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**Article — Manuscript Version (Preprint)**  
**Capital mobility and growth**

Economics letters

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Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

*Suggested Citation:* Diehl, Markus; Gundlach, Erich (1999) : Capital mobility and growth, Economics letters, ISSN 0165-1765, Elsevier, Amsterdam, Vol. 62, Iss. 1, pp. 131-133,  
[https://doi.org/10.1016/S0165-1765\(98\)00200-6](https://doi.org/10.1016/S0165-1765(98)00200-6)

This Version is available at:

<https://hdl.handle.net/10419/1797>

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# Capital Mobility and Growth

by

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## Abstract

We suggest a new way to quantify the growth effects of capital mobility. We find that for reasonable parameter values, capital mobility has a large impact on income growth.

Keywords: Economic growth, capital mobility, convergence

JEL classification: O4, F2

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## **1. Introduction**

We use the open-economy version of the neoclassical growth model (Barro et al., 1995) to study the quantitative impact of physical capital mobility on growth. We suggest a new way of quantifying the difference between the closed economy and partial capital mobility cases. Specifically, we compare the present value of income growth in the two cases. We find that for reasonable parameter values, this difference is large for countries that are not close to their steady state.

Our interpretation of the open-economy version of the neoclassical growth model shows that the quantitative impact of physical capital mobility on growth depends on three variables, namely the real interest rate, the convergence rate to the steady state, and the gap between initial income and steady-state income. Using a standard parameterization for industrialized countries we find that compared to a closed economy, the annual income gain of an open economy is 2.1 percent of steady-state income if both economies start at an initial income which is 75 percent of their steady state income. Such a steady-state gap appears to be a lower bound for most industrialized countries.

## **2. The Income Growth Effect of Capital Mobility**

In the neoclassical growth model, open and closed economies ultimately reach the same steady state for a given rate of factor accumulation. But open economies are predicted to reach their steady state faster than closed economies due to a higher rate of convergence. Hence, the open economy will realize a higher present value of future income than the closed economy and, therefore, a higher growth rate. We call this the income growth effect of capital mobility.

For each economy, the present value ( $PV$ ) of income growth resulting from convergence towards the steady state is given by

$$PV = \sum_{t=1}^{\infty} \left( \frac{1}{1+r} \right)^t (y(t) - y(0)) , \quad (1)$$

where  $r$  is the real interest rate,  $y(t)$  is income at time  $t$ , and  $y(0)$  is initial income. As is customary, income is measured in units of effective labor. Dividing both sides by initial income and substituting a log approximation for the resulting term on the right-hand side, the present value of income growth in terms of initial income is given by

$$\overline{PV} = \frac{PV}{y(0)} = \sum_{t=1}^{\infty} \left( \frac{1}{1+r} \right)^t (\log y(t) - \log y(0)) . \quad (2)$$

The second term of the right-hand side can be substituted for an expression that describes the transition dynamics of the economy around the steady state (see Mankiw et al., 1992)

$$\log y(t) - \log y(0) = \left( 1 - e^{-\beta t} \right) (\log y^* - \log y(0)) , \quad (3)$$

where  $\beta$  is the convergence rate and  $y^*$  is steady-state income. Using the formula for summing an infinite geometric progression and the Taylor approximation of  $e^{-\beta}$  at  $\beta = 0$  , i.e. for the convergence rate to be a small number, equation (2) can be rearranged as

$$\overline{PV} = \left( \frac{1+r}{r} \right) \left( \frac{\beta}{r+\beta} \right) \left( \frac{y^* - y(0)}{y(0)} \right) . \quad (4)$$

This result shows that the present value of income growth is likely to be small for economies that are close to their steady state. But for all other economies, openness in the form of capital mobility could have a large impact on the present value of future income flows, depending on three factors: the real interest rate, the difference between the convergence rates for open and closed economies, and the gap between steady-state and initial income. We use the same parameterization as Barro et al. (1995) to assess the combined impact of these factors.

### 3. A Quantitative Assessment of Capital Mobility

The steady-state real interest rate equals  $\rho + \theta g$ , where  $\rho$  is the rate of time preference,  $\theta$  is the inverse of the intertemporal elasticity of substitution, and  $g$  is the rate of labor-augmenting technological progress. We derive a real interest rate of 6 percent by assuming that  $\theta$  equals 2, and both  $\rho$  and  $g$  equal 2 percent.

The rate of convergence is given by (Barro et al., 1995)

$$2\beta = \left\{ \varphi^2 + 4 \left( \frac{1-\omega}{\theta} \right) (\delta + \rho + \theta g) \left[ \frac{\delta + \rho + \theta g}{\omega} - (\delta + n + g) \right] \right\}^{1/2} - \varphi, \quad (5)$$

where  $\omega$  equals  $(\alpha + \eta)$  for the closed economy and  $(\eta / (1 - \alpha))$  for the open economy;  $\alpha$  is the share of physical capital and  $\eta$  is the share of human capital in factor income,  $\delta$  is the depreciation rate of physical and human capital,  $n$  is the rate of population growth, and  $\varphi = \rho - n - (1 - \theta)g > 0$ .

In addition to the previous assumptions regarding  $\rho$ ,  $\theta$ , and  $g$ , we assume factor shares of 30 percent for physical capital and 50 percent for human capital, a depreciation rate of 5 percent, and population growth of 1 percent. Based on this parameterization, which

seems to be reasonable for industrialized countries, the convergence rate of the closed economy results as 1.4 percent, and the convergence rate of the open economy with physical capital mobility results as 2.2 percent.

The gap between steady-state and initial income can be calculated by solving equation (3) for the log difference between steady-state and initial income. To calculate the growth rate of income in effective units of labor ( $\log y(t) - \log y(0)$ ), we use real per capita income data for 1960 and 1990 (PWT 1994)<sup>1</sup> and assume a rate of technological progress of 2 percent as before. By these measures, we find that the US economy has been close to its steady state in 1960. Therefore, capital mobility cannot have a large quantitative impact for the case of the United States. But this result does not hold in general. Using the derived convergence rate of 2.2 percent, we find that West Germany's income in 1960 was about 73 percent of its steady-state income. For other industrialized countries such as France and Italy, even larger gaps between steady-state and initial income result from the same calculation.

With initial income 25 percent below its steady-state level, the quantitative impact of capital mobility is large, given that all other parameters remain unchanged. The income growth effect of capital mobility can be measured by the difference of the present values of income growth of the open and the closed economy. This difference is given by

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<sup>1</sup> Per capita income is taken from PWT (1994) as real GDP per capita in constant dollars, expressed in international prices, base 1985 (RGDPCH).

$$\overline{PV}_{open} - \overline{PV}_{closed} = \left( \frac{1+r}{r} \right) \left( \frac{\beta_{open}}{r + \beta_{open}} - \frac{\beta_{closed}}{r + \beta_{closed}} \right) \left( \frac{y^* - y(0)}{y(0)} \right) . \quad (6)$$

Thus compared to a closed economy, an open economy with an initial steady-state gap of 25 percent would experience an *additional* present value of income growth that is about 47 percent of its initial income if the same real interest rate and the same convergence rates are assumed as before.

To put this figure into perspective, it can be translated into a constant annuity by multiplication with the real interest rate. This calculation suggests that an open economy with an initial steady-state gap of 25 percent will experience an annual income gain of 2.8 percent of initial income or of 2.1 percent of steady-state income, compared to an otherwise identical closed economy. This quantitative impact of capital mobility on growth is large compared to previous measures.

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