries where the condition for immiserizing capital imports holds is three times higher than the number of countries which receives more favourable conditions from international donors (i.e.  $i_{prox} < n$ ) so that it is no surprise that under the regression capital imports affect the per capita income negatively as predicted by our model.

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## Annex

### A1: Data Set [Source: World Bank (2001)]

Country	PCI 1999	s 1970-99	kim 1971-99	n 1970-99	i <sub>prox</sub> 1970-99
Burkina Faso	267,04	18,09	3,94	2,32	2,20
Cape Verde	1.460,72	28,21	3,51	1,66	n.a.
Chad	217,87	7,14	4,03	2,49	1,18
Gambia, The	365,42	15,21	8,63	3,46	1,11
Guinea-Bissau	183,18	5,01	23,20	2,80	n.a.
Mali	280,08	10,26	6,96	2,39	0,47
Mauritania	483,13	12,42	17,67	2,63	n.a.
Niger	209,08	7,16	5,47	3,21	n.a.
Senegal	590,91	6,30	6,08	2,81	3,92
Ethiopia	112,21	8,98	9,22	2,71	2,56
Kenya	336,62	15,06	6,74	3,30	4,96
Benin	402,21	7,42	5,85	2,91	n.a.
Cote d'Ivoire	787,03	8,36	9,89	3,65	4,25
Ghana	409,55	9,93	5,73	2,71	21,49
Guinea	602,65	13,88	4,64	2,16	n.a.
Nigeria	249,87	16,23	7,95	2,95	14,34
Sierra Leone	138,00	0,81	7,44	2,16	3,17
Togo	326,99	19,68	8,40	2,91	5,43
Burundi	142,99	9,51	5,61	2,21	1,38
Cameroon	656,17	13,47	6,38	2,78	3,24
Central African Rep.	346,85	6,92	4,31	2,26	n.a.
Namibia <sup>a</sup>	n.a.	25,27	n.a.	2,67	14,92
Congo, Rep.	840,16	18,34	14,37	2,85	4,85
Equatorial Guinea	1.149,01	n.a.	11,00	1,46	n.a.
Gabon	4.368,84	31,21	6,19	3,01	n.a.
Randa	234,84	12,91	3,41	2,93	2,22
Uganda	347,23	4,26	5,23	2,76	n.a.
Botswana	3.710,78	36,47	2,85	3,21	5,92
Malati	156,48	11,85	11,72	3,04	4,58
Tanzania	188,22	7,99	3,45	3,07	n.a.
Zambia	388,72	5,66	9,59	3,00	3,31
Zimbabwe	702,83	14,48	3,86	2,87	8,08
Madagascar	241,90	3,97	6,44	2,73	2,46
Bangladesh	361,59	14,49	3,94	2,28	n.a.
India	450,24	20,66	2,15	2,10	5,97
Nepal	222,22	13,14	3,95	2,52	2,18
Pakistan	507,83	20,23	4,61	2,80	4,98
Sri Lanka	814,27	19,36	5,21	1,47	5,51
Thailand	2.717,22	27,93	4,00	1,86	7,65
Vietnam	341,58	17,90	14,27	2,08	n.a.
Indonesia	961,84	27,10	6,07	1,99	4,28
Malaysia	4.525,95	30,46	4,67	2,58	6,62
Philippines	1.137,80	21,57	4,30	2,40	6,86
Congo, Dem. Rep. <sup>a</sup>	n.a.	5,84	9,53	3,13	2,65
Papua New Guinea	1.007,78	20,90	5,59	2,32	7,02
Belize	2.768,41	22,88	4,24	2,49	n.a.
Costa Rica	3.994,18	16,90	4,02	2,56	6,11
El Salvador	1.752,20	14,47	2,33	1,92	4,15

Country	PCI 1999	s 1970-99	kim 1971-99	n 1970-99	i <sub>prox</sub> 1970-99
Guatemala	1.545,43	11,28	1,98	2,62	5,39
Honduras	689,25	17,08	9,30	3,11	n.a.
Mexico	3.613,37	20,56	3,83	2,29	12,82
Nicaragua	471,80	2,21	19,16	2,95	5,09
Panama	3.245,56	20,38	7,41	2,20	7,65
Dominica	3.353,81	18,78	3,62	0,26	n.a.
Dominican Republic	1.916,44	16,91	3,27	2,26	2,20
Grenada	3.553,04	18,90	3,73	0,05	n.a.
Haiti	370,54	10,33	1,98	1,90	1,64
Jamaica	1.690,70	19,09	5,16	1,15	3,79
St. Vincent and the Grenadines	2.731,48	17,02	4,19	0,90	n.a.
Trinidad and Tobago	4.936,23	22,67	2,61	1,00	9,93
Bolivia	955,53	13,10	5,85	2,30	3,55
Brazil	4.478,70	18,87	2,36	1,97	48,13
Colombia	2.260,64	17,43	2,34	2,14	11,20
Ecuador	1.418,82	17,51	6,33	2,57	n.a.
Paraguay	1.726,57	16,42	2,45	2,87	5,91
Peru	2.345,70	17,50	3,20	2,28	5,60
Venezuela, RB	3.213,40	27,10	3,78	2,80	9,19

n.a.: not available, <sup>a</sup>: country data only used for confronting i<sub>prox</sub> and n in fig. 8.

## A2: Definition of Variables (World Bank series name in parentheses)

- PCI 1999: GDP (constant 1995 US\$) (NY.GDP.MKTP.KD) of 1999 divided by total population (SP.POP.TOTL) of the same year, total,
- s 1970-99: Savings rate calculated as average of Gross National Savings in % of GDP (NY.GNS.ICTR.ZS) of the period from 1970 to 1999,
- kim 1971-99: Capital import ratio calculated as average of the period from 1971 to 1999 from the following Data:  $[(D_t - D_{t-1})/Y_t]$  with  $(D_t - D_{t-1})$  being the difference of a country's total External Debt in current US-\$ (DT.DOD.DECT.CD) of two subsequent years t-1 and t,  $Y_t$  is a country's GDP in current US-\$ (NY.GDP.MKTP.CD) of year t, t = 1971, ... 1999,
- n 1970-99: Population growth rate calculated as average of the period from 1970 to 1999 in the following way:  $((N_t - N_{t-1})/N_t) \cdot 100$ , with  $(N_t - N_{t-1})$  being the difference of a country's total Population (SP.POP.TOTL) of two subsequent years t-1 and t, t = 1970, ... 1999,
- i<sub>prox</sub> 1970-99: interest rate that the countries' central governments are paying on domestic and on foreign debt. Calculation as average of the period 1970 to 1999 based on annual data from the following data series: Central governments interest payments in % of total expenditure (GB.XPC.INTP.ZS) times total expenditure in % of GDP (GB.XPD.TOTL.GD.ZS) divided by Central government's total debt in % of GDP (GB.DOD.TOTL.GD.ZS).

## Abstract

In this paper we demonstrate that the Post-Keynesian Two-Gap Model merits its destiny as a ghost in economic discussions not only as a result of the well-known neoclassical criticism on its assumptions but also because of its general inconsistency. If adjusted for this inconsistency the Two-Gap Model, which stresses the limits to growth set by domestic savings (savings gap), and foreign currency reserves (foreign currency gap), turns into a Harrod-Domar-type One-Gap Model with domestic savings and capital inflows as sole determinants defining a country's limitations to grow economically. Therefore, the model can no longer be used, not even for analyzing the variation of a developing country's short term limits of growth brought about, e.g., by changes in the countries foreign trade strategies or in its obligations to pay interests on foreign debt. Such analysis is still common practice in the work of World Bank and the IMF. Instead we are proposing an extended structural closed economy one-sector neoclassical growth model which could be applied to a small open low income country (LIC) where the growth potential is highly restrained by too low domestic savings and by foreign exchange shortages. This model demonstrates that development strategies which rely on net borrowing abroad leads to a position of sustainable foreign indebtedness (provided that all capital imports are used for investment financing) but such strategy in general turn out to be immiserizing.

Keywords: Two-Gap Models, immiserizing growth, foreign debt, low income countries  
JEL classification: F34, F43, O10, O19, O41

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