Country Portfolios and the Solow-Model

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Abstract

This paper shows that an open economy Solow model provides a good description of international investment positions in industrialized countries. More than half of the variation of net foreign assets in the 1990's can be attributed to cross country differences in the savings rate, population and productivity growth. Furthermore, these factors seem to be an important channel through which output and wealth affect international investment positions.

We interpret this finding as evidence that decreasing returns are an important source of international capital movements. The savings rate (and population growth) influence the composition of country portfolios through their downward (upward) pressure on the marginal productivity of capital.

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1 Introduction

International trade in assets allows capital to find its way to the most productive locations, thereby promoting an efficient allocation of capital. This is, apart from risk sharing, the main motivation for the global integration of capital markets. In this paper we analyze to what extent actual net foreign investment positions can be explained by differences in the productivity of capital that would exist if capital movements were restricted.

Differences in the marginal productivity of capital are inherently linked to decreasing returns to capital. In an autarkic economy with decreasing returns, the long run productivity of capital is lower the more capital it accumulates per efficiency unit of labor. In an open economy, the (risk adjusted) return to capital should be equal across countries. Therefore, (i) differences in savings and (ii) differences in the growth rate of efficiency units of labor lead to nonzero net foreign asset (NFA) positions, tending to equalize the returns to capital across countries. An open economy version of the standard Solow model provides a framework to analyze international investment positions in which both factors are incorporated.

We test the predictions of the model using a dataset of 21 industrialized countries. For the last 20 years, the model provides a very good description of net foreign asset positions both across countries and over time. In the 1990's the model explains more than 50% of the variation across countries. Hence, decreasing returns to capital are an important source of differences in the return to capital that lead to foreign investments. We interpret this finding as evidence that the global integration of capital and goods markets improves the allocation of capital substantially.

A recent strand of literature analyzes the behavior of *stocks* of net foreign asset positions. The most robust finding is that richer countries tend to have higher external assets. Kraay, Loayza, Serven and Ventura (2000) find a strong positive relationship between financial wealth and the net foreign asset position. Moreover, variations in wealth explain most of the variation in net foreign assets. Lane and Milesi-Ferretti (2001b) show that GDP has a strong positive impact on long run international investment positions. In their regressions, a country's relative output per capita is the only explanatory variable that is highly significant throughout all specifications for industrialized countries.

The (heuristic) approach of the literature has difficulties in explaining the behavior of NFA in a few big countries, most importantly the U.S. Although being a country with high output per capita, and also considerable financial wealth, the U.S. has been a net debtor for almost 20 years. Our approach provides an explanation for this observation. The reason is that there are two different sources why some countries are richer than others. If high output (and therefore wealth) is the result of high savings - as stressed by Solow (1956) and Mankiw, Romer and Weil (1992), countries tend to have positive NFA. In contrast, if population and productivity growth is the dominating source of growth, the resulting increase of the marginal productivity of capital will ceteris paribus lead to negative NFA. This reasoning is confirmed by our empirical results. The savings rate and the population growth rate, both measured relative to the world average, capture much of the effect previously attributed to GDP or financial wealth.

A further branch of related literature attempts to explain capital *flows*. The intertemporal approach to the current account leads to the view that an increase savings should be fully invested abroad, i.e. increase the country's current account one-to-one. However, since Feldstein and Horioka (1980) it is well documented that the correlation between savings and current accounts is much lower. In a series of papers Kraay and Ventura argue, that in the long run the marginal unit of wealth is invested as the average one. In other words, savings are invested abroad in the same proportion in which existing wealth is already invested abroad. The authors provide a theoretical foundation of this "new rule". If decreasing returns to capital are weak compared to investment risk, optimal portfolio choice implies that investors follow the new rule. In their model, the amount of savings determines the growth of the country portfolio while the composition of the portfolio is determined by risk characteristics of different countries.

The open economy Solow model provides an additional theoretical foundation of the empirical findings of Kraay and Ventura (2000). Although decreasing returns play a crucial role in the model, it predicts that current accounts follow the "new rule" in the long run. Hence, a cross country correlation of one between the current account and the savings rate multiplied by the share of net foreign assets in total wealth is not sufficient to assess the presence or absence of decreasing returns to capital.

The paper is organized as follows. In section 2 we briefly set up the open economy Solow model. We analyze to what extent the time series variation of net foreign asset positions can be explained by the model in section 3. In section 4 we turn to the cross country evidence and section 6 concludes.

2 An Open Economy Solow Model

2.1 The Model

We consider a collection of small open economies. In each economy, there is a large number of firms that has access to the same constant returns to scale production technology that transforms capital and labor into a homogenous final good. Output is tradable across countries and capital is mobile at no cost. Countries differ with respect to their exogenous savings rates and their growth rates of efficiency units of labor.

Capital mobility guarantees that the interest rate equalizes across countries. We consider a deterministic framework, i.e. firms do not face production risk. Therefore, the interest rate corresponds to the marginal return to capital less the depreciation rate. This assumption implies, that all assets are perfect substitutes and gross foreign asset positions are not determined. Only net foreign assets are determined by differences between asset supply of firms (investments) and asset demand of households (savings).

Let K_j be the stock of physical capital in country j, and let H_j be the efficiency units of labor employed in country j. Gross domestic product in economy j is produced according to a standard Cobb-Douglas production function (see equation 2.1). All variables except for the savings rates and the exogenous growth rates are time variant. To simplify notation, time indices are dropped. Denote by r the world rate of return to capital and by w_j the wage in country j. The representative agent in economy j has wealth A_j, which can be decomposed into domestic physical capital K_j and his net foreign asset position F_j. His income consists of labor income generated in his home country, and of capital income. Equation 2.2 defines the gross national product $\tilde{Y}_j$ and its decomposition into gross domestic product Y_j and income from foreign assets rF_j.

$$Y_j = K_j^{\alpha} H_j^{1-\alpha} \tag{2.1}$$

$$\tilde{Y}_j = rA_j + w_j H_j = Y_j + rF_j \tag{2.2}$$

Agent j saves a constant fraction s_j of his income $\tilde{Y}_j$. He has to cover the depreciation of his assets out of his savings. The physical depreciation rate is δ. The exogenous growth rate of efficiency units of labor is g_j, capturing both exogenous population and productivity growth. Denote by $k_j, a_j, f_j, \tilde{y}_j$ and y_j the respective variables normalized by efficiency units, e.g. $k_j = K_j/H_j$. As in the closed Solow model, the dynamics towards steady state can be described by:

$$\dot{a}_j = \dot{k}_j + \dot{f}_j = s_j(y_j + rf_j) - (\delta + g_j)(k_j + f_j). \tag{2.3}$$

Lower case variables without country index denote world averages and upper case variables without country index denote world aggregates. Since capital is mobile, the marginal productivity of capital in every country corresponds the world interest rate. This implies that the capital intensity k_j equals the world average k. This has to be true in every period, such that the time derivative has to be equal as well, $\dot{k}_j = \dot{k}$. With the simple Cobb Douglas production function, the global production intensity is $y = k^\alpha$. The evolution of the world capital intensity k depends on world averages. Since the world as a whole is a closed economy at every point of time, $a \equiv k$, we have:

$$\dot{a} = \dot{k} = sy - (\delta + g)k. \tag{2.4}$$

Details on aggregation are described in appendix A. The world savings rate s corresponds to the average country savings-rates, weighted by $\tilde{Y}_j/Y$. Furthermore, the world growth rate g equals the average country growth rates, weighted by the relative efficiency units of labor, H_j/H. The world average growth rate will therefore converge to the growth rate of the fastest growing country in the very long run. The average savings rate will increase as long as countries accumulate foreign assets on their way to the steady state. This effect is due to the fact that the weight of high-savings countries increases until they reach the steady state ratio of GNP to world output.

Using $\dot{k}_j = \dot{k}$, equations 2.4 and 2.3 simplify to an equation that describes the evolution of the net foreign asset position.[1] Using $r = \alpha k^{\alpha-1}$ one obtains:

$$\dot{f}_j = (s_j - s)y - (g_j - g)k + \left(s_j \alpha k^{\alpha-1} - (g_j + \delta)\right) f_j. \tag{2.5}$$

This equation says that in every period, one feeds the net foreign asset position out of excess savings that find no productive investment in country j. It is convenient to normalize the net foreign asset positions over the domestic capital stock. We therefore rewrite equation 2.5 using equation 2.4 in order to obtain equation 2.6.

[1] Equations 2.5 and 2.4 define a (block recursive) system of differential equations in $\{k, f_j\}$.

Evaluating this equation at the steady state yields equation 2.7.

$$\left(\frac{\dot{f_j}}{k_j}\right) = (s_j - s)\frac{y}{k} - (g_j - g) - \mu_j \frac{f_j}{k_j} \quad (2.6)$$

$$\frac{f_j}{k_j}^* = \frac{1}{\mu_j}\left((s_j - s)\frac{y}{k} - (g_j - g)\right). \quad (2.7)$$

where $\mu_j = -(s_j \alpha \frac{y}{k} - s\frac{y}{k}) + (g_j - g)$.[2] In both equations k/y is determined by equation 2.4 as in the closed economy Solow model. The sign of the net foreign asset positions are solely determined by the savings rate and the growth rate of efficiency units of labor. The last term in equation 2.7 determines whether country j is a creditor or a debtor. Whenever the savings rate is high enough compared to the world average and corrected for differences in the (exogenous) growth rate, a country invests abroad. The first term is a "multiplier" that is determined by the difference between marginal and average productivity.

2.2 A Permanent Increase in Savings and Productivity Growth

We now turn to some comparative statics exercises. First, we discuss the behavior of wealth, capital, and net foreign asset positions after a permanent increase in the savings rate. We assume for simplicity, that the country is small enough such that the increase in its savings rate does not affect the world average savings rate and that the country starts in a steady state.

In the basic open economy Solow model, an increase in the savings rate does not affect the capital to output ratio since all additional savings are invested abroad. The ratio of net foreign assets over output increases until the increased depreciation (and repartition due to exogenous growth) offsets the capital flows. The ratio of

[2]Note that $\mu_j > 0$ for values of s_j and g_j that are sufficiently close to the world average rates s and g, respectively. This ensures the existence of a steady state in which net foreign assets are growing as fast as output and capital.

wealth to output, being just the sum of the capital to output ratio and the ratio of net foreign assets over output, increases as well. The Solow model therefore predicts a strong positive relation between the wealth to output ratio $\frac{a}{y}$ and ratio of net foreign assets to capital $\frac{f}{k}$.

The increase of the net foreign assets due to a permanent increase in the savings rate takes place at a decreasing rate (see Figure 1). This is a direct consequence of decreasing returns to capital. The intuition can be best described in two steps: (i) Consider a country that is identical to the world average ($s_j = s, g_j = g$) but has nonzero net foreign assets. The capital intensity of this economy grows at rate $sk^{\alpha-1} - g - \delta$, which depends - among other things - on the average return to capital $y/k = k^{\alpha-1}$. The growth rate of the net foreign assets is $sr - g - \delta$ and depends on the marginal return to capital, r. Since the marginal return is lower than the average return, the ratio $\frac{f}{k}$ decreases over time. The country continuously eats up its stock of foreign wealth. (ii) A country with permanently higher than average savings will accumulate net foreign assets over time. However, the more assets already accumulated, the more important is the "eating-up" component. In a steady state, both effects cancel and the net foreign assets over output ratio remains constant.

Let us now turn to the effects of a change in the growth rate. A permanent increase in the exogenous growth rate has an effect that is qualitatively and quantitatively opposite to an increase in the savings rate. Again, we assume for simplicity that the country is small enough such that we can treat the world average growth rate as exogenous and independent of the country's growth rate.

In a closed economy, a increase in productivity growth would ceteris paribus lead to an increase in the marginal productivity of capital and thus the interest rate. In an open economy, foreign capital inflows will offset the upward pressure on the interest rate. Whereas the capital to output ratio remains stable, the wealth to output ratio decreases. Therefore, the Solow model predicts that a decrease in net

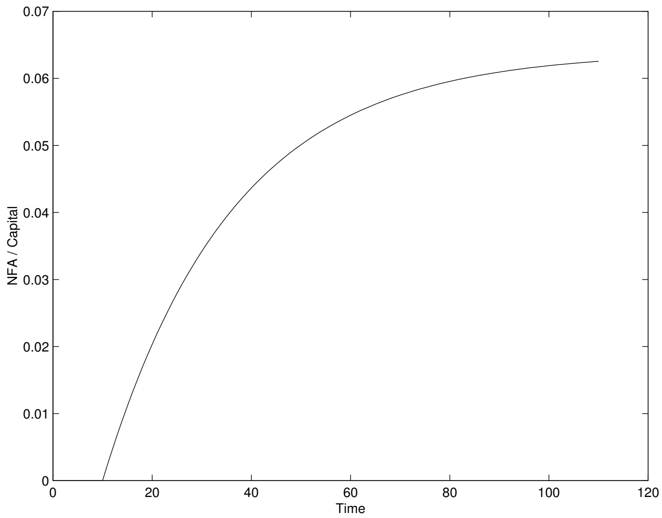

Figure 1: Evolution of NFA/capital after a permanent increase in savings. Simulation for $s_j = s = 0.25$, $\delta + g_j = \delta + g = 0.06$ and $\alpha = 0.33$ for the first ten periods and $s_j = 0.26$ afterwards.

foreign assets comes along with a decrease in the wealth to output ratio.

Similar to the previous case, the decrease in net foreign assets takes place at a decreasing rate. The externality of foreign owned capital on domestic labor productivity leads to an average return to wealth that is higher than the average return to capital. In other words, since foreign capital is remunerated with the marginal return to capital, the average return to domestically owned capital (=wealth) is higher than the average return to total capital. A constant fraction of income is saved such that wealth increases faster than capital, ceteris paribus. This, in turn, implies that net foreign assets (debt) accumulate at a lower rate than capital and output.

Quantitatively, the predictions of the open economy Solow model are almost identical to the standard closed economy model. One can show that the speed of convergence for an average country is given by $\mu = (1-\alpha)(\delta+g)$, which corresponds to the speed of convergence of a closed economy with growth rate g. Calibrating the model such that $\delta + g_j = \delta + g = 0.06$ and $\alpha = 0.33$ yields $\mu = 0.04$ (see Mankiw et al. (1992) for a discussion). This implies that it takes the economy about 17 years to get halfway to the steady state. This can also be seen in figure 1. Given that major capital market liberalizations took place in the 1980's and 1990's it is unlikely that the capital markets are already close to steady state.

2.3 Decreasing Returns and Current Accounts

A potentially important consequence of decreasing returns is that the cross country correlation between savings and current accounts is not equal to one. The current account is given by $CA_j = \dot{F}_j + \delta F_j$. In the steady state it must hold that $\dot{F}_j = F_j g_j$ in order to keep the ratio of net foreign assets to wealth (or output) constant. Using the Solow model to derive the steady state ratio of wealth to gross national product ($\frac{A}{Y^*} = \frac{s_j}{\delta + g_j}$), the long run capital account surplus as a fraction of GNP is given by:

$$\frac{CA_j}{Y_j^*} = \frac{F_j}{A_j} s_j. \tag{2.8}$$

In the long run, the unique role of savings is to foster portfolio growth. The composition of country portfolios, F_j/A_j, remains unchanged. Thus, the model predicts that international capital flows follow the "new rule" (Kraay and Ventura, 2000) in the long run. A cross country correlation of 1 between current accounts and savings multiplied by $\frac{F_j}{A_j}$ is not sufficient to assess the presence or absence of decreasing returns to capital. It is therefore important to estimate directly the impact of savings, population and productivity growth on country portfolios.

3 Time Series Evidence

3.1 Data and Specification

Is the Solow model suited to describe the actual behavior of net foreign asset positions over time? We want to investigate whether countries that experience an increase in their savings rates or a decrease in population or productivity growth accumulate more net foreign assets.

We use data for 21 industrialized countries. Due to the reunification in 1990 (structural break), we exclude Germany in the dynamic regressions such that there are 20 countries left. The data for the savings rates and for population are taken from the Penn World Tables (Heston, Summers and Aten, 2002). The world savings rate s and the world population growth rate is calculated as a average of all countries in the sample, weighted by the countries' gross national products and population, respectively.

Data on international investment positions, population and capital stocks are taken from Kraay et al. (2000). They are available from 1966 to 1997. As for total factor productivity, we adopt the usual approach to construct the Solow residual.[3] However, the employment data (OECD Labour Force Statistics) necessary to construct the residual are not available for all countries for all time periods. In the 1970's, we have data for only 14 out of the 20 countries.

Major capital market liberalizations took place in the 1980's and even 1990's. For example, the principle of full freedom of capital movements was incorporated in

[3] The Solow residual is the annual growth rate of GDP in constant 1990 U.S dollars (at PPP), less the share of wages in GDP times the growth rate of total civilian employment, less one minus this share times the gorwth rate of the gross domestic capital stock as constructed by Kraay et al. (2000) (which is also 1990 constant U.S. dollars at PPP). The share of wages in GDP is measured as average over the sample period (1966-1997) of compensation of employees divided by GDP. The data are taken from OECD Labour Force Statistics, OECD National Accounts and the IFS (IMF).

European law only with the entry into force of the Treaty on European Union on November 1, 1993. Most of the European countries, however, were forced to liberalize capital markets until July 1990. Transitional arrangements were introduced for Spain, Portugal, Greece and Ireland.[4] In order to account for potential restrictions to capital movements at the beginning of the sample period, we consider not only the whole sample period, but also the second half separately, starting in 1982.

Our basic specification in this section is a dynamic panel with fixed effects. As endogenous variable we use a country's net foreign asset position normalized over the domestic capital stock:

$$\left(\frac{F}{K}\right)_{j,t} = (1-\mu)\left(\frac{F}{K}\right)_{j,t-1} + a_1(s_{j,t} - s_t) + a_2(g_{j,t} - g_t) + \varepsilon_j + \nu_{j,t}, \quad (3.1)$$

where $g_j = (g_j^L, g_j^A)$ is a vector containing the population growth rate g_j^L and the productivity growth rate g_j^A, and $g = (g^L, g^A)$ is a vector containing the respective average values. ε is a country specific fixed effect and ν the usual error term. The motivation for choosing regression equation 3.1 is twofold. First, it can be easily derived from equations 2.6. In theory, the coefficient on the lagged dependent variable varies over time and across countries, with $\mu_j = -(s_j r - s\frac{y}{k}) + (g_j - g)$. Simple calibration of the term reveals that differences are small compared to the average value and unlikely to be distinguishable in an empirical analysis. For simplicity, we therefore impose the restriction that μ_j is constant across countries and over time.

The second motivation for choosing regression equation 2.6 is empirical. In the most simple model as presented above, the capital to output ratio is independent of country specific parameters. In the data, however, we observe that the capital to output ratio varies over time and across countries. Normalizing over capital allows to assess whether net foreign positions react more strongly than domestic capital to an increase in savings and population or productivity growth.

[4]Most of these countries were allowed to maintain restrictions until December 31, 1992. An extension not exceeding three years was granted to Portugal and Greece: the latter availed itself of this possibility up to May 16, 1994. (see http://europa.eu.int/scadplus/leg/en/lvb/l25001.htm).

In a panel with fixed effects, a lagged dependent variable violates the strict exogeneity assumption. Therefore we use the Arellano and Bond (1991) estimator that involves first differencing of the model in order to remove fixed effects. The differenced equation is estimated, the lagged dependent variable is instrumented with lags of the variable in levels.

We report three specifications. The first one (benchmark) includes only the savings and population growth rates as exogenous variables. In the second specification we include the growth rate of total factor productivity. We finally include other variables that could be potentially important in explaining international investment positions. We repeat the regressions for all three specifications using the second half of the sample period only.

3.2 Results

The first and the fourth column of Table 1 report the results for the benchmark regression. Three aspects of the results support the Solow model. First, the coefficient of savings is positive and highly significant. Moreover, its magnitude is astonishingly close to what is predicted by the theory. One would expect a coefficient that is equal to the inverse of the capital output ratio. In fact, in the second sub-sample, i.e. the period after 1982, the coefficient is roughly one third. For the total sample, the coefficient is slightly smaller. Second, the coefficient on population growth is negative. In the second sub-sample, it is significantly different from zero and it cannot be rejected that it is different from minus one. Third, and perhaps most important, the coefficient on the lagged dependent variable is significantly smaller than one and very close to the value predicted by the Solow model. Following the calibration of Mankiw et al. (1992), i.e. $\alpha = 0.33$ and choosing savings $s = 0.25$ and the capital output ratio $\frac{K}{Y} = 3$, one would expect a coefficient of roughly 0.94 for the average country.

The long-run impact of the savings and the population growth rates on net

	1966-1997			1982-1997		
	$\left(\frac{NFA}{K}\right)_t$			$\left(\frac{NFA}{K}\right)_t$		
$\left(\frac{NFA}{K}\right)_{t-1}$	**0.92**	**0.89**	**0.90**	**0.91**	**0.88**	**0.90**
	(72.03)	*(56.34)*	*(56.23)*	*(48.09)*	*(41.78)*	*(38.49)*
$s_j - s$	**0.23**	**0.25**	**0.26**	**0.35**	**0.35**	**0.4**
	(13.34)	*(9.47)*	*(11.99)*	*(11.16)*	*(7.01)*	*(11.36)*
$g_j^L - g^L$	**-0.01**	**-0.05**	**-0.23**	**-0.74**	**-0.24**	**-0.57**
	(-0.31)	*(-1.76)*	*(-1.53)*	*(-2.94)*	*(-0.97)*	*(-2.22)*
$g_j^A - g^A$		**-0.01**			**-0.01**	
		(-1.35)			*(-0.09)*	
Public Debt			**-0.001**			**0.01**
			(-0.13)			*(1.44)*
Gov. Exp.			**-0.001**			**0.0004**
			(-0.89)			*(2.09)*
$\log(\frac{A}{Y})$			**0.014**			**0.014**
			(4.04)			*(2.61)*
$\log(\frac{Y}{L})$			**-0.02**			**-0.01**
			(-1.74)			*(-0.70)*
$\log(L)$			**-0.11**			**-0.06**
			(-5.00)			*(-1.30)*
long run: $(s_j - s)$	2.88	2.27	2.60	3.89	2.92	4
Sargan. $Pr > \chi^2$	1	1	1	1	1	1
Obs.	517	370	462	300	223	300

Table 1: Time Series Estimation Results. Arellano Bond estimator for dynamic panel with fixed effects. The samples are (slightly) unbalanced. Germany has been excluded due to a structural break in 1990. t-statistics are in parenthesis and italics. The Sargan test of over-identifying restrictions (results from 2-step GMM with standard errors not corrected for heteroscedasticity.)with "H_0 : The over-identifying restrictions are valid.".

foreign asset position can be calculated by dividing the respective coefficients by one minus the coefficient of the lagged dependent variable. The implied long run coefficient on savings is therefore 2.8 for the whole period and 3.9 for the period between 1982 and 1997. Both coefficients are highly significant. However, they are still smaller than the calibrated value, which would be between 5 and 6. A possible explanation for this finding is the low speed of convergence. Especially in the second sample the estimation period of 15 years is not even sufficient to go half way to the steady state. As one can see in Figure 1 (and as discussed in section 2), standard parameter values imply that it takes 17 years to halve the distance to the steady state. A second explanation would be the role of non-tradeable goods as discussed below.

Introducing TFP growth in our second specification as further explanatory variable has little effect. The variable is insignificant and almost zero. This is not extremely surprising, given that the data are constructed in a complicated way. The measure itself is highly volatile on a year to year basis and the number of observations is reduced substantially.

In the third specification we introduce variables that are related to (i) fiscal policy and (ii) the scale of the economy. Government expenditure has a small but significant positive effect on net foreign assets in the second sub-sample. An increase in government spending could be accompanied by an increase in the general level of taxation, which leads to a decrease of the return to capital in the home country. Public debt has no significant influence.

As expected, the wealth to output ratio has a positive effect on net foreign assets. An increase in wealth has therefore a stronger effect on net foreign assets than on capital. GDP per capita has no significant impact, whereas population has a significant negative impact in the total sample. Population might therefore capture part of the effect that the Solow model would attribute to population growth. Since we consider a fixed-effects regression, the negative effect cannot be attributed to a scale-effect.

To summarize, the time series evidence is in line with the predictions of the Solow model. We interpret the positive effect of the savings rate, the negative coefficient of population growth and the coefficient of the lagged dependent variable as evidence of decreasing returns to capital.

4 Cross Country Evidence

To what extent can the Solow model explain actual cross country variation of net investment positions? In other words, we want to investigate whether net foreign assets are higher in countries with higher saving rates and lower in countries with higher values of population and productivity growth. We first test the basic specification and then discuss the robustness of the results with respect to other exogenous variables and included countries.

4.1 Basic Specification

We use the same dataset as above. It contains observations for 21 industrialized countries. Switzerland was identified as an outlier and is therefore excluded in most specifications.[5] For most countries, data are available from 1966 to 1997. In order to account for potential improvements of capital mobility over this time period, we consider not only the whole sample period, but also every decade separately starting with the 1970's.

Our basic empirical specification in this section is given by equation 4.1:

$$\left(\frac{F}{K}\right)_j = a_0 + a_1(s_j - s) + a_2(g_j - g) + \varepsilon_j, \tag{4.1}$$

[5]Introduction of Switzerland would support the Solow model even more, i.e. the coefficients gain substantially in size and significance.

where ε is a country-specific shock and $g_j = (g_j^L, g_j^A)$, $g = (g^L, g^A)$ are the same vector as above, containing the population growth rate g_j^L and the productivity growth rate g_j^A.

Since data on productivity growth are not available for some time periods and some countries, we consider also the specification with population growth only. In the 1970's data on productivity growth are only available for 14 countries due to missing employment data in the OECD Labour Force Statistics. In the other decades data are available for all countries, however not necessarily for all years.

We take averages (within the respective time period) of the explanatory variables. As endogenous variable we choose again the ratio of net foreign assets to capital, since it allows to assess whether net foreign assets increase more strongly than capital in response to variations in the explanatory variables. We consider both the average value and the value in the last year of the sample period. If country portfolios have not yet reached steady state values, the coefficients should be higher at the end of the sample period[6].

Table 2 reports the results of the basic specifications. The first two columns correspond to the specification with population growth only. We find that the population growth rate has a negative effect on $\frac{F}{K}$, highly significant in most of the time periods. In the 1990's the coefficient is quantitatively close to the value predicted by the Solow model. Assuming that world population growth is constant, equations 2.5 and 2.4 on page 6 imply that the long run coefficient of population growth on net foreign assets is $\frac{1}{s_j \alpha k^{\alpha-1} - \delta - g}$. Using standard parameter values (i.e. $\alpha = 0.33, K/Y = 3$ and the average savings rate $s \approx 0.25$) to calibrate the (average) value one obtains a theoretical value for the coefficient of -18. The empirical estimates are -9 for the whole sample period, and -17 for the 1990's.

The savings rate has a positive impact on $\frac{F}{K}$. In other words, the savings rate

[6]For the last time period we take the last but one value of 1996, since in 1997 data are missing for some countries

	$\left(\frac{NFA}{Capital}\right)_{Average}$		$\left(\frac{NFA}{Capital}\right)_{Final}$		$\left(\frac{NFA}{Capital}\right)_{Average}$		$\left(\frac{NFA}{Capital}\right)_{Final}$	
	Coef.	*St.E.*	**Coef.**	*St.E.*	**Coef.**	*St.E.*	**Coef.**	*St.E.*
	(1)		**(2)**		**(3)**		**(4)**	
				1966-1997				
$s_j - s$	**0.36**	*0.29*	**0.56**	*0.38*	**0.49**	*0.29*	**0.60**	*0.40*
$g_j^L - g^L$	**-9.76**	*3.93*	**-11.8**	*4.37*	**-12.59**	*4.77*	**-10.72**	*4.87*
$g_j^A - g^A$					**-2.74**	*1.38*	**1.32**	*2.36*
R^2	0.33		0.33		0.38		0.37	
Obs.	20		20		20		20	
				1970-1979				
$s_j - s$	**0.09**	*0.23*	**0.33**	*0.25*	**0.34**	*0.39*	**0.25**	*0.39*
$g_j^L - g^L$	**-7.01**	*3.23*	**-7.49**	*3.68*	**-7.20**	*4.05*	**-7.44**	*3.99*
$g_j^A - g^A$					**-4.87**	*3.59*	**-1.09**	*2.02*
R^2	0.28		0.36		0.36		0.30	
Obs.	20		20		14		14	
				1980-1989				
$s_j - s$	**0.50**	*0.35*	**0.47**	*0.37*	**0.24**	*0.36*	**0.47**	*0.38*
$g_j^L - g^L$	**-6.73**	*4.95*	**-9.95**	*5.25*	**-5.14**	*5.48*	**-8.28**	*5.79*
$g_j^A - g^A$					**-1.18**	*1.60*	**1.82**	*2.48*
R^2	0.17		0.22		0.09		0.25	
Obs.	20		20		20		20	
				1990-1997				
$s_j - s$	**0.62**	*0.29*	**0.85**	*0.30*	**0.50**	*0.27*	**0.90**	*0.30*
$g_j^L - g^L$	**-16.71**	*4.39*	**-16.13**	*4.92*	**-17.38**	*3.90*	**-16.7**	*4.90*
$g_j^A - g^A$					**-1.72**	*0.91*	**-1.45**	*1.25*
R^2	0.52		0.50		0.61		0.54	
Obs.	20		20		20		20	

Table 2: Baseline results. Cross country regression for 20 countries. The explanatory variables are the country averages of the respective time period.

has a stronger impact on net foreign assets than on capital. The coefficient is small and not significant in the 1970's. It increases for later time periods and also gains in significance. In the 1990's one obtains a value of 0.6. It is still much smaller than predicted by the Solow model, but highly significant. Moreover, if one uses the stock of net foreign assets at the end of the period (instead of the average one) as an endogenous variable, the coefficients are higher and more significant. The explanatory power of the regressors is substantial. The R^2 of the regressions for the whole sample period is 35%, but goes up to 50% for the regressions in the 1990's.

The last two columns of Table 2 report the results of the regressions including productivity growth. The coefficients of the saving rates and population growth remain basically unchanged. Productivity growth has the expected sign though insignificant in most of the specifications. In column three, with average net foreign assets as endogenous variable, productivity growth is significant at the 10 % level for the total sample period and for the 1990's.

The contribution of productivity growth to overall explanatory power of the model is limited. Still, in the 1990's, the R^2 increases up to 61%. Note that the R^2 in column 3 might be lower than in column 1 since the underlying data are not necessarily the same due to missing productivity data.

To summarize, the Solow model provides a remarkably good description of the composition of country portfolios in the 1990's. The fact that it increases its predictive power over time is in line with the fact that capital markets were liberalized in the beginnings of the 1990's.

4.2 Robustness

We check the robustness of the results along three dimensions. First, we include more variables that are potentially important in explaining country portfolios. Second, we look more in detail at the countries included in our dataset. Finally, we briefly discuss the results if a different dataset on net foreign asset positions is used.

4.2.1 Variables

In Table 3, we include ten more variables as explanatory variables. Since we have only 20 country observations we do not include all variables at once but in different blocks. The first block investigates the role of human capital growth. The remaining blocks consider variables that have been stressed by either Kraay et al. (2000) or Lane and Milesi-Ferretti (2001b). Including them in the regression allows to asses their explanatory power once one controls for the savings rate and population growth.

4.2.1.1 Human capital growth Exogenous productivity growth plays a crucial role in the Solow model. We therefore test the robustness with respect to another variable that could capture productivity growth. We include the growth rate of average years of schooling as reported by de la Fuente and Domenech (2001). It turns out to be insignificant in all regressions. The coefficients on savings and population growth change only slightly compared to the baseline specification.

4.2.1.2 Scale Variables In the second block, we introduce variables that are related to the size of the economy. Small economies are likely to have high foreign asset positions in order to compensate a lack of diversification possibilities in their own countries. As for GDP, Lane and Milesi-Ferretti (2001b) argue that it is the principal determinant of the net foreign asset positions. In addition to population and GDP per capita, we include the level of average years of schooling as a proxy for the efficiency units of labor.

Whereas the coefficients on GDP per capita and years of schooling are insignificant in all regressions, the coefficient on population is significantly positive - but

		$\frac{NFA}{Capital}$		$\frac{NFA}{Capital}_{final}$		$\frac{NFA}{Capital}$		$\frac{NFA}{Capital}_{final}$		$\frac{NFA}{Capital}$		$\frac{NFA}{Capital}_{final}$		$\frac{NFA}{Capital}$		$\frac{NFA}{Capital}_{final}$	
		Coef.	*St.E.*	**Coef.**	*St.E.*	**Coef.**	*St.E.*	**Coef.**	*St.E.*	**Coef.**	*St.E.*	**Coef.**	*St.E.*	**Coef.**	*St.E.*	**Coef.**	*St.E.*
		1966-1997				1970-1979				1980-1989				1990-1997			
1	$s_j - s$	**0.35**	*0.3*	**0.54**	*0.4*	**0.01**	*0.25*	**0.26**	*0.27*	**0.49**	*0.36*	**0.44**	*0.37*	**0.54**	*0.3*	**0.85**	*0.31*
	$g_j^L - g^L$	**-9.18**	*4.35*	**-11.75**	*4.51*	**-7.85**	*3.39*	**-8.16**	*3.86*	**-5.57**	*5.38*	**-8.25**	*5.56*	**-18.67**	*4.84*	**-16.97**	*5.54*
	HK growth	**0.32**	*0.9*	**0.24**	*1.17*	**0.64**	*0.72*	**0.51**	*0.72*	**0.49**	*0.79*	**0.77**	*0.81*	**-0.53**	*0.51*	**-0.19**	*0.52*
	R^2	0.34		0.36		0.31		0.37		0.19		0.26		0.54		0.51	
	Obs.	20		20		20		20		20		20		20		20	
2	$s_j - s$	**0.35**	*0.27*	**0.50**	*0.46*	**0.03**	*0.20*	**0.23**	*0.19*	**0.36**	*0.32*	**0.57**	*0.4*	**0.58**	*0.4*	**0.85**	*0.43*
	$g_j^L - g^L$	**-11.03**	*3.78*	**-12.57**	*5.08*	**-7.67**	*2.84*	**-7.23**	*2.85*	**-9.76**	*4.57*	**-12.35**	*5.34*	**-19.96**	*6.07*	**-15.53**	*6.91*
	$\ln(gdp/L)$	**-0.02**	*0.11*	**0.04**	*0.16*	**0.006**	*0.086*	**0.04**	*0.08*	**0.09**	*0.11*	**-0.05**	*0.13*	**-0.01**	*0.15*	**0.06**	*0.16*
	School.	**0.004**	*0.014*	**-0.002**	*0.021*	**-0.006**	*0.011*	**-0.008**	*0.011*	**-0.004**	*0.015*	**-0.006**	*0.018*	**0.014**	*0.019*	**-0.004**	*0.021*
	$\ln(L)$	**0.03**	*0.01*	**0.02**	*0.02*	**0.03**	*0.03*	**0.03**	*0.01*	**0.04**	*0.01*	**0.04**	*0.02*	**0.02**	*0.02*	**0.01**	*0.02*
	R^2	0.64		0.43		0.59		0.70		0.62		0.53		0.54		0.51	
	Obs.	20		20		20		20		20		20		20		20	
3	$\ln\frac{A}{L}$	**0.08**	*0.04*	**0.08**	*0.06*	**0.06**	*0.04*	**0.09**	*0.04*	**0.13**	*0.04*	**0.09**	*0.05*	**0.13**	*0.05*	**0.13**	*0.05*
	R^2	0.18		0.10		0.10		0.22		0.35		0.14		0.28		0.26	
	Obs.	20		20		20		20		20		20		20		20	
	$\ln\frac{A}{Y}$	**0.21**	*0.08*	**0.24**	*0.10*	**0.12**	*0.08*	**0.16**	*0.08*	**0.26**	*0.07*	**0.28**	*0.09*	**0.22**	*0.07*	**0.21**	*0.08*
	$\ln\frac{Y}{L}$	**0.01**	*0.06*	**-0.02**	*0.08*	**0.02**	*0.06*	**0.06**	*0.06*	**0.04**	*0.05*	**-0.03**	*0.07*	**0.03**	*0.08*	**0.04**	*0.08*
	R^2	0.31		0.24		0.14		0.26		0.37		0.37		0.37		0.34	
	Obs.	20		20		20		20		20		20		20		20	
	$s_j - s$	**-0.17**	*0.44*	**0.00**	*0.78*	**0.30**	*0.86*	**0.15**	*0.85*	**-0.56**	*0.58*	**-0.24**	*0.51*	**0.23**	*0.40*	**0.88**	*0.48*
	$g_j^L - g^L$	**-10.22**	*5.50*	**-9.53**	*6.44*	**-6.92**	*5.41*	**-6.89**	*5.13*	**-5.49**	*4.92*	**-4.24**	*6.38*	**-21.37**	*5.62*	**-21.92**	*8.00*
	$g_j^A - g^A$	**-1.64**	*1.41*	**1.42**	*2.44*	**-5.16**	*4.55*	**-1.45**	*2.65*	**-0.90**	*1.23*	**1.58**	*2.32*	**-1.66**	*0.99*	**-1.67**	*1.51*
	$\ln\frac{A}{Y}$	**0.18**	*0.12*	**0.14**	*0.19*	**0.04**	*0.20*	**0.06**	*0.18*	**0.27**	*0.09*	**0.27**	*0.12*	**-0.03**	*0.10*	**-0.07**	*0.12*
	$\ln\frac{Y}{L}$	**0.10**	*0.07*	**0.06**	*0.09*	**0.05**	*0.15*	**0.04**	*0.17*	**0.11**	*0.08*	**0.01**	*0.09*	**0.15**	*0.07*	**0.10**	*0.09*
	R^2	0.53		0.41		0.37		0.32		0.53		0.44		0.70		0.58	
	Obs.	20		20		14		14		20		20		20		20	
4	$s_j - s$	**0.06**	*0.39*	**0.60**	*0.48*	**-0.14**	*0.33*	**0.02**	*0.38*	**0.05**	*0.36*	**0.15**	*0.44*	**0.51**	*0.31*	**0.80**	*0.33*
	$g_j^L - g^L$	**-12.25**	*9.89*	**-25.25**	*8.22*	**0.53**	*6.81*	**-7.47**	*9.11*	**-6.41**	*7.02*	**-9.9**	*8.23*	**-25.61**	*8.05*	**-29.83**	*11.23*
	$\chi^2(demog)$	**2.11**	*0.55*	**4.81**	*0.19*	**4.03**	*0.26*	**1.86**	*0.6*	**8.6**	*0.04*	**3.19**	*0.36*	**4.65**	*0.19*	**3.73**	*0.29*
	R^2	0.42		0.43		0.41		0.42		0.46		0.34		0.61		0.59	
	Obs.	20		20		20		20		20		20		20		20	
5	$s_j - s$	**0.37**	*0.35*	**0.74**	*0.37*	**0.18**	*0.29*	**0.43**	*0.3*	**0.39**	*0.42*	**0.58**	*0.45*	**0.68**	*0.34*	**0.94**	*0.33*
	$g_j^L - g^L$	**-11.19**	*4.86*	**-10.12**	*4.11*	**-5.85**	*3.62*	**-7.71**	*4.03*	**-7.52**	*5.41*	**-9.58**	*5.87*	**-16.26**	*4.81*	**-14.59**	*5.25*
	$\frac{pubDebt}{Y}$	**0.02**	*0.1*	**0.14**	*0.11*	**-0.04**	*0.11*	**0.05**	*0.1*	**-0.01**	*0.09*	**-0.01**	*0.11*	**0.02**	*0.07*	**0.06**	*0.07*
	$\frac{G}{Y}$	**0.001**	*0.004*	**0.005**	*0.005*	**0.001**	*0.003*	**0.001**	*0.004*	**-0.002**	*-0.004*	**0.002**	*0.004*	**0.002**	*0.004*	**0.003**	*0.005*
	R^2	0.34		0.43		0.26		0.41		0.19		0.24		0.53		0.51	
	Obs.	20		20		20		20		20		20		20		20	

Table 3: Predicting Power of other explanatory variables.

small - in the 1970's and 1980's. In the 1990's, however, GDP per capita is insignificant as well. The coefficients on savings and population growth remain unchanged.

4.2.1.3 Wealth The third block of regressions investigates the role of wealth in explaining net foreign asset positions. We follow Kraay et al. (2000) who argue that wealth per capita is the most relevant explanatory variable. In another set of regressions we decompose the effect into the wealth to output ratio and output per capita. Finally, we include the latter two variables in the regressions with savings, population and productivity growth.

In all time periods, wealth per capita has a significant positive impact. The size of the coefficient is slightly higher but similar to the estimates of Kraay et al. (2000), although we restrict ourselves to industrialized countries only. The second set of regressions reveals that the positive impact of wealth per capita can be fully attributed to the wealth to output ratio. We decompose $\ln\left(\frac{A}{L}\right) = \ln\left(\frac{A}{Y}\right) + \ln\left(\frac{Y}{L}\right)$ and find that GDP per capita has no impact on net foreign assets. In contrast, the wealth to output ratio is significant in almost all regressions. What matters is therefore not wealth per capita, as argued in Kraay et al. (2000), nor GDP per capita (Lane and Milesi-Ferretti, 2001b), but the ratio of the two.

This result could be interpreted as confirming the Solow model which predicts a strong positive correlation between the wealth to output ratio and the ratio of net foreign assets and capital. A model without decreasing returns, e.g. the AK-model, does not predict any relation between the wealth to output ratio and net foreign assets. This finding could therefore be seen as further evidence for decreasing returns to capital. Note that the wealth to output ratio is not a measure of wealth. In the 1990's, the United States had an average wealth to output ratio of 2.17 which was well below average, roughly at the same level as Portugal. In contrast, Japan had a level of GDP per capita that was close to the one of the U.S., but had a wealth to output ratio of 5.

Including our standard explanatory variables (savings, population growth and productivity growth) and $\frac{A}{Y}$ in one regression suffers from the fact that the wealth to output ratio itself is strongly correlated with savings and exogenous growth rates. Given the relatively small sample size of 20 cross country observations, it is unlikely that the effects can be clearly separated. It turns out the most of the coefficients are insignificant and much smaller than if the variables are included separately. In some time periods, $\frac{A}{Y}$ captures most of the effect resulting in highly insignificant coefficients for savings. In the 1990's, however, savings and population growth seems to capture most of the effect and the wealth to output ratio is insignificant.

4.2.1.4 Demographic Variables Demographic factors are potentially important determinants of international investment positions. The most important channel through which the age structure may influence investment positions is its impact on savings. A relatively young workforce may point to low savings and high investment, whereas an older workforce may be associated with high savings for retirement motives. Savings might be low if there are many retirees that actually dissave. If this was the only channel, one should not expect finding a significant impact of demographic factors once the savings rate is included.

However, there are more potentially important channels. First, risk aversion is likely to change as people grow older and richer. Second a high youth dependency ratio may require heavy investment in social infrastructure as education and housing. Finally, to the extent that capital markets are not perfect, young entrepreneurs might be forced to finance their projects with own savings, which would lead to natural co-movement of savings with investments.

Following Lane and Milesi-Ferretti (2001b), we construct three composite variables that reflect the demographic structure. They are based on United Nations data on population shares for 12 age cohorts and summarize the entire age distribution in a parsimonious way[7]. In the last but one block of regressions in table 3 we report the χ^2 statistics (and the associated p value) of a likelihood ratio test that the three demographic variables are jointly significant.

Although the demographic variables are significant in only one of the regressions (1980-1989), they reduce the coefficient on savings in some of the regressions. This however, is not surprising to the extent that the demographic structure is an important determinant of a country's aggregate savings behavior. In the 1990's, the savings rate is significant and has roughly the same magnitude as in the benchmark regressions. Population growth is significant throughout all the regressions, such that we take this evidence as further confirmation of the Solow model.

4.2.1.5 Fiscal Policy International investment positions might finally depend on fiscal policy. The first variable we consider is the stock of public debt. Public debt is defined as the sum of external public debt, net of foreign-exchange reserves, and gross domestic public debt.[8] An increase in public debt will not be offset by an increase in private savings whenever the Ricardian equivalence does not hold. In that case, higher levels of public debt may be associated with a decline in the external position. A second variable that could capture basically the same effect is government spending. Moreover, government spending could be a measure of public infrastructure that increases the return to capital.

The last block of regressions in Table 3 shows, that neither of the variables is significant. The coefficients on savings and population growth remain in their usual range. In terms of explanatory power, fiscal policy does not seem to add a significant amount.

[7]See the appendix in Lane and Milesi-Ferretti (2001b), page 114, for details on the construction of the variables.

[8]The data on public debt were constructed by Lane and Milesi-Ferretti (2001b). I thank the authors for kindly sharing their data. Their original source of data for public debt is the OECD (central government definition).

4.2.1.6 Summary Controlling for additional variables does not alter the main conclusion, that the Solow model provides a good description of the data. Finding insignificant coefficients in the reported regressions, however, does not imply that the respective variables do not influence investment positions. It implies, that the only channel through which they might affect the investment positions, is via the savings rate.

4.2.2 Countries

In order to understand the results of this paper relative to the literature, it is interesting to extend the sensitivity analysis to the countries included in the empirical analysis. In particular, a strict interpretation of the "new rule", proposed by Kraay and Ventura (2000), would imply that the ratio of net foreign assets to wealth or capital does not depend on the savings rate. If the marginal unit of wealth - generated e.g. through an increase in savings - is invested in foreign assets to the same extent that existing wealth is invested in foreign assets the composition of a country's portfolio does not change. In our specifications above, however, we find direct evidence for a positive effect of savings on the composition of a country's portfolio.

We therefore have a closer look at the countries that Kraay and Ventura include in their empirical analysis. In Table 4 we report the baseline results for the last time period, i.e. 1990 to 1997 for three sub-samples. First we consider the total dataset (including Switzerland), the 13 countries used by Kraay and Ventura and the remaining countries. We also report the results for the regressions with TFP-growth.

The results show that the negative relationship between population growth and net foreign assets is robust. The coefficient on savings, is not significantly different from zero for the 13 countries considered by Kraay and Ventura. In the remaining sample, however, the impact of savings is large and highly significant. Figure 2 visualized this finding by plotting the bivariate relationship between savings (relative to the world average) and net foreign assets.

Regressions	Endogenous variable: $\frac{NFA}{Capital}$ in 1996					
	All countries		**"New rule"**		**Remaining**	
	Coef.	*Std. Err.*	**Coef.**	*Std. Err.*	**Coef.**	*Std. Err.*
$s_j - s$	**1.04**	*0.4*	**0.38**	*0.52*	**1.51**	*0.72*
$g_j^L - g^L$	**-14.58**	*6.62*	**-10.96**	*6.38*	**-24.97**	*14.91*
R^2	0.36		0.29		0.52	
Obs.	21		13		8	
$s_j - s$	**1.09**	*0.38*	**-0.14**	*0.44*	**2.12**	*0.62*
$g_j^L - g^L$	**-15.94**	*6.29*	**-12.43**	*4.9*	**-34.96**	*12.44*
$g_j^A - g^A$	**-2.77**	*1.53*	**-3.97**	*1.39*	**-5.92**	*2.82*
R^2	0.47		0.63		0.77	
Obs.	21		13		8	
	Descriptive statistics: Standard deviations					
$\frac{f}{k}$ (1996)	0.12		0.07		0.17	
$s_j - s$	0.05		0.04		0.08	
$g_j^L - g^L$	0.003		0.003		0.004	
$g_j^A - g^A$	0.014		0.012		0.016	

Table 4: The effect of savings and population growth depending on the included countries. The first columns correspond to the total dataset, including Switzerland. The second columns report the results for the 13 countries that have been included in the empirical analysis in Kraay and Ventura (2000). The last columns correspond to the the remaining 8 countries.

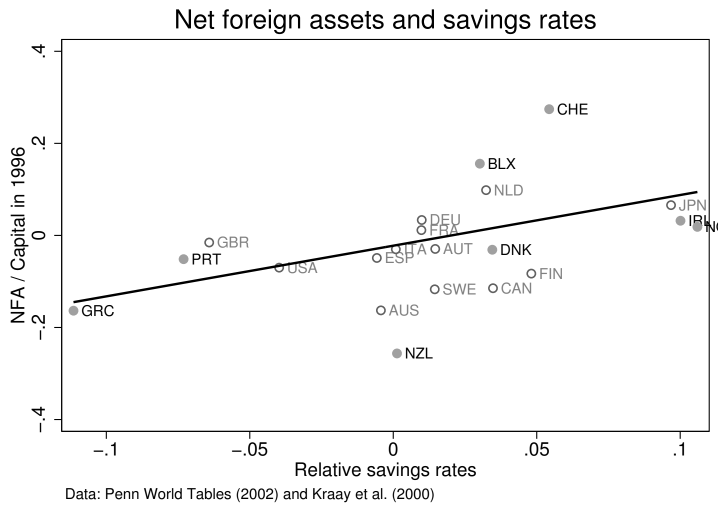

Figure 2: Bivariate relation between the ratio of NFA over capital in 1996 and the average savings rate between 1990 and 1997. The bold labelled countries are not used in the empirical analysis of Kraay and Ventura (2000).

A possible explanation for this finding lies in the size of the gross country variation of the respective variables. The second part of Table 4 documents that the standard deviations of net foreign assets in 1996 and the savings rate is much smaller in Kraay and Ventura's dataset than in the remaining countries. The standard deviations of the savings rate are 4 versus 8 percentage points, respectively.

We therefore think that the insignificant coefficient on savings in the first subsample should not be taken as evidence against the Solow model. There are many factors that affect the return to capital, such as taxation, labor market institutions, competition policy and so on, that might cloud the effect on capital accumulation on the return to capital. As soon as the variation of savings becomes large enough, the effect becomes visible.

4.2.3 Data

A further way of testing the robustness would be the use of a different dataset. Using the dataset of Kraay et al. (2000) has the advantage that the authors provide coherent data not only on net foreign assets but also on financial wealth and capital. This allows us to "normalize" the stock of net foreign assets over capital, which is a stock variable itself. The dataset of Lane and Milesi-Ferretti (2001a) contains as measure of international investment positions the fraction of net foreign assets in output. Using this measure as endogenous variable, the results are quantitatively and qualitatively the same for both dataset. Moreover, they are completely coherent with the results reported here, i.e. the sign of the coefficients is identical and the magnitude is roughly scaled by the capital to output ratio (factor 3).

5 Gross investment positions

The question arises whether introduction of small but nonzero country specific production risk, i.e. production risk that cannot be diversified among the large number of firms within every country, would lead to completely unrealistic predictions for gross stocks of international investment positions, and whether this feature would render the model implications for net positions worthless.

Country specific production risk together with transaction cost of capital movements determine the desire of agents for international risk sharing. If transaction costs are small compared to the production risk, complete risk sharing will be optimal. One way to implement the first best allocation (subject to the constraint that the savings rates are exogenous) is to have representative agents that completely diversify their portfolios. This, however, would be in contrast to well known empirical evidence that country portfolios are heavily biased towards investments in the home country.

Assuming that transaction cost are high will avoid unrealistic predictions for gross capital flows. However, high transaction costs will also restrict the possibilities of net capital flows to equilibrate differences in the return to capital, that are at the heart of the open-economy Solow model. The only way to establish that capital does indeed flow to the location where returns are highest, but gross flows are small, is to assume that both transaction costs and gains from diversification are very small, but transaction costs are still larger than gains from portfolio diversification.

The evidence on the gains from global risksharing is mixed. An empirical paper that finds rather large values is Athanasoulis and Wincoop (2000). For a sample of 21 OECD countries they find a gain of 1.5%, corresponding to a welfare equivalent increase in consumption. In contrast, Cole and Obstfeld (1991) argue that the gains are small. The authors calibrate a general equilibrium model with output uncertainty and find social gains from international risk sharing to be in the order of 0.2 % of output per year. A crucial mechanism underlying their results is the effect of output uncertainty on the relative prices at which international commodity trade occurs. Since a country's terms of trade are negatively correlated with growth in its export sector, commodity trade plays an important role in automatically pooling national output risks.

6 Conclusion

Most countries are either persistent international net creditors or international net debtors. This observation raises the question of what are the determinants of a country's long run portfolio composition.

In this paper we analyze to what extent international investment positions can be explained by an open-economy Solow model. We find that in the 1990's, differences in the savings rates and the population growth rates can explain more than half of the cross country variation of net foreign assets. A dynamic panel estimation shows that Solow model also provides a good description of the time series behavior of NFA. The overall impact of savings on the composition of country portfolios is smaller than predicted by the model. This however might be due to the relative short sample period together with a very slow speed of convergence. In fact, the model calibrated with standard parameters used e.g. by Mankiw et al. (1992) predicts that the net foreign asset positions approach their steady state level with a half-life period of 17 years.

A Aggregation in the Simple Solow Model

The world average capital intensity is $k = \frac{K}{H}$ with $K = \sum_{j=0}^{N} K_j$ and $H = \sum_{j=0}^{N} H_j$. Define the world average savings rate s and growth rate g to be

$$s \equiv \frac{\sum_{j=0}^{N} (s_j(Y_j + rF_j))}{\sum_{j=0}^{N} Y_j} \tag{A.1}$$

$$g \equiv \frac{\sum_{j=0}^{N} (g_j H_j)}{\sum_{j=0}^{N} H_j} \tag{A.2}$$

Both s and g increase over time. The average savings rate s approaches a constant as soon as the world economy approaches constant ratios of net foreign asset positions over GDP. The growth rate g converges to the growth rate of the fastest growing country in the very long run since all other countries become vanishingly small.

Since we can observe the world average growth rate in the data, we typically treat it as exogenous variable. This implies that we make the assumption that we consider a small country j whose growth rate has negligible influence on the world average. Additionally, we consider a relatively short time period for which even the fastest growing small economy remains small.

The evolution of the world average capital intensity is described by

$$\begin{aligned}
\dot{k} &= \frac{\sum_{j=0}^{N} \dot{K}_j}{H} - k\frac{\sum_{j=0}^{N} \dot{H}_j}{H} \\
&= \frac{\sum_{j=0}^{N} (s_j(Y_j + rF_j)) - \delta \sum_{j=0}^{N} (K_j + F_j)}{H} - k\frac{\sum_{j=0}^{N} g_j H_j}{H} \\
&= sy - (\delta + g)k, \qquad \text{(A.3)}
\end{aligned}$$

using equations A.1 and A.2 together with $\sum_j F_j = 0$, $y_j = y$ and $k_j = k$. Equation A.3 corresponds to equation 2.4 in the main part of the paper.

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