Where Did Capital Flow? Fifty Years of International Rate of Return Differentials and Capital Flows

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INTRODUCTION

World capital flows are substantial. Since 2000, gross world capital flows have averaged about 25 percent of world GDP per year, while net capital flows have been in excess of 4 percent of world GDP. Figure 1 shows these net flows as a fraction of world gross domestic product (GDP) over this period. Robert Lucas (1990) presumed that poor countries would have higher marginal products of capital (MPKs) than rich countries, and thus asked why capital doesn't flow from the rich to the poor. There

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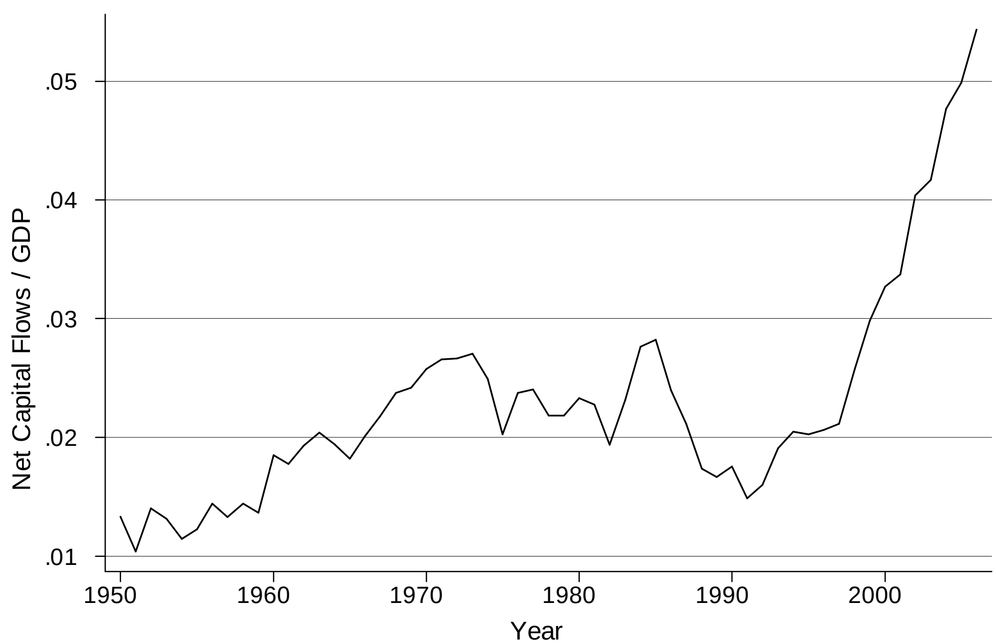
have been many proposed answers to Lucas's question, including the hypothesis that poor countries have low total factor productivity (TFP), low human capital, and/or that poor countries tend to disproportionately confiscate capital. Nevertheless, the organizing principle behind Lucas's analysis, as well as the broader implications of standard optimal growth theory, predict that capital should flow from countries with low marginal products of capital (MPKs) to countries with high MPKs.



But does capital flow to locations with a relatively high marginal product/high rate of return? We address this question by constructing a panel database of 200 countries between 1950 and 2005. This set of countries accounts for about 99 percent of world real income in 2005. With this data, we construct two measures of the rate of return to capital. The first measure is from the production side of the economy using the marginal product of capital. The second measure is from the household side of the economy using the consumer's intertemporal marginal rate of substitution.

Our main finding is that for much of the last half century, capital has not flowed from low return to high return countries, with returns measured either using the MPK or the IMRS. This finding holds at the individual country level, and also holds for various levels of aggregation of countries. Specifically, Latin America received significantly more international capital than is consistent with standard theory, while the Asian tigers received much less capital than is consistent with standard theory.

These findings lead us to restate Lucas's (1990) puzzle from "why doesn't capital flow to the poor", to "why doesn't capital flow to high return countries"? To address this puzzle, we assess whether common departures from standard theory, including models of contracting imperfections, or models with incomplete markets, can shed light on these findings. We find that none of these classes of models can sufficiently reconcile the fact that capital has not flowed to high return countries. The main reason why existing theory cannot account for observed flows is that *all* of these models retain the feature that capital flows from low to high return countries. Various frictions or market imperfections may *limit* these flows, but they do not *reverse* these flows to low return countries, as observed in the data. We conclude by discussing possible modifications of theories to advance our understanding of this phenomenon.

The paper is organized as follows. Section 1 describes the panel dataset, with a focus on constructing capital stock measures and the associated returns. Section 2 presents the model economy and describes the set of analyses that we carry out. Section 4 presents the results. Section 5 discusses the implications of the findings for different classes of theoretical models. Section 7 discusses related literature, and section 8 concludes.

DATA

This section presents the data that we use to construct our panel dataset. There are several sources for the data including the World Bank, the OECD, Gronningen, GDC, the United Nations, as well as several country-specific data sources. The Appendix presents the data and sources in detail. We have obtained and/or constructed measures of the following (real) quantity variables, all measured relative to the adult (16 and over) population: GDP, consumption, investment, employment, hours (for a small subset of countries), and net exports, which we use to measure capital flows, for the 1950-2005 period. For 19 countries, we also have some of these measures for the 1900-1930 period as well. For accounting purposes, note that output is given by:

$$Y = C + Stat + I + X - M,$$

where C is private and public consumption, I is private and public investment, X-M is net exports, and stat is the statistical discrepancy.

Capital Stock

We begin with the law of motion for the capital stock:

$$K_{t+1} = I_t + (1 - \delta)K_t$$

It is standard to use the perpetual inventory method to construct capital stocks. Cross-country studies that have used this approach include the World Bank wealth study for 2000, Lane Milesi-Ferretti (), and Nehru and Derashwar (), and King and Levine (). We use 2 approaches to estimate an initial capital stock, both of which use steady state results to infer the initial stock.

The first approach is used by Caselli and Feyer (), which assumes the following relationship between investment in the first year and the capital stock:

$$K_0 = \frac{I_0}{g + \delta},$$

where I_0 is investment in the first year of data, δ is the depreciation rate, and g the average growth rate for investment between the first year of data availability and 1970. This result follows from a steady state growth path in which capital depreciates at rate δ and the steady state growth rate of the economy is g, and I_0 is assumed to be the steady state level of investment. is the steady state investment level scaled by the growth rate of the economy.

The second approach to inferring the initial capital stock follows from King and Levine (), who also exploit steady state results to back out an initial capital stock:

$$K_0 = \frac{I/Y}{g + \delta} Y_0,$$

where I/Y is measured as the average investment rate for the decade of the 1950s, and Y_0 is the average income for the first three years of the sample. King and Levine the growth rate of the economy, g as follows:

$$g = \frac{1}{4} g_{1950} + \frac{3}{4} g_{world},$$

where g_{1950} is the average growth rate of GDP for the country during the decade of the 1950s, and g_{world} is the average growth rate of the world economy over the full sample.

While it is common to use steady state results to construct an initial capital stock, we note that this assumption will be less accurate for countries that are in the process of transiting to a steady state. Thus, an alternative approach which combines data on consumption growth and labor can be used in conjunction with the growth model to estimate an initial stock for countries that are in the transition process. (Not in this draft).

Consumption

We'll focus on private consumption, and as a robustness check we add government consumption and the statistical discrepancy as robustness This gives us four measures:

1. private final consumption
2. private final consumption plus the discrepancy (private final consumption etc)
3. total final consumption
4. total final consumption plus the discrepancy (final consumption etc).

Labor

Our standard measure for labor will be employment because it is much more widely available than hours. We note that labor will not be required for the analysis for the case in which preferences are separable in consumption and leisure.

MODEL ECONOMY

We consider the perfect foresight maximization problem for a representative household in country n :

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U\left(c_{nt}, (1-h_{nt})\right),$$

subject to its flow budget constraint

$$c_{nt} + k_{nt+1} + b_{nt+1} \leq w_{nt}h_{nt} + \left(r_{nt}^K + (1-\delta)\right) k_{nt} + \left(1 + r_{nt}^B\right) b_{nt},$$

with k_0, b_0 given. We use the standard convention by referring to individual choice variables with lower case letters (e.g. c_{nt}) and per-capita variables that the household treats parametrically. Note that we have written factor prices and bond returns as varying across countries. We interpret these country specific prices as capturing country specific distortions, which will be discussed in detail in section 4..

A competitive, representative firm with a constant returns to scale technology hires labor and capital to maximize profits:

$$\max F(K_{nt}, H_{nt}) - w_{nt}H_{nt} - r_{nt}K_{nt}$$

The first order conditions for the household and the firm yield:

$$\begin{aligned}
\frac{U_2\left(c_{nt},(1-h_{nt})\right)}{U_1\left(c_{nt},(1-h_{nt})\right)} &= w_{nt}, \\
U_1\left(c_{nt},(1-h_{nt})\right) &= \beta E\{U_1\left(c_{nt+1},(1-h_{nt+1})\right)\left[r^K_{nt+1}+(1-\delta)\right]\}, \\
U_1\left(c_{nt},(1-h_{nt})\right) &= \beta E\{U_1\left(c_{nt+1},(1-h_{nt+1})\right)\left(1+r^B_{nt+1}\right)\},
\end{aligned}$$

To calculate the marginal product of capital and carry out the analysis, we need to choose functional forms for preferences and the technology. Our specification includes a Cobb-Douglas technology with a capital share parameter (α) that in our benchmark parameterization is identical across countries:

$$F\left(K_{nt}, H_{nt}\right) = A_{nt}K^{\alpha}_{nt}H^{1-\alpha}_{nt},$$

and we specify logarithmic preferences with a preference share parameter (θ) that is also identical across countries for our benchmark parameterization:

$$U\left(C_{nt},(1-h_{nt})\right) = \theta \ln C_{nt} + (1-\theta)\ln\left(1-h_{nt}\right),$$

The intertemporal marginal rate of substitution is used to construct the return to capital from the consumers side (r^B_{nt}), the marginal product of capital is used to construct the return to capital from the production side (r^K_{nt}), and the wage is constructed using the household's efficiency condition

$$
\begin{aligned}
r_{nt}^{B} &= \frac{C_{nt+1}}{\beta C_{nt}} - 1 \\
r_{nt}^{K} &= \alpha \frac{Y_{nt}}{K_{nt}} - \delta \\
w_{nt} &= \frac{\theta \left(1 - h_{nt}\right) L_{nt}}{\left(1 - \theta\right) C_{nt}},
\end{aligned}
$$

where later we also consider measuring the return to labor from the estimated marginal product of labor.

To parameterize the model, we make the following choices. We choose log preferences over consumption and leisure ($\log(C_t) + \theta \log(1 - h)$), and choose a parameter value of θ such that household work one third of their time endowment. We set the capital share parameter $\alpha = 0.4$, we set the depreciation rate $\delta = 0.05$, we set the household discount factor $\beta = 0.95$.

Given these choices, we construct the capital stock using the procedures described above, and then calculate r_{nt}^{B} and r_{nt}^{K} for all n and all t.Note that we estimate two separate rates of return, which differs from the more standard "Business Cycle Accounting" procedure which estimates a single Euler equation wedge between these two objects, and interprets time-variation in the difference between r_{nt}^{B} and r_{nt}^{K} as time variation in some capital market distortion, such as financial market imperfections or capital income taxes. This is a valuable diagnostic, as it may shed light on why capital does not flow to high MPK countries. We therefore also compute the Euler equation wedge, which is equivalent to the following expression with taxation of capital income:

$$
\begin{aligned}
& U_1 \left(C_{nt}, \left(1 - h_{nt}\right) L_{nt}\right) \\
= & {}_1 \left(C_{nt+1}, \left(1 - h_{nt+1}\right) L_{nt+1}\right) \left(1 - \tau_{Knt}\right) \left[A_{nt+1} F_1 \left(K_{nt+1}, h_{nt+1} L_{nt+1}\right) + \left(1 - \delta\right)\right],
\end{aligned}
$$

which can be rearranged to yield the Euler wedge, which is the ratio of the IMRS return to the MPK return.

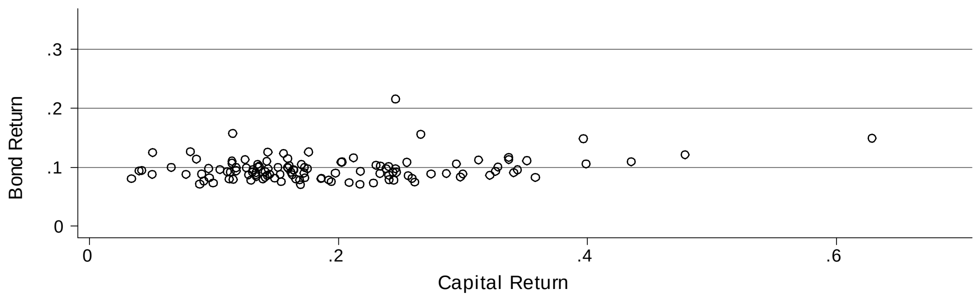
$$\begin{aligned} 1-\tau_{Knt} &= \frac{U_1\left(C_{nt},\left(1-h_{nt}\right)L_{nt}\right)}{\beta U_1\left(C_{nt+1},\left(1-h_{nt+1}\right)L_{nt+1}\right)}\frac{1}{A_{nt+1}F_1\left(K_{nt+1},h_{nt+1}L_{nt+1}\right)+\left(1-\delta\right)} \\ &= \frac{1+r^B_{nt}}{1+r^K_{nt}} \end{aligned}$$

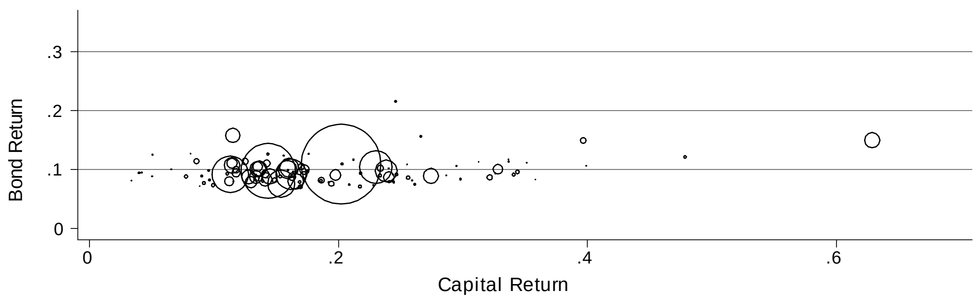
Note, however, than a comparison of wedges across countries need not be informative as to international capital market imperfections: if international markets are competitive but domestic capital markets differ in their levels of imperfection, wedges could vary substantially across countries. In this case, we would compare the levels of the implied bond and capital returns, as well as their ratios.

RESULTS

In this section, we present our early results on this dataset. In what follows, all bond returns correspond to our measure using private consumption, while all capital returns are derived from capital stocks constructed using the Caselli-Feyrer method if estimating initial capital stocks. Results are similar if the King and Levine method is used.

We begin by examining the relationship between our different return measures. Figure One plots the average capital return against the average bond return for each of our countries. The top panel represents a scatter plot of the relative returns, while the bottom panel weights each country by its share of world GDP. As can be seen, the relationship between the return measures is positive, and particularly so once one weights by GDP. In particular, the correlation between returns measures is 0.25 in the unweighted sample, and rises to 0.51 for the weighted sample.



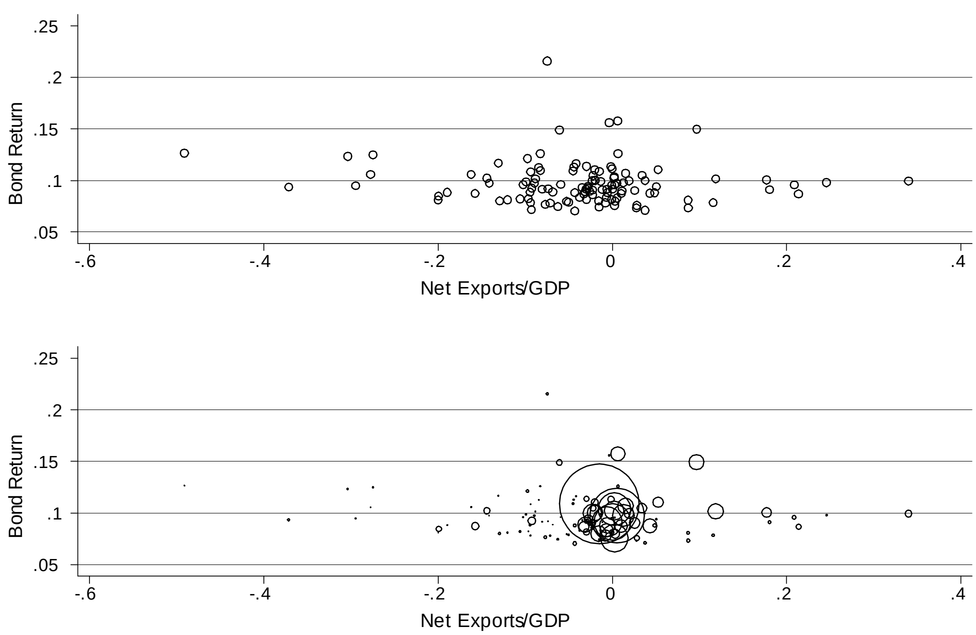


This is consistent with our expectations: countries with high observed capital returns have faster consumption growth. Nonetheless, the relationship is not perfect, suggesting there is a role for various "frictions" within countries – ranging from inefficiencies in domestic capital markets, to (efficient) adjustment costs – in explaining the pattern of returns. The relationship is also stronger for rich countries, which is consistent with stronger domestic financial systems in these countries, but also could reflect better measurement.

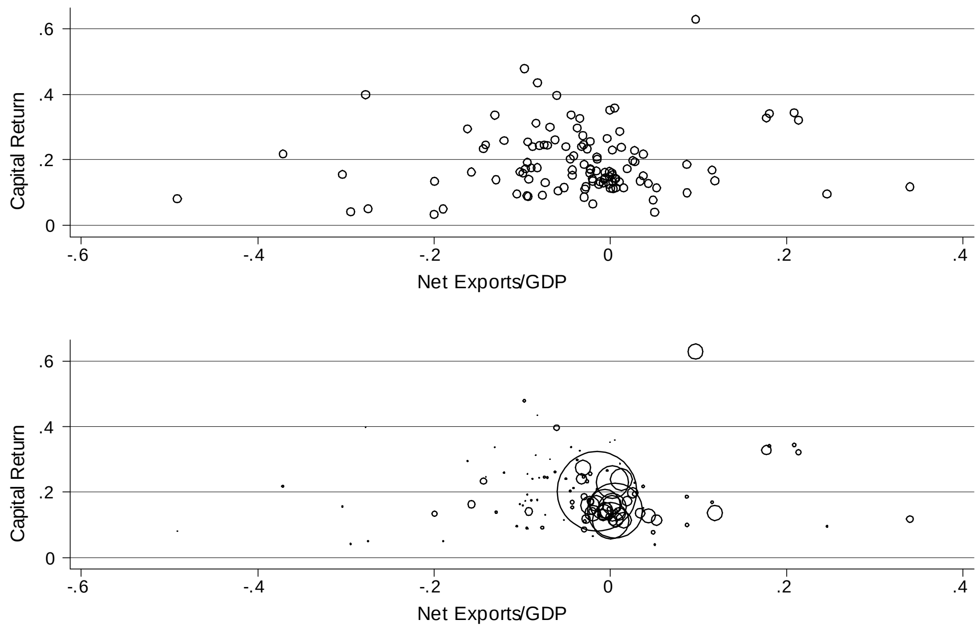
Next, we examine the relationship between returns and capital flows. Initially, we focus on net exports as our measure of capital flows. This is for two reasons, one empirical and one theoretical. The first reason is that other measures of capital flows, most notably the current account, are known to be measured with substantial error. In fact, in some years, the world is found to have run a massive current account deficit with itself. As this error is found to lie mostly within the income side of the current account, we focus on net exports because it appears to be better measured.

The second reason is theoretical: in some models, net exports are uniquely pinned down while the current account may be indeterminate, as a result of the sensitivity of factor income to the details of the market environment assumed. To put it another way, some allocations can be decentralized in multiple ways, and the factor incomes associated with different asset market structures can differ substantially.

The next two figures presents the relationship between net exports to GDP ratios and both of our returns measures. Beginning with the bond return measure, the next graph shows that the relationship has the expected negative sign: capital flows in to economies (net exports are negative) with high returns. However, at first glance the relationship appears quite weak. Indeed, in the top panel, where countries are not weighted, the correlation coefficient is only -0.11. When countries are weighted by their importance to world GDP, this correlation coefficient becomes slightly positive 0.06. Nevertheless, the low correlation is puzzling from the perspective of frictionless models of capital flows.



The relationship appears weaker once we look at capital returns. The top panel of the next figure shows that the relationship does not even appear to be negative, with a correlation coefficient of positive 0.1. When weighted by GDP, the correlation becomes more positive, as shown in the bottom panel, but remains only 0.17. That is, capital seldom seems to flow to high return countries and often appears to flow to low return countries.



The fact that the relationship appears stronger, and more negative, for rich countries is consistent with the view that these countries are better integrated into world financial markets. It may also suggest that the weak relationship is due to measurement error in developing countries. However, we have good reasons to believe that this is not the case. The next two figures examine the relationship between returns and capital flows for two groups of middle income countries. These countries all have very good data, and in particular have investment data extending back into the early part of the twentieth century, which implies that returns in the early part of the sample are not driven by our initial estimates of the capital stock.

The two groups of countries are the Asian Tigers – Japan, Korea, Hong Kong and Singapore – and the Main Latin American countries – Mexico, Argentina, Brazil, Columbia, and Chile. Individual returns estimates are aggregated by assuming that each region constitutes one large country with a representative agent. To do this, we convert our data to a common currency (the US dollar) and then do the same procedures summed over all countries n in region j

$$\begin{aligned} r_{jt}^{B} &= \frac{\sum_n C_{nt+1}}{\beta \sum_n C_{nt}} - 1, \\ r_{jt}^{K} &= \alpha \frac{\sum_n Y_{nt}}{\sum_n K_{nt}} - \delta. \end{aligned}$$

Note that this implies

$$\begin{aligned} 1 + r_{jt}^{B} &= \frac{\sum_n C_{nt+1}}{\beta \sum_n C_{nt}} \\ &= \sum_n \frac{C_{nt+1}}{\beta C_{nt}} \frac{C_{nt}}{\sum_n C_{nt}}, \end{aligned}$$

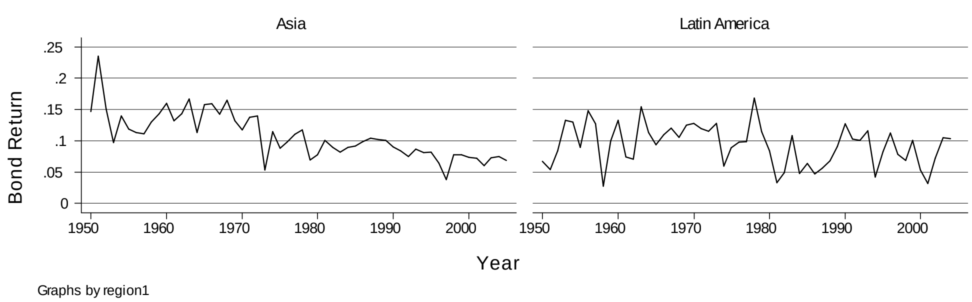
so that the bond rate of return is a consumption weighted average of bond returns in all countries in the region, while

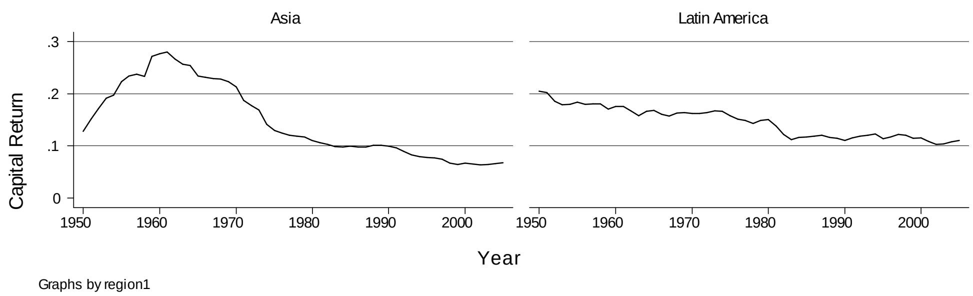
$$\delta + r_{jt}^{K} = \alpha \sum_n \frac{Y_{nt}}{K_{nt}} \frac{K_{nt}}{\sum_n K_{nt}},$$

is a capital stock weighted average. We find similar results when using GDP weights, as well as (for these samples) when using population weights.

The comparison is striking. For most of the first few decades of the sample, both bond returns and capital returns in Asia were higher than those in Latin America. Despite this, capital inflows into Asia were small, and in some cases, negative implying that capital flowed out of this high return region. By contrast, capital inflows to Latin America were large. By the end of the period, and in particular following the Latin American debt crisis of the 1980s, capital flows to both Asia and Latin America look more similar, although this is despite the fact that our estimates imply that returns in Asia were by then somewhat lower than in Latin America.

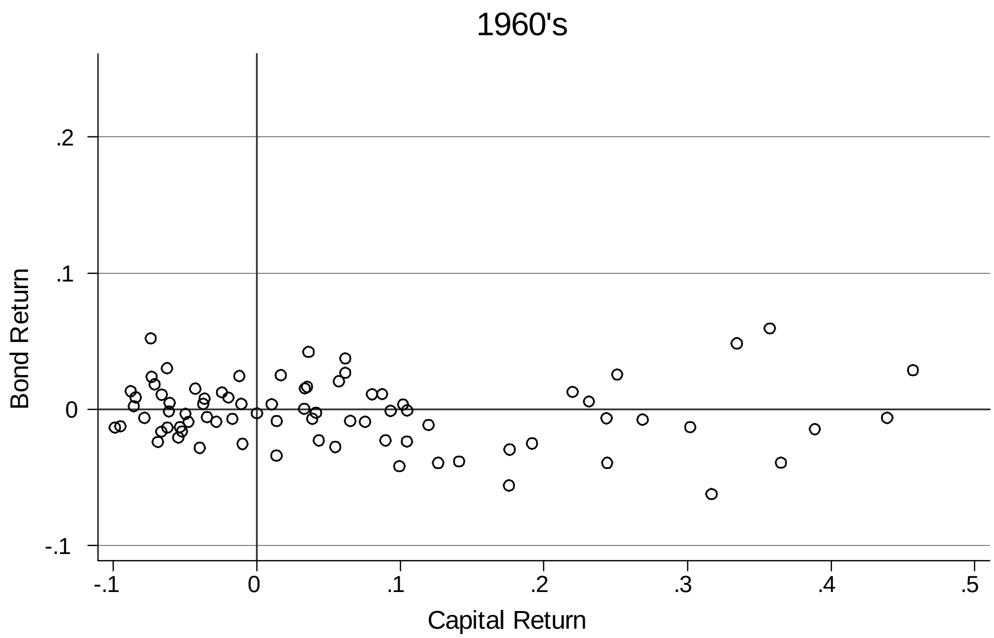
It is important to stress that this patter is robust to a number of alternative measurement assumptions. Importantly, in the light of the results of Caselli and Feyrer, these results on the return to capital are robust to variations in the measurement of the capital share. One can produce convergence between rates of return in Asia and Latin America in the latter period by assuming that Asia had a relatively higher capital share. However, this only serves to widen the difference between rates of return in the early period and intensify the puzzle of mid twentieth century capital flows.

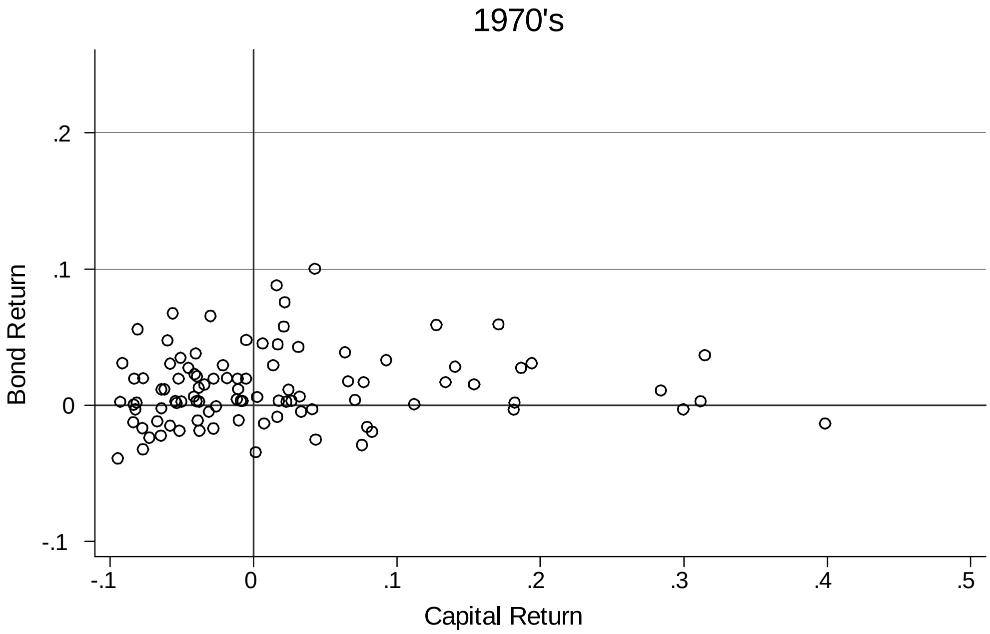




Nonetheless, the patterns found for Latin America and Asia do suggest convergence in returns over time. This is, in turn, consistent with an increased level of integration in international financial markets. To examine this more systematically, the next set of figures plots the preceding relationships over time. We begin with the decade of the 1960s, for which we have data on more countries, and then proceed by decades, grouping all the years after 1990 together.

The first set of figures examine the relationship between bond and capital returns by decade. Returns in each country are transformed by taking the difference form the world average rate of return constructed as described above. Convergence in returns is thus represented by a convergence in all points to the origin. This pattern of convergence is indeed what is observed, with there being notably much less dispersion in the capital rate of return over time, but also some less dispersion in bond rates of return. The last of this series of Figures graphs the change in the correlation between our returns measures over time. This shows that, while the relationship has not gotten noticeably stronger for all countries, it has become stronger for rich countries with the correlation between the measures in the weighted sample positive for the past two decades (the half decade from 2000-2005 being the obvious exception). This is consistent both with an increase in the efficiency with which domestic financial markets work (the increased relationship between bond and capital returns within countries) as well as with improved operation of international financial markets.




1970's
Bond Return
.2
.1
0
-.1
-.1
0
.1
.2
.3
.4
.5
Capital Return


1980's
Bond Return
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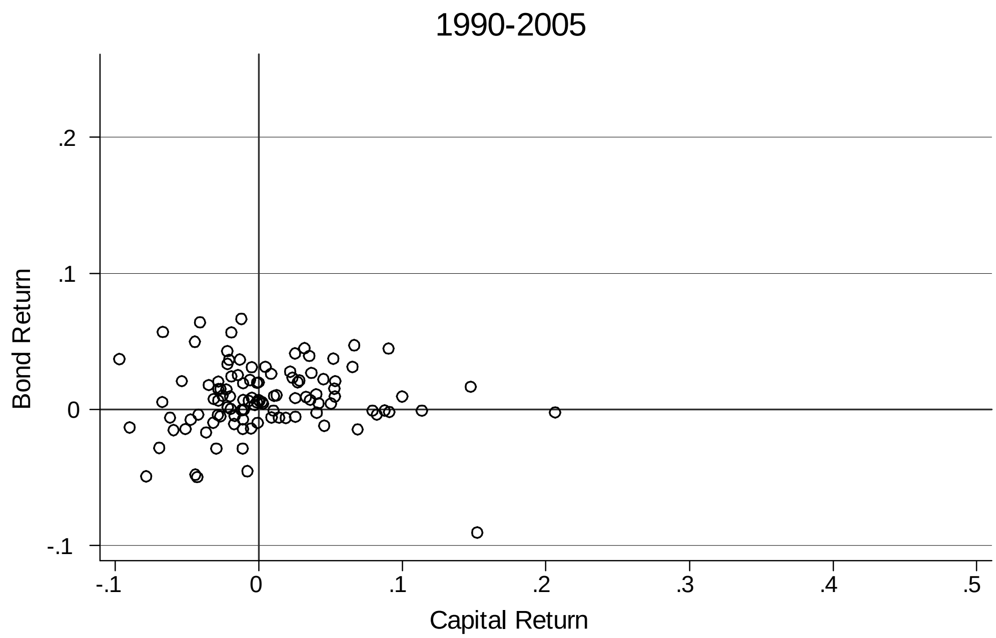
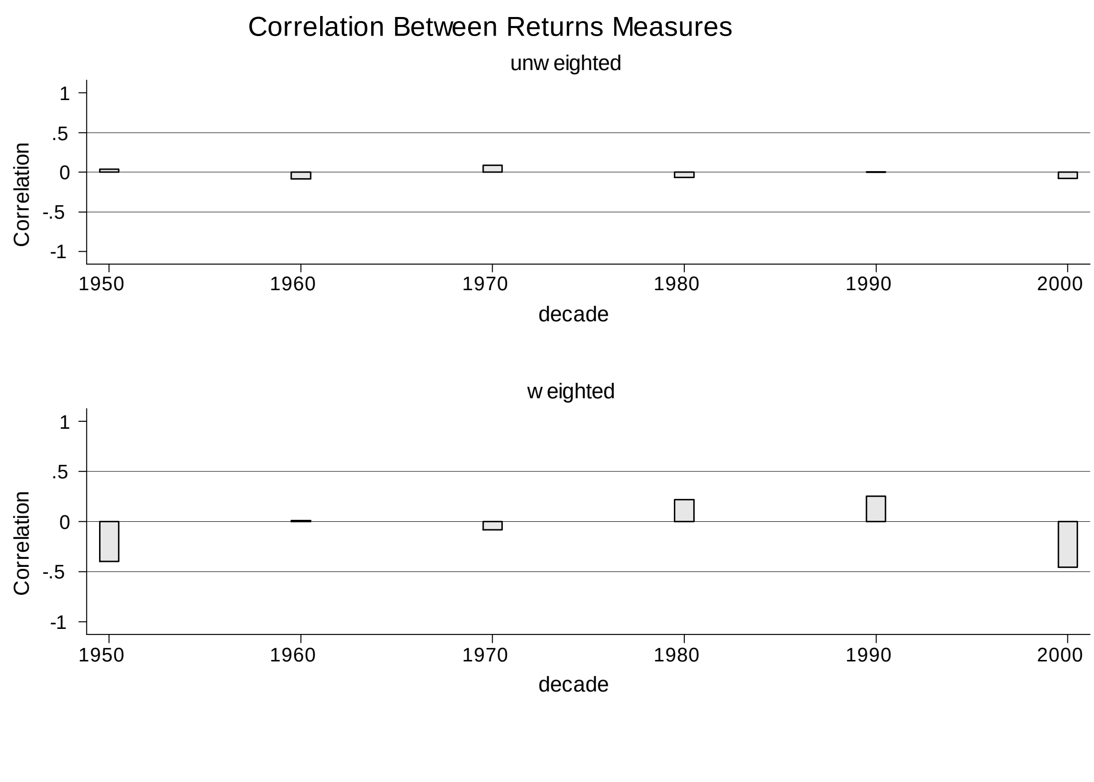
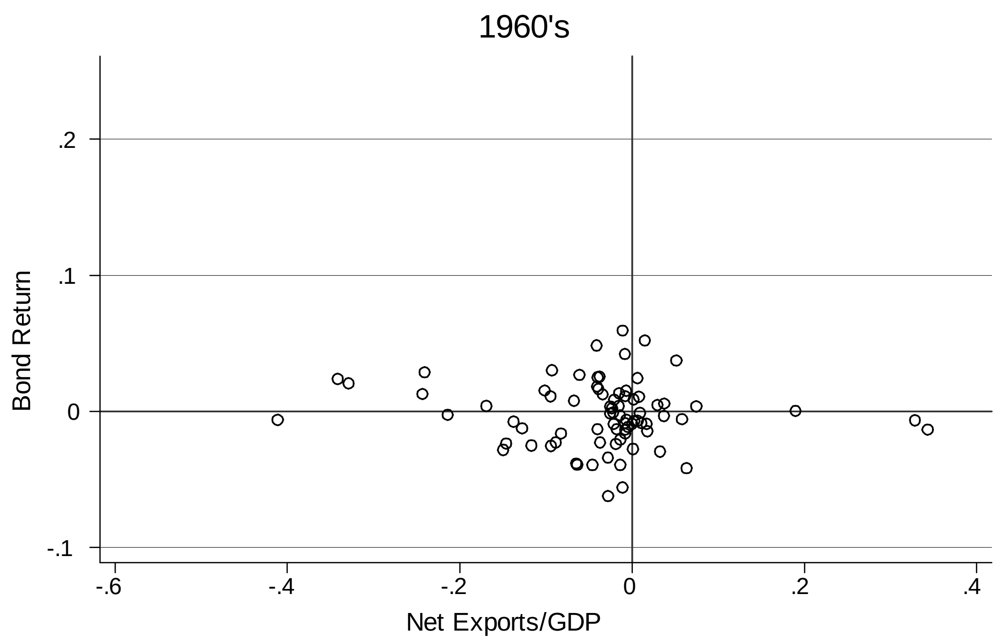
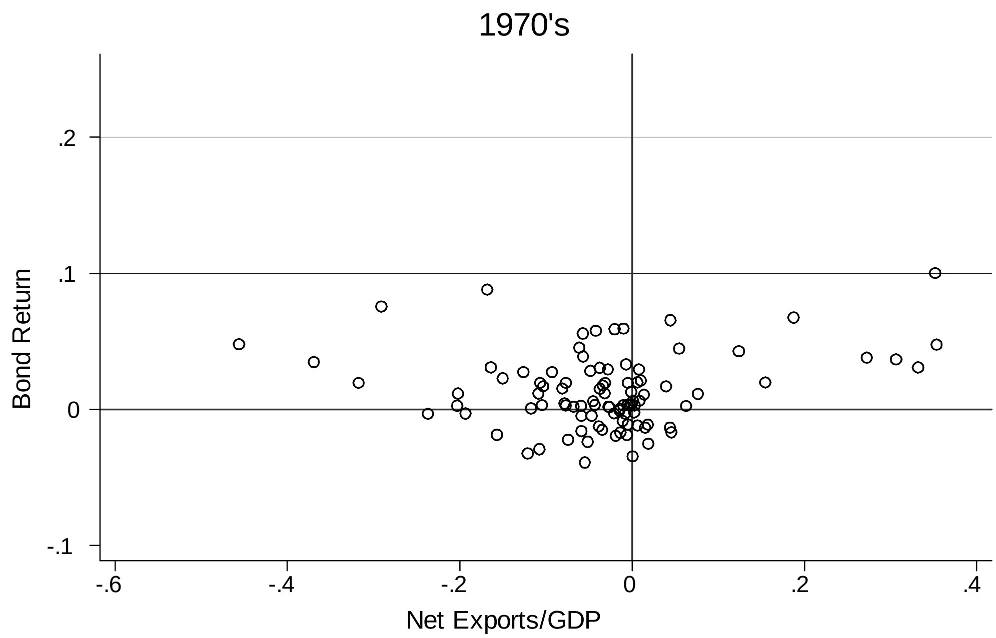
0
-.1
-.1
0
.1
.2
.3
.4
.5
Capital Return


1990-2005
Bond Return
Capital Return
.2
.1
0
-.1
-.1
0
.1
.2
.3
.4
.5


Correlation Between Returns Measures
unw eighted
Correlation
decade
1950
1960
1970
1980
1990
2000
w eighted
Correlation
decade

Next we examine the relationship between bond returns and capital flows. This relationship does appear to have become more negative over time, although the relationship is weak. Indeed, for many years the pattern in the scatter plots looks to have a positive relationship. The last plot graphs the correlation coefficient by decade and shows that the relation between capital flows and bond returns was close to zero for the middle decades of our sample, and was weakly negative in both the early and latter decades. Nonetheless, in many decades the relationship is positive suggesting that international capital markets worked poorly in the early part of the sample. Perhaps surprisingly, there is positive relationship in the weighted sample for the half decade since 2000.




1970's
Bond Return
.2
.1
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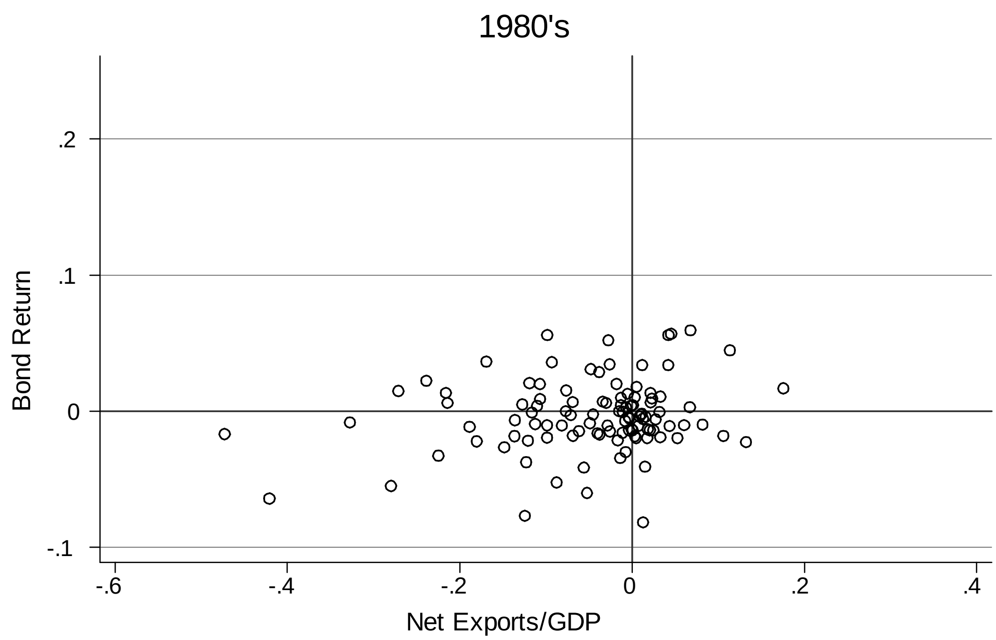
-.1
-.6
-.4
-.2
0
.2
.4
Net Exports/GDP


1980's
Bond Return
.2
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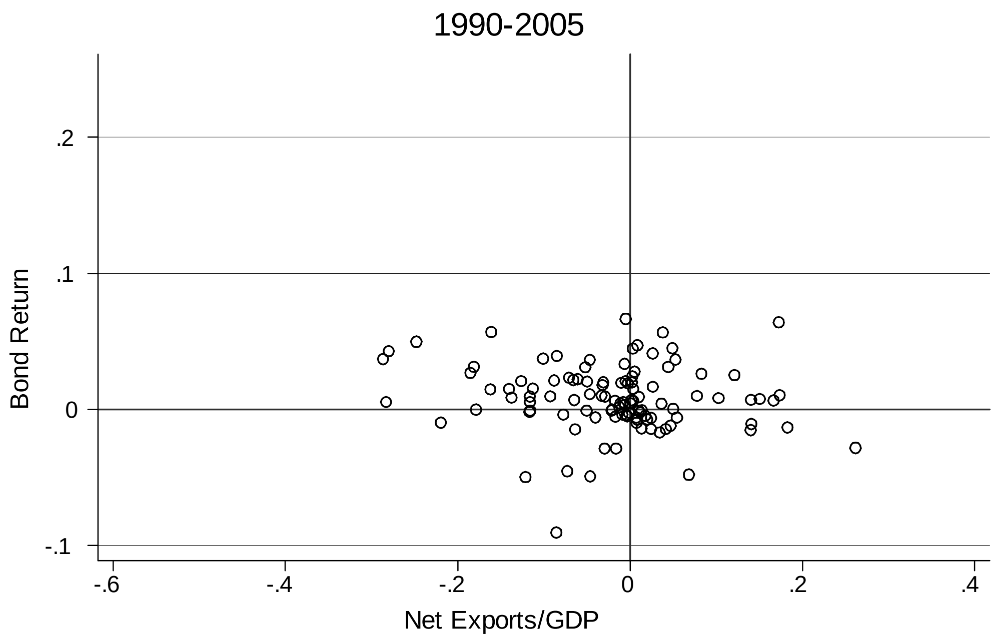
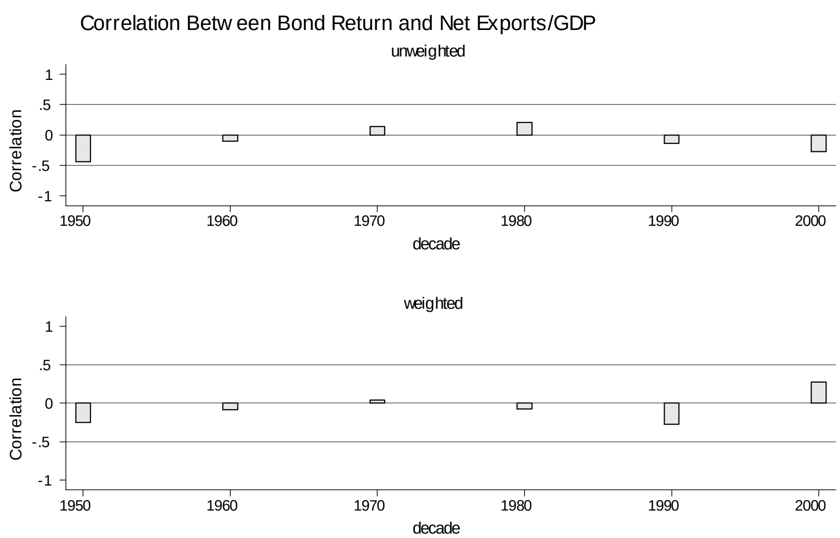
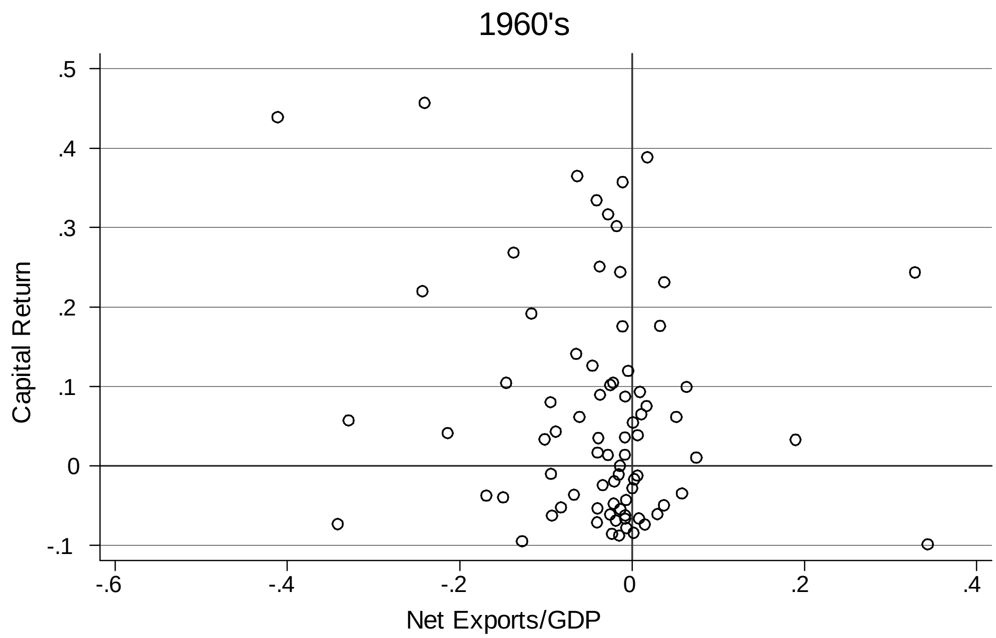
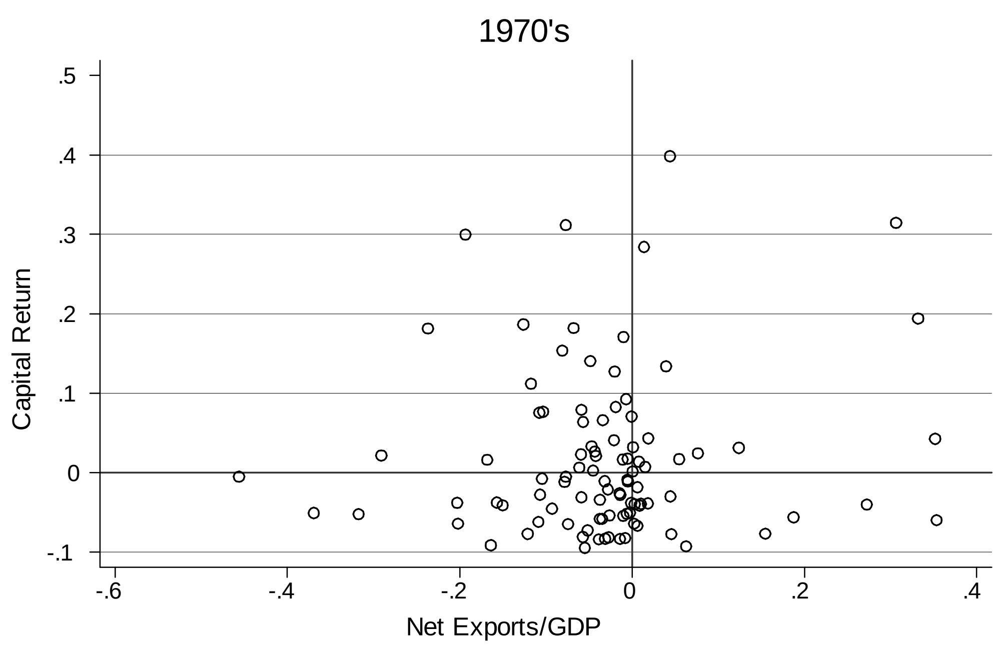
-.1
-.6
-.4
-.2
0
.2
.4
Net Exports/GDP





The relationship looks even weaker when examining capital returns, where the relationship looks close to zero in every decade. However, when weighting by GDP, the last figure shows that the correlation was substantially negative for the past three decades.


1960's
Capital Return
.5
.4
.3
.2
.1
0
-.1
-.6
-.4
-.2
0
.2
.4
Net Exports/GDP


1970's
Capital Return
.5
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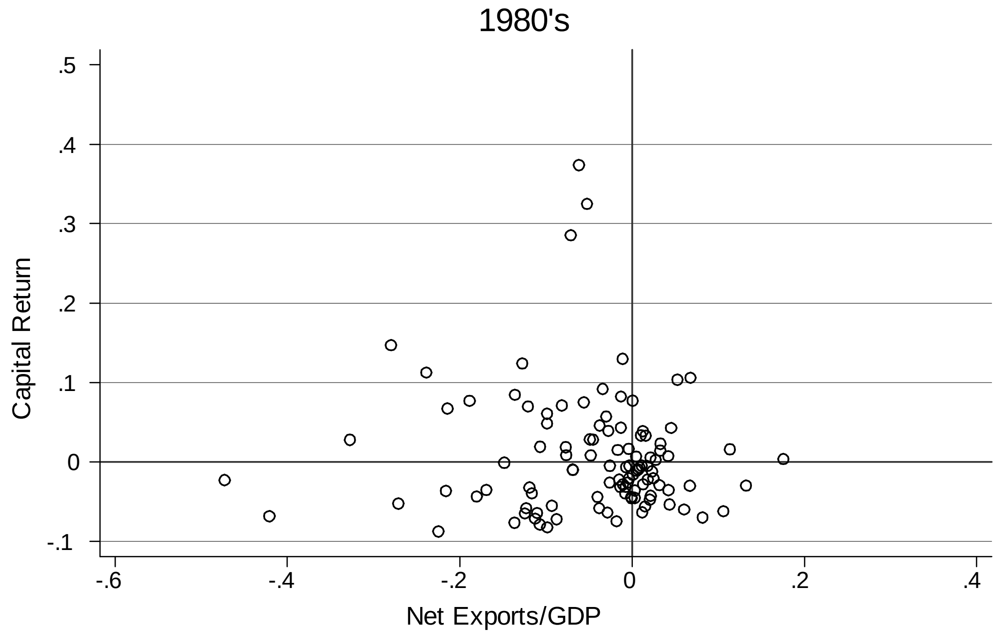
.3
.2
.1
0
-.1
-.6
-.4
-.2
0
.2
.4
Net Exports/GDP


1980's
Capital Return
Net Exports/GDP
.5
.4
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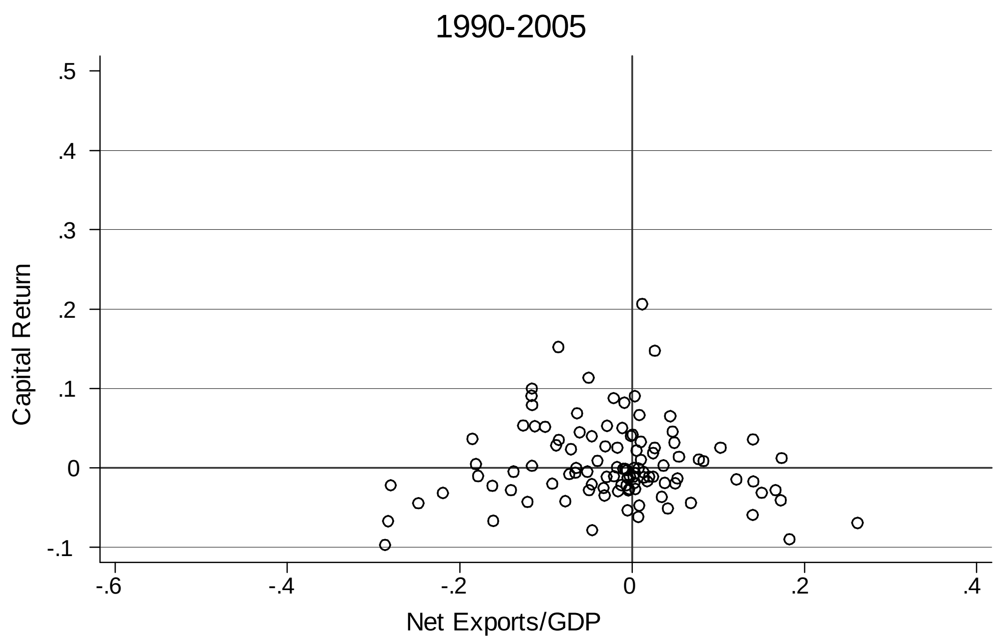
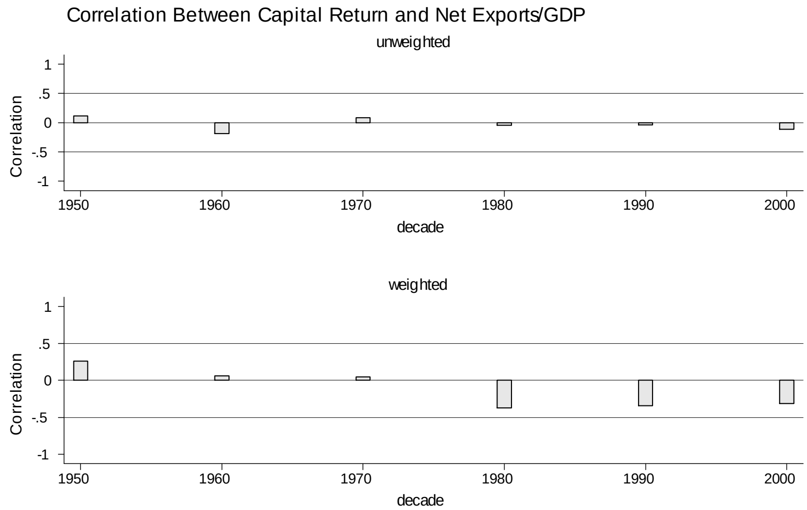
.2
.1
0
-.1
-.6
-.4
-.2
0
.2
.4


1990-2005
Capital Return
Net Exports/GDP
.5
.4
.3
.2
.1
0
-.1
-.6
-.4
-.2
0
.2
.4

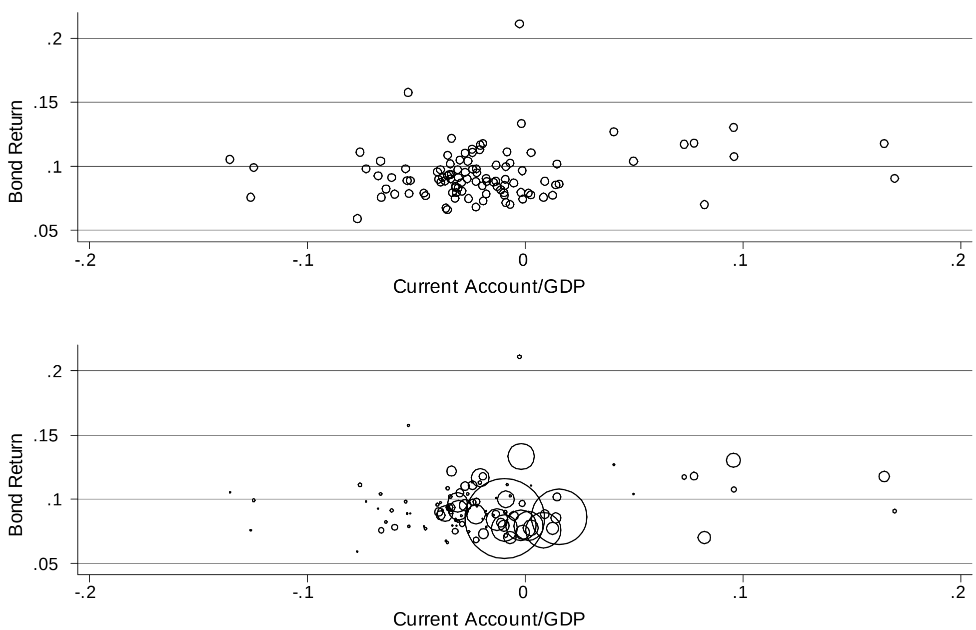


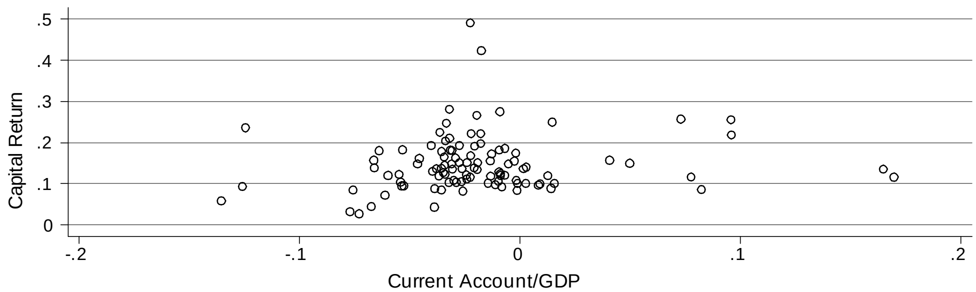
Overall, these pictures paint a picture in which world financial markets work at best only poorly to allocate capital where it has the highest return. Moreover, although there is substantial evidence that domestic capital markets are working better over time, especially in rich countries, there is little evidence that capital markets are doing a better job are allocating capital to the highest return countries. The convergence in capital returns over time suggests that the costs of this may not be large today, although the costs of capital market inefficiencies in history may have been much larger (welfare costs to be completed).

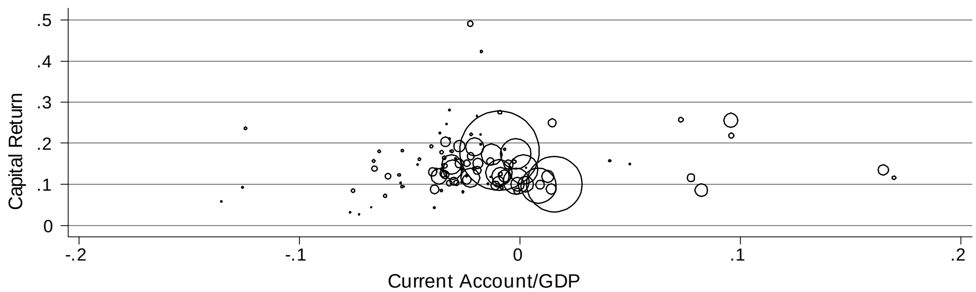
Returns and the Current Account

Above we worked exclusively with net exports as of measure of capital flows. However, some models predict a more direct relationship with the current account. In this subsection, we suppress our concerns about measurement of the current account and explore this relationship.

We use data on the current account drawn from Lane and Milesi-Feretti (2006) which runs from 1970 to the present. The next two figures examine the relationship graphically. When we compare the current account surplus as a percentage of GDP to our measure of the bond return we find that the relationship is actually positive, and remains positive when looking at richer countries: the unweighted correlation coefficient is 0.18 while when weighted by GDP it falls to 0.10. No strong negative relationship emerges when we look at capital returns with an unweighted correlation of 0.13 and a weighted correlation of -0.17.



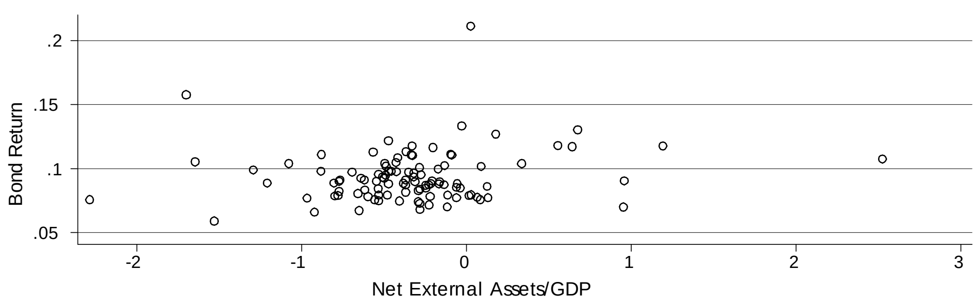


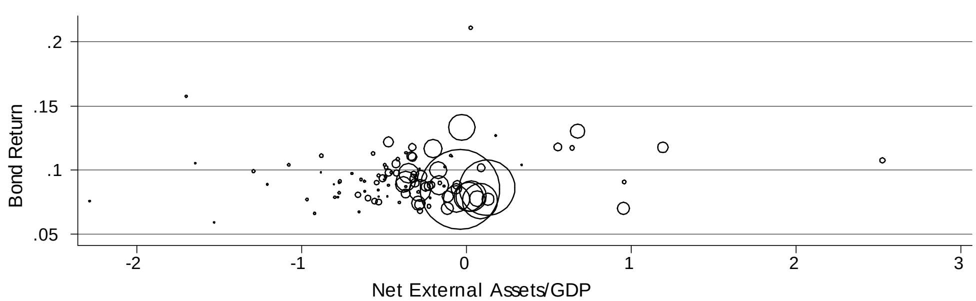


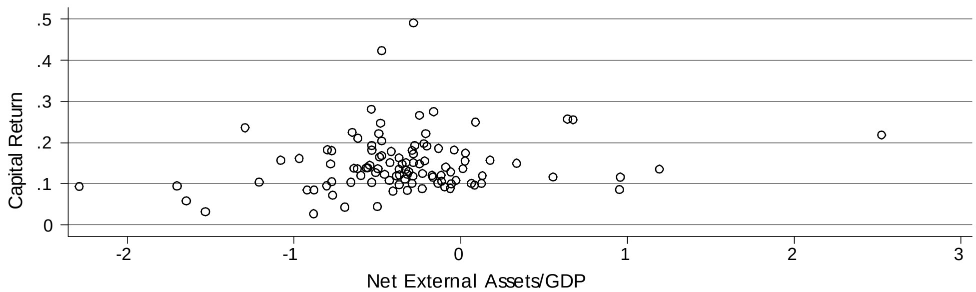
Some of the theories we examine below suggest that the relationship between returns and capital flows should be non-linear: negative for capital importers and zero for capital exporters. Inspection of the above graphs reveals little evidence that this is the case. When we break the sample this way, the correlation between capital flows and the bond return is 0.07 (-0.09 when weighted) for capital importers, and 0.41 (0.71 when weighted) for capital exporters. When we examine the relationship with capital returns, a robustly positive relationship emerges: for capital importers, a correlation of 0.21 (0.17 weighted) while for capital exporters a correlation of 0.20 (0.42 weighted). That is, the greatest capital exporters tend to be high return countries.

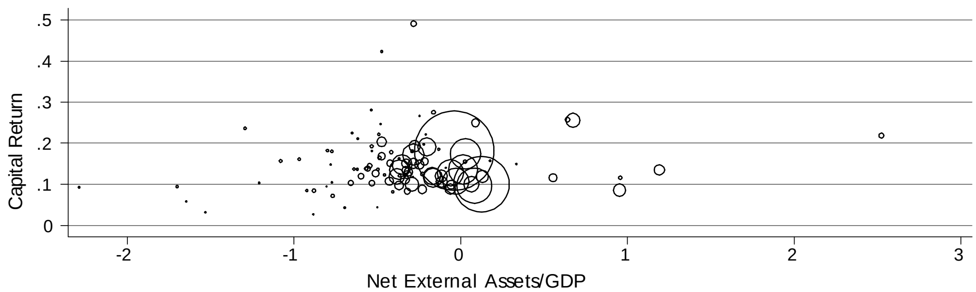
Returns and Asset Positions

Theories of defaultable debt predict that creditor nations should face lower returns than debtor nations. In this subsection, we examine the relationship between our returns measures and the stock of external assets, drawing our data from Lane and Milesi-Feretti (2006). The relationship is examined graphically in the following two figures. As for the current account, the relationship looks positive, and strongly so when weighted by GDP. This is driven in part by the fact that the USA is a large debtor nation, and also faces low returns, although this pattern is also present in the remainder of the data. The correlations coefficient between our measure of bond returns and net external assets is 0.15 (falling to approximately zero when weighted by GDP), while for our measure of capital returns it is 0.18 (falling to-0.08 when weighted by GDP).









Some of the theories we examine below suggest that the relationship between returns and foreign net liabilities should be non-linear: negative for net debtors and zero for net creditors. Inspection of the above graphs reveals some evidence that this is the case: debtors tend to have a negative relationship but, contrary to theory, creditors have a strong positive relationship. When we break the sample this way, the correlation between net assets and the bond return is -0.02 (-0.12 when weighted) for debtors, and 0.02 (0.5 when weighted) for creditors. When we examine the relationship with capital returns, a robustly positive relationship emerges: for debtors, a correlation of 0.2 (0.28 weighted) while for creditors a correlation of 0.23 (0.2 weighted). That is, the greatest capital exporters tend to be high return countries.

ROBUSTNESS

To what extent could our findings be driven by an error in the assumed functional forms? To what extent could heterogeneity across countries be driven by heterogeneity in the functional forms? In this section, we consider some possibilities.

Preferences

Discount Factors.—

Clearly, an error in our choice of β implies a level shift in the estimated bond rate for all countries and leaves our major conclusions unaffected.

What about heterogeneity in β? Intuitively, if some countries are more patient, their consumption should grow faster and we should misattribute this to higher rates of return. To see this, suppose that all countries face the same marginal return on savings so that

$$\frac{C_{nt+1}}{\beta_n C_{nt}} = 1 + r_t^W = \frac{C_{n't+1}}{\beta_{n'} C_{n't}}.$$

Suppose we measure

$$1 + r_{nt} = \frac{C_{nt+1}}{\beta C_{nt}},$$

for some common β. Then

$$\frac{1 + r_{nt}}{1 + r_{n't}} = \frac{C_{nt+1}/C_{nt}}{C_{n't+1}/C_{n't}} = \frac{\beta_n}{\beta_{n'}}.$$

Then if $\beta_n > \beta_{n'}$ so that country n is more patient than n', we will estimate higher interest rates for country n.

In future, we plan to "test" this view by comparing our estimates of these rates of return with observables by country. For example, if rich countries have lower rates of return, this would require rich countries to be less patient. But we typically think of them as being more patient (which is why they are rich). We could also directly examine relationships to wealth or changes in wealth too.

Elasticities of Substitution.—

Clearly, an incorrect specification here implies a proportional error in the estimated bond rates, and leaves our main results qualitatively unaffected. In fact, if elasticities of substitution are lower than one, our method implies greater dispersion in bond returns as higher interest rates are required to induce consumers to accept higher rates of consumption growth.

What about heterogeneity? If countries are growing, then consumption will grow faster for countries with the highest intertemporal elasticity of substitution (lowest $\sigma's$ in a CRRA specification). This would be misattributed as higher rates of return as well. To see this, suppose that all countries face the same marginal return on savings so that

$$\frac{1}{\beta}\left(\frac{C_{nt+1}}{C_{nt}}\right)^{\sigma_n} = 1 + r_t^W = \frac{1}{\beta}\left(\frac{C_{n't+1}}{C_{n't}}\right)^{\sigma_{n'}}.$$

Suppose we measure

$$1 + r_{nt} = \frac{1}{\beta}\left(\frac{C_{nt+1}}{C_{nt}}\right)^{\sigma},$$

then

$$\begin{aligned}\frac{1+r_{nt}}{1+r_{n't}} &= \left(\frac{C_{nt+1}/C_{nt}}{C_{n't+1}/C_{n't}}\right)^{\sigma} = \left(\frac{\left(\beta\left(1+r_t^W\right)\right)^{1/\sigma_n}}{\left(\beta\left(1+r_t^W\right)\right)^{1/\sigma_{n'}}}\right)^{\sigma} \\ &= \left(\beta\left(1+r_t^W\right)\right)^{\sigma/\sigma_n - \sigma/\sigma_{n'}} \\ &= \left(\beta\left(1+r_t^W\right)\right) \hat{} \left(\frac{\sigma\left(\sigma_{n'}-\sigma_n\right)}{\sigma_n\sigma_{n'}}\right).\end{aligned}$$

Hence, if $\beta\left(1+r_t^W\right) > 1$, if n has a higher intertemporal elasticity of substitution (or lower σ) so that $\sigma_{n'} - \sigma_n < 0$, we will estimate n as having a higher rate of return.

Non-homogeneity.—

There are clearly many forms of non-homogeneity we could consider. One possibility that might be especially relevant in comparisons involving developing economies is to include some form of subsistence consumption level. Intuitively, poor countries would be less likely to substitute intertemporally, and thus with flatter consumption profiles we would impute lower rates of return on bonds.

To see this, suppose that

$$U(C) = \ln\left(C - \bar{C}\right).$$

Then if capital markets were perfect, the actual consumption profile would satisfy

$$\frac{C_{nt+1} - \bar{C}}{C_{nt} - \bar{C}} = \beta\left(1 + r_t^W\right).$$

Then if we measure

$$1 + r_{nt} = \frac{1}{\beta}\left(\frac{C_{nt+1}}{C_{nt}}\right)$$

we would get

$$1 + r_{nt} = 1 + r_t^W + \frac{\bar{C}}{C_{nt}}\left[\frac{1}{\beta} - \left(1 + r_t^W\right)\right].$$

If rates of return exceed discount rates so that consumption is growing, the second term is negative, and will be more negative the smaller is C_{nt} (that is, the poorer the country).

In future, we examine this possibility by examining more closely the relationship between our measures and income per capita.

Preference Non-separability.—

Suppose preferences were the following

$$U(C, L) = \frac{\left(C^{\alpha} L^{1-\alpha}\right)^{1-\sigma}}{1-\sigma}.$$

Then marginal utilities are given by

$$\left(C^{\alpha} L^{1-\alpha}\right)^{-\sigma} \alpha C^{\alpha-1} L^{1-\alpha}$$

Then the Euler equation takes the form

$$\frac{1}{\beta}\frac{\left(C_t^{\alpha} L_t^{1-\alpha}\right)^{-\sigma} C_t^{\alpha-1} L_t^{1-\alpha}}{\left(C_{t+1}^{\alpha} L_{t+1}^{1-\alpha}\right)^{-\sigma} C_{t+1}^{\alpha-1} L_{t+1}^{1-\alpha}} = 1 + r_t^W.$$

If we estimate

$$1 + r_{nt} = \frac{1}{\beta}\left(\frac{C_{nt+1}}{C_{nt}}\right)^{\sigma},$$

then

$$1 + r_{nt} = \frac{1}{\beta}\left(\frac{C_{nt}}{C_{nt+1}}\right)^{-\sigma} = \left[\left(1 + r^{W}\right)\left(L_t/L_{t+1}\right)^{(1-\alpha)(1-\sigma)}\right] \hat{}\ \left(-\sigma/\left(\alpha\left(1-\sigma\right)-1\right)\right)$$

and so

$$\frac{1 + r_{nt}}{1 + r_{n't}} = \left[\frac{\left(L_{nt}/L_{nt+1}\right)}{\left(L_{n't}/L_{n't+1}\right)}\right] \hat{}\ \left(-\sigma\left(1-\alpha\right)\left(1-\sigma\right)/\left(\alpha\left(1-\sigma\right)-1\right)\right).$$

How does this matter? If leisure is increasing faster in n than in n', then the numerator of the square bracket is greater than one. The exponent of this term is always positive, and so the implied interest rate in n is larger. Why? Because leisure is growing, and increases in leisure increase the marginal utility of consumption, the country defers more consumption. This appears to imply a higher interest rate. In future, we examine this implication empirically.

Heterogeneity in Technology

Different Capital Shares.—

Clearly, if a country has higher capital shares than average, our method will understate returns for that country. How can we ensure that capital is appropriately measured? There are two main issues involved. The first is the treatment of proprietors income. In particular, the wage income of the self-employed is often treated as capital income. This is especially important in poor countries which are concentrated in industries like agriculture in which self employment is more important. Gollin (2002) proposes several adjustments to income share estimates to reflect this:

1. reweight industries according to US industry weights to produce comparable shares

2. treat all income reported as operating surplus of private unincorporated enterprises (OSPUE) as labor income

3. allocate income reported as operating surplus of private unincorporated enterprises in proportion to the split for the rest of the economy

$$wages\ share = \frac{Corporate\ Employee\ Compensation}{GDP - indirect\ taxes - OSPUE}$$

4. divide NIPA employee compensation by the number of employed workers and use this to impute wages for the self employed

$$wages\ share = \frac{Corporate\ Employee\ Compensation}{Corporate\ Share\ of\ Employment \times (GDP - indirect\ taxes)}$$

Bernanke and Gurkaynak note that OSPUE is not available for many countries. As a result, they impute OSPUE to get

$$\begin{aligned} & wages\ share \\ = \ & Corporate\ Employee\ Compensation/ \\ & GDP - indirect\ taxes - \\ & (1 - Corporate\ Share\ of\ Employment) \times Total\ Private\ Sector\ Income \end{aligned}$$

although only for countries with a corporate share of employment larger than 1/2. We also use these estimated capital shares in our analysis (to be completed).

The second issue concerns the treatment of non-reproducible capital income. In particular, capital income may also include returns to land and natural resources. As an adjustment for this, Caselli and Feyrer (2006) assume that land and other non-reproducible capitals earn the same return as reproducible capital, and hence compute the capital share as

$$reproducible\ capital\ share = (1 - wages\ share) \times \frac{PkK}{W},$$

where the wages share is from Bernanke and Gurkaynak, and the value of total wealth and reproducible capital are from the World Bank. We use Caselli and Feyrer's measure below (to be completed).

As might be imagined, any attempt to construct estimates of the wealth of countries around the world involves making a number of heroic assumptions about the data. For our purposes, a number of assumptions used by the World Bank survey seem especially problematic as they would seemingly introduce the potential for a upward bias in estimates of non-reproducible capital for developing countries, which would understate returns in developing countries. For example, the World Bank study assumes that

1. urban land value is proportional to total capital stocks: proportion is 24%. This might overstate nonreproducible wealth in developing countries if an abundance of land in these countries keeps rents low. This assumption also has the effect of implying large land shares in the economies of Singapore and Hong Kong.

2. all mineral wealth is calculated using the following approach: take profit from activity at time t and scale it up according to

$$\pi_t \left(1 + \frac{1}{r^*}\right)\left(1 - \frac{1}{(1+r^*)^T}\right),$$

where

$$r^* = \frac{r-g}{1+g},$$

r is the social discount rate, and g the rate at which unit rents grow (that is, prices of commodities). T is the date resources are expected to run out, and is chosen by estimating reserves and production levels in each country and assuming constant production. This is then ignored, and a value of 20 is used for all assets and all countries. g is set relative to r for all countries and commodities in the same way. The only variation then comes from π_t chosen in some year close to 2000. Note that if developing countries "over exploit" relative to stock, this will imply they have too large mineral wealth as π_t will be relatively large (and this wont be compensated for by shorter extraction times).

3. "profits" for timber, calculate flow of production of timber, and average price from trade data. A regional average of costs was then subtracted. If poor country in region has higher costs (lower productivity), it overstates their values.

4. cropland. forecast of rents hold value of production constant between 2020 and 2024. Developing countries rents are assumed to grow more than twice as fast as in rich countries. If wrong, then overstates value of developing country crops.

Combined with these concerns, the analysis also produces some strikingly counter-intuitive implications for actual capital shares. As a result, we consider an alternative measure for adjusting capital shares based on Harberger (1978). In particular, drawing on a series of detailed studies of national accounts in developing countries, Harberger (1978) found that the income to land could be well approximated by taking one third of agricultural income, plus one-tenth of the imputed rental income of dwellings. We also use Harberger's approach below.

It is important to note that making a one-off adjustment to capital shares cannot change the basic implications of our analysis above. For example, looking at the comparison between the Asian Tigers and Latin America, increasing the capital share in Asia relative to Latin America would have the effect of narrowing the rate of return difference in the modern period, but only at the cost of increasing the rate of return difference in the early period. In order to argue that the entire picture is being driven by mismeasurement of capital shares, one needs to argue that the capital share in Asia was relatively low in the early period, and relatively high in the later period.

Another advantage of the Harberger approach is that it allows us to compute annual estimates of the adjusted capital share.

LESSONS FOR THEORY

In the last section, we argued that our results imply the existence of substantial frictions in the workings of international, as well as domestic, capital markets. In this section, we review the implications of the results found above for several different popular theories of frictions in capital markets.

One Sector Models

We begin by considering one sector models of capital flows. In these models, consumption can be transformed into investment on a one-for-one basis, in the absence of frictions in domestic financial markets. We begin by assuming that only the consumption good can be transferred internationally, and must be transformed into the investment good using the domestic economies financial system.

We begin by considering the effects of some explicit capital controls, before turning to the implications of models that limit capital flows using default risk.

Taxes on Borrowing.—

Suppose the country faces

$$c_t + \left(1 - \tau_a \mathbb{I}_{\{a_{t+1}<0\}}\right) a_{t+1} + k_{t+1} - (1-\delta)\, k_t = A_t k_t^{\alpha} + R a_t,$$

Then optimality implies

$$r_t^B \equiv \frac{1}{\beta}\frac{c_{t+1}}{c_t} = \begin{cases} \frac{R}{1-\tau_a} - 1 & a < 0 \\ R - 1 & otherwise \end{cases},$$

and

$$r_t^K \equiv r_t^B.$$

That is, our rates of return would be the same within, but different across, countries. Moreover, they would only be greater in countries with negative assets.

Tax on Capital Outflows.—

Suppose the country faces

$$c_t + \left(1 - \tau_{nx^+}\mathbb{I}_{\{a_{t+1} - Ra_t > 0\}}\right)(a_{t+1} - Ra_t) + (k_{t+1} - (1-\delta)\, k_t) = A_t k_t^{\alpha},$$

then we have

$$1 + r_{t+1}^{B} = \begin{cases} \frac{R}{1-\tau_{nx^+}} & if\ a_{t+1} - Ra_t > 0 \text{ and } a_{t+2} - Ra_{t+1} \leq 0 \\ (1-\tau_{nx^+})\, R & if\ a_{t+1} - Ra_t \leq 0 \text{ and } a_{t+2} - Ra_{t+1} > 0 \\ R & otherwise \end{cases} = 1 + r_{t+1}^{K}.$$

That is, the relationship between rates of return across countries depends on the change in net exports from period to period. Symmetric results exist for the case of controls on capital inflows.

Defaultable Debt.—

There has been a great deal of recent interest in models of defaultable debt in the tradition of Eaton and Gersovitz (1983). For the most part, these papers, which include Arellano (2006), Aguiar and Gopinath (2007), Yue (2007), and Benjamin and Wright (2007) consider only endowment economies, or, such as with Pitchford and Wright (2007), with very simple production sectors that do not allow application of our results on differences in the marginal product of capital and in the intertemporal marginal rate of substitution. In this subsection, we sketch a simple model of defaultable debt with production and show that it implies that creditor nations should all face the same interest rate, and that the bond and capital returns should be equal in creditor countries.

Specifically, consider a country represented by an agent with the simple loglinear preferences assumed in Section 2 above. That country has access to international capital markets for a single debt instrument that is state non-contingent except for the fact that it allows the country to default in any state of the world. That is, the country can issue defaultable debt which we denote by b_t. For simplicity, we will follow much of the literature in assuming that default leads to infinite exclusion from financial markets.

Under these assumptions, the budget constraint faced by the country is given by

$$c_t + k_{t+1} - (1-\delta) k_t - q(k_{t+1}, b_{t+1}, s_t) b_{t+1} \leq A_t k_t^{\alpha} - b_t,$$

while competition in international financial markets implies that the bond price satisfies

$$q(k_{t+1}, b_{t+1}, s_t) = \frac{1 - \pi(k_{t+1}, b_{t+1}, s_t)}{R},$$

where $\pi(k_{t+1}, b_{t+1}, s_t)$ is the probability that a country defaults, and R is the gross world interest rate as before.

Clearly, the probability of default (and the way it varies with the countries choice of capital stock and debt level) will be the primary determinants of the bond and capital rates of return in equilibrium. This may, in general, be quite complicated, as it depends on the exact shape of the probability distribution governing A_t. Moreover, the non-convexity of the constraint set implies implied by the discrete choice to default or repay can lead to the existence of multiple equilibria. However, it is straightforward to establish that if a country is a creditor in international capital markets, then they must face the international rate of return R.

Proposition 1 *If $b < 0$, the probability of default is zero for all states s and all capital stocks k.*

Proof. A country defaults in state s given k and b if and only if the value to repaying the debt $V^R(k, b, s)$ is less than the value to default $V^D(k, b, s)$. The value to repayment satisfies the functional equation

$$V^R(k,b,s) = \max_{c,k',b'} u(c) + \beta E\left[V(k',b',s')\,|s\right],$$

subject to

$$c + k' - (1-\delta)k - q(k',b',s)\,b' \leq A(s)\,k^{\alpha} - b,$$

where $V(k,b,s) = \max\left\{V^R(k,b,s), V^A(k,b,s)\right\}$. Similarly, the value to default satisfies the functional equation

$$V^A(k,b,s) = \max_{c,k'} u(c) + \beta E\left[V^A(k',s')\,|s\right],$$

subject to

$$c + k' - (1-\delta)k \leq A(s)\,k^{\alpha}.$$

But if $b \leq 0$, we have that

$$\begin{aligned} V^R(k,b,s) &\geq \max_{c,k'} u(c) + \beta E\left[V(k',0,s')\,|s\right] \\ &\quad s.t.\ c + k' - (1-\delta)k \leq A(s)\,k^{\alpha} - b \\ &\geq \max_{c,k'} u(c) + \beta E\left[V^A(k',s')\,|s\right] \\ &\quad s.t.\ c + k' - (1-\delta)k \leq A(s)\,k^{\alpha} - b \\ &> \max_{c,k'} u(c) + \beta E\left[V^A(k',s')\,|s\right] \\ &\quad s.t.\ c + k' - (1-\delta)k \leq A(s)\,k^{\alpha} \\ &= V^A(k,b,s), \end{aligned}$$

where the first inequality follows from the fact that forcing the country to choose $b' = 0$ shrinks the countries choice set, the second inequality follows from the definition of V, and the third inequality follows from $b < 0$ and the fact that V^A is strictly increasing. ■

Hence, if $b \leq 0$, $q(k,b,s) = 1/R$. While the non-convexity of the overall borrowing problem means that the value function need not be differentiable, if we assume that the optimal choice is at a point where the value function is differentiable then we recover the result that the intertemporal marginal rate of substitution is equated to the marginal product of capital and are equal to the world interest rate.

Limited Commitment and Default Risk.—

Another popular class of models assume that capital flows to a country are limited by that countries inability to commit to repay their debt. Unlike the models of defaultable debt above, securities markets are assumed to be complete, while access to these markets is limited so that default does not occur in equilibrium. Once again, most applications of these models (for example, Kletzer and Wright 2001 or Wright 2005) involve endowment economies, although versions of these models with production have been studied by Kehoe and Perri (2002) and Wright (2003). In this section, we sketch the implications of this class of models for our measures of returns, using a simple deterministic approximation to these models.

In particular, suppose the country faces the budget constraint

$$c_t + a_{t+1} + k_{t+1} - (1-\delta) k_t = A_t k_t^{\alpha} + R a_t,$$

and faces a sequence of constraints that ensures that the future utility it receives from engaging in international trade be larger than some function of its capital stock

$$\sum_{s=t}^{\infty} \beta^t \ln C_s \geq V(k_t),$$

for all t. This resembles the participation constraints found in many models of international capital flows with sovereign risk. In this case, we get that

$$1 + r_{t+1}^{B} = R \frac{1 + \sum_{s=0}^{t+1} \beta^s \mu_s}{1 + \sum_{s=0}^{t} \beta^s \mu_s} > R,$$

where μ_s is the multiplier on the period s participation constraint. Similarly,

$$1 + r_{t+1}^{K} = R + \frac{\mu_{t+1}}{\lambda_{t+1}} V'(k_{t+1}).$$

That is, in this class of models we know the following facts. First, since negative next exports implies $\mu_{t+1} = 0$ in these models, net importers of capital face domestic interest rates that are equal, and are equal to world rates. Second, if participation constraints bind, both domestic rates will be higher than world rates, but need not be ordered.

RELATED LITERATURE

Caselli and Feyer (2007) , and Gourinchas and Jeanne (2005) are related in that they discuss the implications of differences in either the marginal product of capital or investment rates across countries for the efficiency of capital markets. The analysis presented here is sufficiently different as to complement these other studies.

Caselli and Feyer address whether there are large differences in the marginal product of capital across countries, with a focus on 1996 data from the Penn World Tables. Thus, the focus on one year in their analysis differs from the 50 year panel focus of our analysis. They find that the marginal product of capital is quite similar across countries in 1996 after using World Bank estimates to adjust capital's share of income for non-reproducible factors of production, including land and natural resources, and after making adjustments for differences in the relative price of investment goods. They also conduct an analysis over time, and find that the MPK differences are smaller today than they were 30 years ago, which leads them to conclude that international credit market distortions have declined over time.

Our results also suggest a decrease in the variance of the MPK across countries, despite the fact that we did not make adjustments for land or for differences in the relative price of capital across countries. Regarding these adjustments, differences in the relative price of capital across countries do not change the implication that capital should flow from low MPK to high MPK countries. We choose a standard value for the capital share, rather than adjust the share for variations in land/natural resources.

We have not yet made these adjustments since there is no canonical procedure for doing this, particularly over time[1]. Caselli and Feyer's conclusion that international credit market imperfections are unimportant is but one interpretation of the fact that marginal products of capital are less diverse today than 50 years ago. Standard closed economy growth theory generates the same implication, with some countries, such as the U.S. and Europe on their steady state growth paths, and other countries, such as the Asian Tigers, catching up.

CONCLUSION

Theory implies that capital should flow from low return countries to high return countries. For much of the last half century, however, international capital flows have been the opposite; low return geographic regions, such as Latin America, have received considerably more capital than high return regions such as East Asia. This finding re-states the puzzle posed by Robert Lucas from "Why doesn't capital flow to poor countries", to "Why doesn't capital flow to high return countries".

The tendency for capital to flow to high return countries is a robust prediction across various classes of models. The main reason is that these models incorporate features that tend to *limit* the size of flows from low return to high return countries, but not the direction of the flows. Thus our findings, whilst confirming the presence of substantial capital market imperfections, is also a challenge to the standard approaches to modeling such imperfections.

[1] A puzzling issue is that reproducible capital share adjusted for land is quite low, less than 20 percent in the U.S. and Canada, and close to zero in countries such as Burundi and Bolivia.

DATA APPENDIX

NIPA Expenditure

Data on the expenditure side of the national income and product accounts was taken from a number of different sources. In all cases, data in constant local currency prices was used. As a general rule, we began with the OECD Annual national Accounts for industrial countries from 1970 to the present, and with the World Bank's Global Development Indicators for all other countries and for the period 1960 to the present. Gaps in these data sources, including data for the period from 1950 to 1960, were filled in first using the World Bank's World Savings database described in Loayza et al (1999?). After this, the United National national Accounts database was used. A number of other official and country specific sources, described below, were used to fill in remaining gaps. Finally, in a small number of cases, data on the expenditure accounts in current values was used along with the GDP deflator to fill in remaining gaps.

The other region and country specific sources used include:

1. Eurostat in the case of Bulgaria and Malta??
2. The Asian Development Bank's *Key Indicators*.
3. The Economic Commission for Latin America and the Carribean's (ECLAC) *Statistical Yearbook for Latin America and the Carribean.*
4. Statistics available from the website of the Economic Community of West African States.
5. The Statistical Service of the Republic of Cyprus: http://www.mof.gov.cy/.

6. Maddock and McLean for Australia.
7. Data from the Kingdom of Bahrain Ministry of Finance http://www.mofne.gov.bh/
8. Data from the Maltese Ministry for Investment, Industry and Information Technology http://www.miti.gov.mt/
9. The Historical Statistics of Canada produced by Statistics Canada:

   http://www.statcan.ca/bsolc/english/bsolc?catno=11-516-X

To be completed.

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