Bad Investments and Missed Opportunities? Capital Flows to Asia and Latin America, 1950-2007

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Abstract

Theory predicts that capital should flow to countries where economic growth and the return to capital is highest. However, in the post-World War II period, per-capita GDP grew almost three times faster in East Asia than in Latin America, yet capital flowed in greater quantities into Latin America. In this paper we propose a 3-country 2-sector growth model, augmented by "wedges" to quantify and evaluate the importance of international capital market imperfections versus domestic imperfections in explaining this anomalous behavior of capital flows. We find that during the 1950's capital controls where important, but domestic conditions dominate. And contrary to what has been thought, after 1960 capital controls in Asia encouraged borrowing.

1 Introduction

Standard economic theory, as applied by Lucas (1990) and others predicts that capital should flow to countries where the productivity of capital and economic growth is the highest. However, Ohanian and Wright (2008) showed that capital has not systematically flowed to regions with the highest capital returns, measured using either the marginal product of capital from a standard Cobb-Douglas technology, or measured using the inter-temporal marginal rate of substitution from time separable preferences with log utility over consumption.

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Perhaps the most striking example of capital flows that are at variance with standard theory is the contrast between flows to post-World War II Latin America and post World War II East Asia. As we describe below in Section 4**,** very little capital flowed to East Asia (Japan, Singapore, Hong Kong, Taiwan, Thailand, Philippines) after World War II, despite the fact that economic growth and capital productivity were very high in this region. In contrast, considerable capital flowed to Latin America during this period, despite the fact that neither capital productivity nor economic growth was high. In fact, as discussed by Cole et al (2005), Latin American economic growth substantially lagged behind the growth of virtually all other countries in Western and Northern Europe, the Asian Tigers, and North America during this period.

There are two very different interpretations of this anomalous pattern of international capital flows. One is that i*nternational capital market imperfections*, including capital controls, and other impediments to international transactions, are the key factor in understanding why capital does not flow to high return and high growth regions (see Edwards (2007) http://papers.nber.org/books/edwa06-1 for several references on this hypothesis). This hypothesis implies that much more capital would have flowed to East Asia and other high return regions, had international capital markets been more open. This view is standard among economists who have studied Asia, as this region adopted severe regulations and controls on international capital flows after World War II. A very different interpretation of these capital flows is that *domestic imperfections, particularly domestic capital market distortions,* are the key factor in understanding international capital flows (see Alfaro et al **(**2011**)**). This hypothesis states that domestic (Asian) capital market distortions are the key factor in keeping international capital from flowing into Asia. However, relatively little is known about the comparative quantitative importance of international vs. domestic market imperfections on international capital flows, because of the inherent difficulty in measuring these various market imperfections. More broadly, the size of these imperfections, how they have changed over time, and how they have impacted world economic activity remain important open questions.

This paper estimates the size of these imperfections and analyzes how they have impacted global capital flows and the world economy. Our approach adapts the business cycle accounting framework of Chari et al (2007) and Cole and Ohanian (2002) to an open economy setting by introducing an *international wedge*, in which a region-specific tax is applied to the purchase of international contingent claims. This region-specific international wedge, in addition to productivity, labor, domestic capital, and government wedges, is sufficient for the model to completely account for the observed variations in output, consumption, investment, labor, and capital flows. Specifically, we construct a three-region general equilibrium model, in which the regions are Latin America, East Asia, and the rest of the world (ROW), which is primarily North America, Western and Northern Europe, and Australia. We measure domestic market imperfections using labor, capital, and productivity wedges, as in Chari, Kehoe, and McGrattan (2007) and Cole and Ohanian (2002). We measure the international wedge using differences

in relative consumption growth.

We first construct time series of these wedges using an estimated version of the model together with panel data that is constructed using country-specific, historical sources. We then conduct a variety of experiments in changing the values of specific wedges, and their stochastic processes, to correspond to a number of substantive policy interventions regarding both international capital market distortions and domestic distortions. These experiments allow us to quantify the importance of international capital market and domestic market imperfections, and assess how events such as the Latin American debt crisis of the 1980s, and how capital controls and regulations adopted in a number of countries have impacted global capital flows and more broadly, the world economy.

Our most striking findings are as follows. First, both international and domestic imperfections have had very large impacts on global capital flows and corresponding world consumption allocations. Specifically, capital flows into, or out of, Asia and Latin America would have been as much as 20 percent larger for much of the post-World War II period had these international and domestic imperfections been reduced, with consumption and labor in these regions differing by as much as 10 - 20 percent compared to the data. Our second key finding is that domestic distortions have played a much larger role in accounting for international capital flows, particularly to East Asia, than is typically recognized in the literature. We find that East Asia would have received capital of about 4 percent of their GDP in the 1950s had international capital market imperfections declined more quickly and smoothly, and would have received capital flows of about 10 percent of their GDP if capital and labor distortions were unchanged after 1950. We also find that the impact of international capital market distortions are large very recently, despite the fact that many countries have liberalized their international capital markets over time. We find that capital flows into Latin America, and out of Asia would have been about 16 percent of GDP over the last two decades with international capital market liberalization. This in part reflects the legacy of the accumulation of international capital market distortions over time. Thus, even if international capital market imperfections are ultimately removed, their history can continue to have very large impacts into the future.

The remainder of the paper is organized as follows. Section 2 discusses previous literature. Section 3 presents the model economy, describes how the closed economy wedge methodology is adapted to the open economy setting and maps the competitive equilibrium into a pseudo planners problem. Section 4 describes the application of the methodology to the East Asia and Latin America case, and shows the results, and section 5 concludes.

2 Previous Literature

There is a substantial literature that attempts to "test" for the efficiency of international capital markets. Much of this literature takes an approach that requires strong auxiliary assumptions about the sources of gains from inter-temporal trade. As a consequence, these tests often have low power against plausible alternatives. Our approach is intended as a complement to this literature that has some important new advantages in being robust to some auxiliary assumptions, and allowing testing of other auxiliary assumptions.

To understand our argument, consider the best known test of the efficiency of international capital flows due to Feldstein and Horioka (1980). They study actual capital flows in a cross section of countries (this approach has also been adopted by Bayoumi and Rose 1993, Dooley, Frankel and Mathieson 1987, Frankel 1992, Sinn 1992, Taylor 1996, and Tesar 1991). Essentially, they examine the correlation between domestic savings and domestic investment, noting that if capital flows are zero the two must be equal. While this tautologically indicates whether capital flows are positive, the absence of capital flows is not sure indicator of the presence of international capital market inefficiencies. Most obviously, capital flows might be small in a world with capital market imperfections because the gains from international trade in capital are small. Other counterexamples have been proposed by other authors (Obstfeld 1986). In other words, these counterexamples demonstrate the low power of the test against plausible alternatives. Some authors have also examined the relationship between savings and investment over time for given countries (eg Feldstein 1983 and Feldstein and Bachetta 1992). Gourinchas and Jeanne (2005) also study differences in savings and investment rates and their relationship to rates of return as proxied by growth rates, although the theoretical underpinnings of these tests are unclear.

Another class of tests have examined the extent of risk sharing across countries (a non-exhaustive list includes Crucini 1999, Crucini and Hess 1999, Lewis 1996 and 2000, Obstfeld 1989, 1993, and 1994, and van Wincoop 1994 and 1999). These tests are typically sensitive to specific assumptions about the functional form of the utility function: homotheticity, separability and the elasticity of substitution between different types of consumption (durable and non-durable, for example), or between consumption and leisure, although some relatively non-parametric calculations have been attempted (eg Atkeson and Bayoumi 1993). Although sensitivity to functional form assumptions can never be entirely avoided, the methods we propose below are robust to some functional form assumptions, while the robustness to other assumptions can be examined. We discuss this further below.

Another approach has examined whether or not capital flows towards countries with high rates of return. Lucas (1990) for example, examines this under the assumption that countries that are poor are "capital scarce" and have high rates of return to capital, and finds that capital flows from high return countries to low return countries. In the papers

most closely related to this proposal Ohanian and Wright (2007,2010) measure rates of return directly from consumption growth and marginal product of capital data and find that capital also has no systematic tendency to flow towards high return countries.

Likewise, Caselli and Feyrer (2007) also consider differences in the marginal product of capital across countries respectively. Caselli and Feyrer 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 marginal product of capital differences are smaller today than they were 30 years ago, which leads them to conclude that international credit market distortions have declined over time. However, the resulting estimates of marginal products are very low, so that after accounting for depreciation the return to investing in capital is negative in most countries, which casts doubt on the estimates.

Ohanian and Wright (2007) have argued that, relative to savings-investment correlations and relative consumption correlations, approaches based on the relationship between capital flows and estimated rates of return are robust to underlying assumptions about the gains from international capital trade. They show, for example, that consumption growth rates and returns to capital are systematically related to capital flows under various assumptions about imperfections in international markets. Although the measurement of rates of return from average products of capital or consumption growth rates are sensitive to functional form assumptions, these sensitivities can be tested. We discuss this further below.

3 An Open Economy Business Cycle Accounting Framework

We first summarize a quantitative framework that we will use to measure changes in capital market efficiency and to quantify their impact on macroeconomic activity over time. The framework extends the closed-economy business cycle accounting approach of Chari, Kehoe, and McGrattan (2007) to a general equilibrium open economy accounting framework. Consider a world populated by $j = 1, ..., J$ countries each with N_{tj} population at time $t = 0, 1, ...$ The decisions of each country are made by a representative agent with standard preferences over consumption and leisure ordered by

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \left\{ \ln \left(\frac{C_{jt}}{N_{jt}} \right) - \frac{\psi}{1+\gamma} h_{jt}^{1+\gamma} \right\} N_{jt} \right].$$

While these preferences are quite standard, we importantly note that many of the results below can be established for more general preference orderings.

At $t = 0$ each country j chooses a state contingent stream of consumption levels C_{jt}, purchases of capital to be rented out next period K_{jt+1} and state contingent international bond holdings B_{jt+1} subject to a sequence of flow budget constraints for each state and date

$$\begin{aligned} C_{jt} + P_{jt}^K K_{jt+1} + E_t \left[q_{t+1} B_{jt+1} \right] &\leq \left(1 - \tau_{jt}^h\right) W_{jt} h_{jt} N_{jt} + \left(1 - \tau_{jt}^B + \Psi_{jt}\right) B_{jt} + T_{jt} \\ &\quad + \left(1 - \tau_{jt}^K\right) \left(r_{jt}^K + P_{jt}^{*K}\right) K_{jt}, \end{aligned}$$

with initial capital K_{j0} and bonds B_{j0} given. Here, q_{t+1} is the price of a bond that pays off in a particular state in period $t+1$, W_{jt} is the wage and r_{jt}^K the rental rate of capital in country j, T_{jt} are government transfers, Ψ_{jt} is a sequence of interest penalties taken as given by the country, and which facilitates asymptotic stationary relative consumptions across countries, P_{jt}^K is the price of new capital goods, and P_{jt}^{*K} is the price of old capital goods. The τ^k for $k = h, B, K$ represent taxes or "wedges" on wage income, interest income and capital services income respectively.All revenue from these taxes above the government spending level G_{jt} are rebated in lump sum fashion each period. Note that the wedges on wage income and capital services income are standard in the business cycle accounting literature (see Cole and Ohanian (2002), and Chari, Kehoe, and McGrattan (2007), but the wedge on interest income from international bonds is added to to create an open economy accounting framework. This term drives a wedge between world inter-temporal prices and the returns received by individuals in a specific country. This wedge captures not only taxes on international financial transactions, but is a proxy for other capital market imperfections including capital controls and other regulations that impede capital flows. The estimated stochastic process for this term will allow us to construct a time series measure of variation over time in international capital market efficiency by country that we will document, interpret within the context of institutional and regulatory changes at the regional level, and that we will use to assess to assess its impact on macroeconomic activity.

Each country has two representative firms. The first hires labor and capital to produce the consumption good from a standard Cobb-Douglas technology $A_{jt} K_{jt}^{\alpha} h_{jt} N_{jt}^{1-\alpha}$. The second type of firm produces new capital goods K_{jt+1} using X_{jt} units of deferred consumption and K_{jt} units of the old capital good. Their objective function is $P_{jt}^K K_{jt+1} - X_{jt} - P_{jt}^{*K} K_{jt}$, and they face a capital accumulation equation with adjustment costs ϕ of the form

$$K_{jt+1} = (1 - \delta) K_{jt} + X_{jt} - \phi \left(\frac{X_{jt}}{K_{jt}} \right) K_{jt}.$$

One of the j countries is designated a reference country R for which productivity and population evolve according to

$$\ln A_{Rt+1} = \ln A_{Rt} + \ln \pi_{ss} + \sigma_R^A \varepsilon_{Rt}^A,$$

$$\ln N_{Rt+1} \quad = \quad \ln N_{Rt} + \ln \eta_{ss} + \sigma_R^N \varepsilon_{Rt}^N,$$

while for the other j countries, we have $A_{jt} = a_{jt} A_{Rt}$, and $N_{jt} = n_{jt} N_{Rt}$. This ensures that the long run (steady state) levels of consumption and consumption per capita are not degenerate. The levels of government spending and the wedges follow first order autoregressive processes.

We let $a_{Rt} = n_{Rt} = 1$, $Z_t = A_{Rt}^{1/(1-\alpha)} N_{Rt}$ be effective labor, with $z_{t+1} = Z_{t+1}/Z_t$ the growth of effective labor and we define $\pi_{t+1} = A_{Rt+1}/A_{Rt}$ and $\eta_{t+1} = N_{Rt+1}/N_{Rt}$. This implies $z_{t+1} = \pi_{t+1}^{1/(1-\alpha)} \eta_{t+1}$. Dividing real variables by Z_t and denoting the result with lower case letters, this allows us to write down an intensive form version of the economy in which households maximize

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\prod_{s=0}^{t} \eta_s \right) \left\{ \ln \left(c_{jt} \right) - \frac{\psi}{1+\gamma} h_{jt}^{1+\gamma} \right\} n_{jt} \right],$$

subject to

$$\begin{aligned} c_{jt} + P_{jt}^K z_t k_{jt+1} + z_t E_t \left[q_{t+1} b_{jt+1} \right] \quad \leq \quad & \left(1 - \tau_{jt}^h \right) \frac{W_{jt} h_{jt} N_{jt}}{A_{Rt-1}^{1/(1-\alpha)} N_{Rt-1}} + \left(1 - \tau_{jt}^B + \Psi_{jt} \right) b_{jt} + t_{jt} \\ & + \left(1 - \tau_{jt}^K \right) \left(r_{jt}^K + P_{jt}^{*K} \right) k_{jt}, \end{aligned}$$

The first order optimality conditions of the consumption good firm

$$w_{jt} = (1-\alpha) a_{jt} \pi_t \left(\frac{k_{tj}}{h_{tj} n_{jt} \eta_t} \right)^{\alpha}, \text{ and } r_{jt}^K = \alpha a_{jt} \pi_t \left(\frac{k_{jt}}{h_{jt} n_{jt} \eta_t} \right)^{-(1-\alpha)},$$

while for the investment good producing firm they are

$$P_{jt}^K = \frac{1}{1 - \phi' \left(\frac{x_{jt}}{k_{jt}} \right)}, \text{ and } P_{jt}^{*K} = P_{jt}^K \left(1 - \delta - \phi \left(\frac{x_{jt}}{k_{jt}} \right) + \phi' \left(\frac{x_{jt}}{k_{jt}} \right) \frac{x_{jt}}{k_{jt}} \right).$$

One technical issue arises. From the FOC in b, if one country is our reference country R we have,

$$\frac{c_{jt+1}/n_{jt+1}}{c_{Rt+1}} = \frac{c_{jt}/n_{jt}}{c_{Rt}} \frac{1 - \tau_{jt+1}^B + \Psi_{jt}}{1 - \tau_{Rt+1}^B + \Psi_{Rt}}.$$

This means we cannot separately identify each country's the international wedge τ^B (and interest penalty term Ψ). In what follows we normalize these levels for our reference country to zero. This means that for all $j \neq R$ we can define relative consumptions $\theta_{jt} = \left(c_{jt}/n_{jt} \right) / c_{Rt}$, from which $\theta_{jt+1} = \theta_{jt} \left(1 - \tau_{jt+1}^B + \Psi_{jt+1} \right)$. This generates non-stationary relative consumption levels, and so in order to ensure stationarity, we

assume that the steady state international wedge for each country is zero, and that in equilibrium

$$\Psi_{jt} = \left(1 - \tau^B_{jt+1}\right)\left[\left(\frac{\theta_{jt}}{\psi_{j0}}\right)^{-\psi_{j1}} - 1\right],$$

which generates

$$\ln \theta_{jt+1} = \psi_{j1} \ln \psi_{j0} + (1 - \psi_{j1}) \ln \theta_{jt} + \ln\left(1 - \tau^B_{jt+1}\right),$$

so that the steady state consumption ratio is then ψ_{j0}. Note that as the wedge is in general not iid, we have autoregressive innovations.

In the model for each country there are 6 exogenous and 2 endogenous state variables. For J large, this necessitates using perturbation methods to solve the model. This process is simplified further by solving the following equivalent pseudo-social planners problem. Specifically, consider a social planner who's problem is to choose state, date and country contingent sequences of C, K, H to maximize

$$E_0\left[\sum_j \chi^C_{jt} \sum_{t=0}^{\infty} \beta^t \left\{\ln\left(\frac{C_{jt}}{N_{jt}}\right) - \chi^I_{jt}\chi^H_{jt}\frac{\psi}{1+\gamma}\left(\frac{h_{jt}N_{jt}}{N_{jt}}\right)^{1+\gamma}\right\} N_{jt}\right],$$

subject to a resource constraint for each state and date

$$\sum_j \left\{C_{jt} + \chi^I_{jt} X_{jt} + G_{jt}\right\} = \sum_j \chi^I_{jt} A_{jt} K^{\alpha}_{jt} \left(h_{jt} N_{jt}\right)^{1-\alpha} + T^{SP}_t$$

and the capital evolution equations above. Here the χ are the social planner version of wedges (as in the competitive equilibrium problem, we normalize $\chi^C_{Rt} = 1$ for all t). Note that the investment wedge now appears in the utility function and the production function, as well as multiplying investment in the resource constraint.

After substituting and rearranging we obtain the intensive form social planners problem of maximizing

$$E_0\left[\sum_{t=0}^{\infty} \beta^t \left(\prod_{s=0}^{t} \eta_s\right) \sum_j \chi^C_{jt}\left\{\ln\left(c_{jt}\right) - \chi^I_{jt}\chi^H_{jt}\frac{\psi}{1+\gamma} h^{1+\gamma}_{jt}\right\} n_{jt}\right],$$

subject to sequences of

$$\sum_j \left\{c_{jt} + \chi^I_{jt} x_{jt} + g_{jt}\right\} = \sum_j \chi^I_{jt} a_{jt} \pi_t k^{\alpha}_{jt} \left(h_{jt} n_{jt} \eta_t\right)^{1-\alpha} + t^{SP}_t,$$

and the intensive form capital accumulation equation. The social planner takes the sequences of $t^{SP\prime}s$ as constant. If in equilibrium, we suppose that these transfers "rebate"

the "revenues" from the investment wedge, then we can write the sequence of constraints as

$$\sum_j \left\{ c_{jt} + z_t k_{jt+1} - (1-\delta) k_t - \phi\left(\frac{x_{jt}}{k_{jt}}\right) k_{jt} + g_{jt} \right\} = \sum_j a_{jt} \pi_t k_{jt}^{\alpha} \left(h_{jt} n_{jt} \eta_t\right)^{1-\alpha}.$$

The proof that the solution to the pseudo-planners problem attains the equilibrium of the competitive equilibrium problem follows from a straightforward comparison of the first order necessary (and sufficient) conditions for an optimum noting that the mapping between competitive equilibrium wedges τ and social planners wedges χ, for labor and investment are given by

$$\begin{aligned} \chi_{jt}^{H} &= \frac{1}{1-\tau_{jt}^{h}}, \\ \frac{\chi_{jt+1}^{C}}{\chi_{jt}^{C}} \frac{\chi_{jt+1}^{I}}{\chi_{jt}^{I}} &= 1 - \tau_{jt+1}^{K}. \end{aligned}$$

For consumption, the first order condition for the social planners problem is

$$\theta_{jt} = \chi_{jt}^{C},$$

and so will have the same form as in the CE problem as long as

$$\ln \chi_{jt+1}^{C} = \left(1-\rho_j^{C}\right) \ln \chi_{jSS}^{C} + \rho_j^{C} \ln \chi_{jt}^{C} + \varepsilon_{jt+1}^{C},$$

for $1-\rho_j^{C} = \psi_{j1}$ and $\chi_{jSS}^{C} = \psi_{j0}$. Importantly, the ε_{jt} must have an autoregressive structure with the same parameters as the process for τ_{jt}^{B} (this is because the competitive equilibrium international wedge governs the change in the social planners international wedge).

One last technical difficulty needs to be dealt with. In order to use the pseudo social planners problem to study the effect of interventions in the competitive equilibrium problem, it is in general necessary to alter the initial conditions for the χ_{j0}^{C} in the social planners problem. That is, if we want to analyze the effect of an intervention in the competitive equilibrium economy *keeping initial wealth constant*, it is necessary for χ_j^{C} to "jump" with the intervention. This can be done using the relationship between bonds and real allocations of the intensive form competitive equilibrium problem

$$b_{jt} = -E\left[nx_{jt} + q_{t,t+1} z_t nx_{j,t+1} + q_{t,t+1} q_{t+1,t+2} z_t z_{t+1} nx_{j,t+2} + ...\right],$$

where net exports are given by

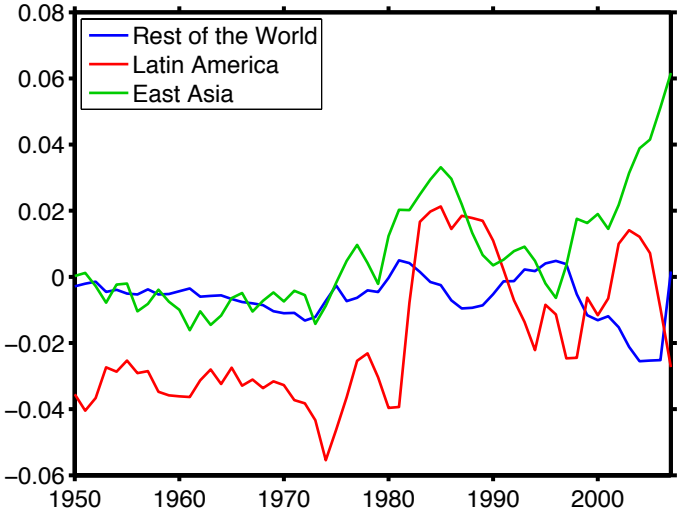
$$nx_{jt} = y_{jt} - c_{jt} - x_{jt} - g_{jt}.$$

It is important to point out that, aside from the technical details underlying the method, the basic approach is intuitive and (somewhat) robust to alternative assumptions. Identification of the wedges is quite intuitive. The international wedge, for example, is determined by differences in consumption growth rates across countries. Likewise, the capital wedge is identified by differences in estimated marginal products of capital (from capital/output ratios) from growth rates of consumption within a country. Up to some concerns about functional forms and parameter values, which we return to in a moment, these comparisons take a relatively modest stand as to the source of gains from inter-temporal trade. To see this, consider the example of a limited commitment model of international financial frictions along the lines of Kehoe and Perri (2002). In this model, regardless of whether or not capital flows are motivated by consumption smoothing, capital scarcity or a desire to shift consumption through time (that is, tilt the consumption profile), the model predicts that the international wedge should never be positive when net exports are negative. Intuitively, this is because the limited commitment constraint does not bind when the country receives a positive net resource transfer. Likewise, a defaultable debt model along the lines of Eaton and Gersovitz (1981) predicts that the international wedge should be zero whenever the country is a net saver (that is, have positive net financial assets) regardless of whether or not the country is motivated to save to insure future consumption fluctuations, or to take advantage of profitable overseas investments.

This is not to say that the approach is free of restrictions imposed by functional forms and parameter values. However, we argue that these concerns are small relative to the alternatives. On the question of functional forms, the long run balanced growth observed for many economies places relatively strong restrictions on the sets of functional forms for production and utility that are admissible. Essentially, at least asymptotically, both have to be invariant to scale suggesting that preferences need to be asymptotically iso-elastic (that is, have constant inter-temporal elasticities of substitution asymptotically) and that production functions need to have constant returns to scale. In addition, under relatively minor restrictions on the behavior of the marginal product of capital (essentially, analogs of the Inada conditions) it can be shown that all "neoclassical" production functions are asymptotically Cobb-Douglas (see Barelli and de Abreu Pessoa 2003 and Litina and Palivos 2008).

In any case, the robustness of our functional form assumptions can be assessed by replicating the above analysis under different assumptions. Likewise, robustness to alternative parameter values can be assessed. For example, differences in discount rates would lead to different consumption growth rates even in the absence of international market imperfections, as would different inter-temporal elasticities of substitution as long as world interest rates do not equal country discount rates. It is typically thought, for example, that wealthier countries are more able to substitute inter-temporally than are poorer countries which are closer to subsistence consumption levels. The extent to which this can explain lower consumption growth in poor countries can be assessed

Figure 1: Net-Exports (%GDP)



by replicating the above analysis under different assumptions for the inter-temporal elasticity of substitution. Furthermore, these parameters can also be estimated and their equality formally tested

In summary, while we do not claim that our approach is free from auxiliary assumptions, we argue that it is exposed to fewer auxiliary assumptions about the sources of gains from trade, and that assumptions about functional forms and parameter values can be assessed using conventional econometric and economic methods.

In the next section we describe the application of this framework to post-war Asian and Latin American capital flows where data is already available. We then briefly discuss the application to data for the past 2 Centuries.

4 Applying the Framework to Analyze Latin American and East Asian Capital Flows

From 1950 to 2004, per-capita GDP grew almost three times as fast in East Asia as in Latin America. This fact, combined with direct estimates of consumption growth and the average product of capital, suggest that the return to investment in East Asia was much higher than in Latin America. Despite this, capital flowed into Latin America in greater quantities than into East Asia throughout this period (see Figure 1).

We use the framework outlined in the previous section to investigate whether these apparently perverse capital flows were a result of inefficiencies in international capital markets, or the internal macroeconomic conditions of the countries in these regions. To implement the framework, we divide countries into three regions. The first is East Asia,

which is made up of the fast growing economies of Japan, South Korea, Taiwan, Hong Kong and Singapore. The second is Latin America, which includes the major non-oil exporting countries in Latin American. All other countries, which from the perspective of GDP importance primarily are North America and Western Europe, are grouped into the "rest of the world" which is our reference economy.

Our methodology follows that of CKM. We use data for each of the three regions together with the optimality conditions of the model to pin down the wedges. We use data on output, consumption, investment, hours worked, population and net-exports for Latin America and Asia to compute seventeen wedges. If we fit the wedges back into our model we recover the original data.

We use a maximum likelihood estimation procedure and apply the Kalman filter to a linearized version of the model to compute the values of the wedges. We use Bayesian estimation to simultaneously recover the processes for the wedges and some of the parameters of the model.

Just as in CKM, to evaluate the effect of each wedge we conduct a counterfactual experiment where we simulate the economy with that wedge fixed at its initial value. Each experiment isolates the direct effect of the wedge, but retains its forecasting effect on the other wedges. This procedure ensures that the expectations of the wedges are identical to those in a model where all the wedges are present at the same time.

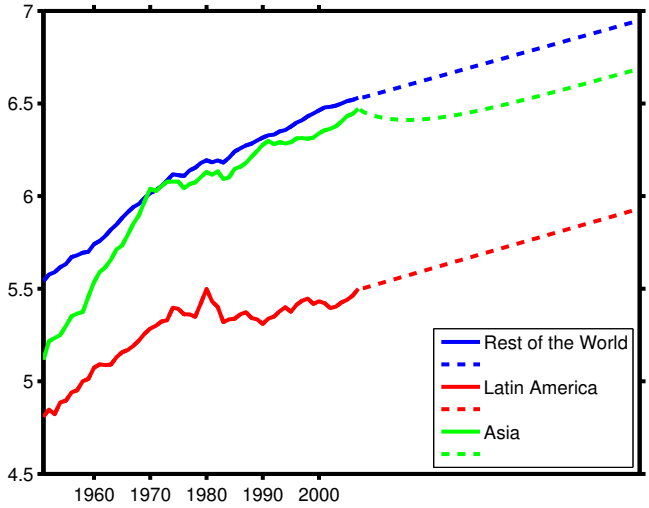
4.1 Processes for the wedges

In the data real output, consumption, investment and population are non-stationary even with respect to a log-linear trend. To make the data comparable to the model, we follow the approach presented in Fernandez-Villaverde (2007) and assume random walks for the two processes that are commonly thought to be extremely persistent: the efficiency wedge for the rest of the world A_R and population for the rest of the world N_R. Thus, the growth rates of the efficiency wedge (π) and population for the rest of the world (η) are assumed to follow first-order autoregressive processes. We denote π_{ss} the mean growth rate of the efficiency wedge for the rest of the world and η_{ss} the mean growth rate of population.

From the optimality conditions of the model we can see that all variables grow at a factor $(\pi_{ss})^{\frac{1}{1-\alpha}} \eta_{ss}$. Then, if we take the first differences of the efficiency wedge and population by defining $\pi_t = \frac{A_{Rt}}{A_{Rt-1}} = \pi_{ss} \exp(\sigma_\pi \varepsilon_{\pi_t})$ and $\eta_t = \frac{N_t}{N_{t-1}} = \eta_{ss} \exp(\sigma_N \varepsilon_{Nt})$, we can derive an aggregate trend $Z_t = A_{Rt}^{1/(1-\alpha)} N_{Rt}$, which is common to all the variables. Hence, we define detrended variables of the form $x_t = \frac{X_t}{Z_{t-1}}$.

We assume that the rest of the wedges follow first-order autoregressive processes around their steady-state values.

Figure 2: The Efficiency Wedge



4.2 Data

We have collected data on the main national accounting aggregates, the labor market, the balance of payments, and stocks of net foreign assets for as many countries as possible. For most OECD countries, and for years in the latter half of the 20th Century, data came from the OECD. For non-OECD countries these data came from the World Bank's *Global Development Indicators* database. These data were extended back to 1950 using a range of sources including most notably Mitchell (2003a,b,c) but also other country specific sources. To obtain accurate estimates of capital stock, data on gross capital formation was obtained for as long a time period before 1950 as possible. The sources consulted included Pyo (1996) for Korea, Ohkawa et al (1973, 1979) for Japan, Miziguchi (undated) for Taiwan, Balboa and Fracchia (1959) for Argentina, Patriota (1961) for Brazil, Feinstein (1972) for the United Kingdom, Eckstein (1955) for Hungary and many many others. Asian capital stocks were adjusted for war damage using the estimates of US Strategic Bombing Command.

4.3 Behavior of the Wedges

The following figures depict the model estimates of the pseudo social planners wedges, along with the predicted future path of these wedges estimated from the data. Figure 2 reports our estimates of total factor productivity across the three economies (the "efficiency wedge"). The figure shows that productivity growth in Asia during the 1950s and 1960s was considerably faster than that observed in either Latin America, or the rest of the world on average, which further suggests capital should have flowed to Asia.

Figure 3: The Labor Wedge

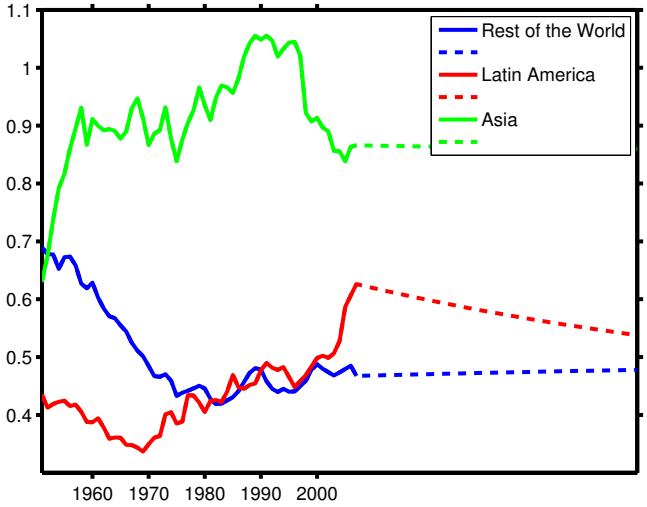
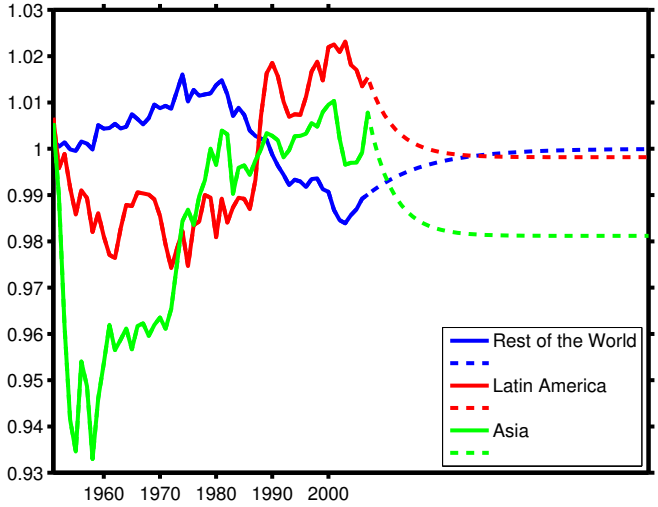


Figure 3 reports our estimate of the labor wedge. A number greater than one here denotes employment at levels greater than predicted by the model, which is interpreted as a subsidy to labor; a number less than one identifies relatively low employment which is interpreted as frictions that have effects analogous to a labor tax. The Figure shows that Latin America faced larger labor wedges than all other regions in the early decades of this period, although these labor wedges improve towards the end. Asia started with relatively low labor wedges that fall quickly and end up as labor subsidies. This pattern coincides roughly with the movement of workers from rural to urban areas throughout Asia in this period.

Figure 4 presents our estimates of the capital wedge. Recall that this wedge affects the Euler equation; it thus reflects the difference between returns to investment estimated from the marginal product of capital, and the return to savings estimated from the growth rate of consumption. We interpret this wedge as an estimate of domestic capital market distortions. All three regions are identified as having a capital tax (a wedge less than one) with the capital tax in Asia starting at a much higher level than in the other regions. This domestic distortion falls dramatically between 1950 and 2000. Latin America is estimated as having smaller domestic capital market distortions that are fairly stable throughout the period. Figures 3 and 4 together suggest that domestic factor market distortions in Asia were relatively large at the beginning of the sample, and declined quickly throughout the middle decades of the sample. This is one potential explanation for the relatively low capital flows into Asia during this period.

The role of capital controls, as estimated from the international wedge, is depicted in Figures 5 and 6. Figure 5 plots the international wedge from the planners problem while Figure 6 recovers the international wedge from the competitive equilibrium problem. Since all wedges are relative to the rest of the world, there are only two lines in these

Figure 4: The Capital Wedge



Figures. Figure 6 shows that the international wedge for Asia was greater than one in the early years of the sample. This means that Asia was faced with a tax on borrowing (or alternatively a subsidy on international savings) in the early years of the period (a number greater than one makes repayments on debts larger and hence more negative, and increases the return on foreign savings). Latin America, by contrast, had wedges that were frequently negative during this period, which acts as a subsidy on borrowing.

By the 1990s these wedges had largely converged. This is consistent with the pattern identified in Figure 1 which shows that capital flows to the two regions become more synchronized towards the end of the sample. Overall, the results for the international wedge are supportive of a role for capital controls, or other frictions in international capital markets, in discouraging capital flows into Asia and encouraging flows into Latin America. Figure 7 also plots the government wedge identified form the data.

In addition, we will be connecting the estimated international wedges to policy and institutional variations. Specifically, It is well known that institutional factors have played a key role in the adoption and subsequent removal of capital controls and other regulatory impediments to international capital flows. But previous research has been challenged in terms of quantifying the size of these distortions. Specifically, measuring the effective size of these controls within an economic model context, much less quantifying the impact of these impediments, has been difficult. This reflects the fact that controls, regulations, and international transaction taxes and fees are complicated, they vary considerably over time, and moreover, they may or may not be enforced. To see this, consider the case of Japan, which incorporated substantial regulation and restrictions on capital flows in the postwar period, as their goal was to limit new debt accumulation and thereby not weaken their international credit rating (Pyle, 1996). Restrictive capital controls were in place in the 1950s and 1960s, particularly on foreign

Figure 5: The Cumulative International Wedge

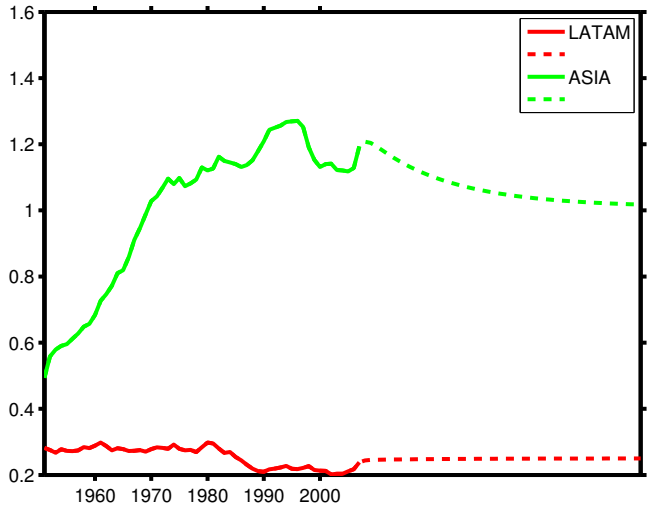


Figure 6: The Competitive Equilibrium International Wedge

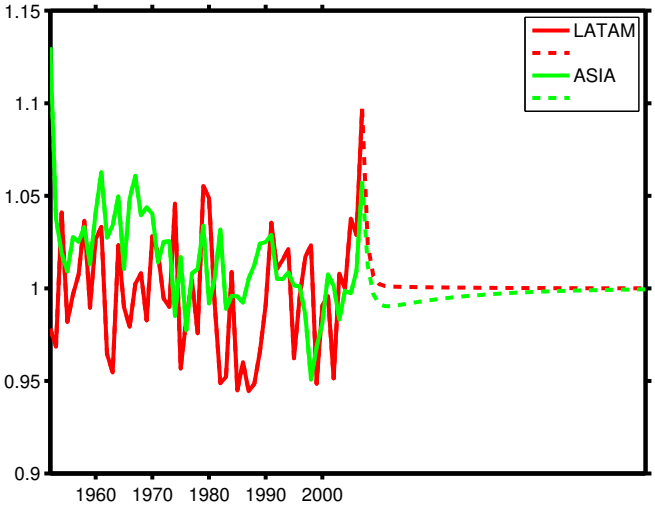
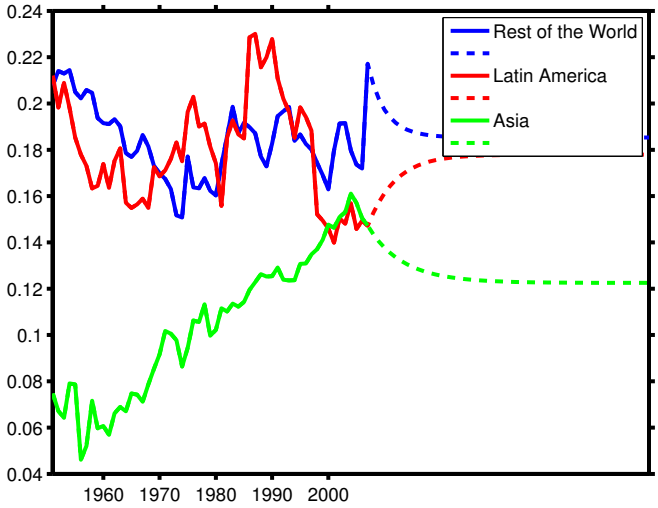


Figure 7: The Government Wedge

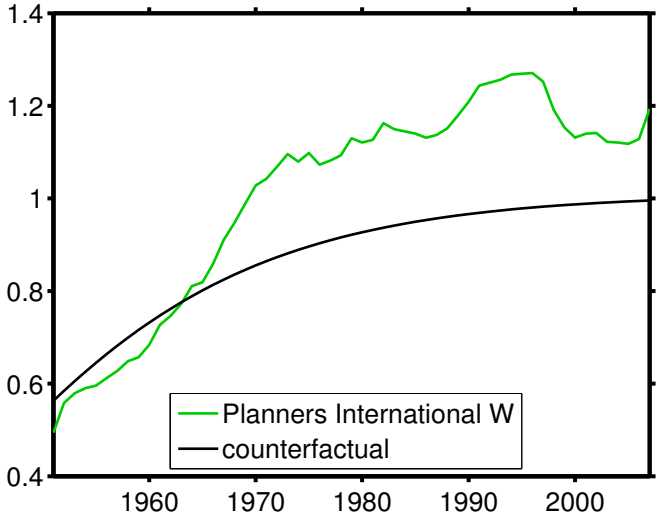


direct investment, though on the other hand, Japan encouraged international licensing arrangements to access new technologies. By the late 1960s, Japan's entrance into the OECD required some capital market liberalization. By 1980, broad controls were apparently eliminated, though many international financial transactions were still subject to a variety of specific controls and regulations. In the mid-1980s, the dollar-yen accord created additional liberalization by establishing markets that previously had not existed for some final instruments. Our estimated international capital flow wedges provide a measure of the importance of these various complicated controls, taxes, and fees. Moreover, we will interpret the movements in these wedges within the context of the evolution of the controls, taxes, and fees as summarized above.

4.4 Counterfactuals

We now conduct experiments to assess the impact of various policy changes. To quantify the impact of changes in international capital market imperfections, we conduct an experiment that changes the international wedge by treating it parametrically and then fixing its values over time. Figure 8 shows the counterfactual international wedge and the estimated planners international wedge for Asia. The counterfactual wedge gradually declines over time to zero. This change appears to be fairly modest compared to the estimated international wedge, but it has a very large impact on allocations. Figures 9-11 show these changes. First, note the very large change in Asian consumption. The observed very steep consumption profile is flattened considerably by this change in the international wedge, as consumption under the counterfactual is significantly above the data in the 1950s and 1960s, which is made possible by a substantial capital inflow that averages more than four percent per year in the 1950s and early 1960s. After the

Figure 8: Planners International Wedge vs. Counterfactual Path, Asia



mid-1960s, Asian consumption in the counterfactual is much lower than in the data, and labor input and output are much higher, as there is a substantial capital outflow from Asia to the ROW, which in turn has substantial implications for the ROW. In particular, the large Asian capital outflows after the mid-1960s lead to ROW consumption rising at least five percent over that period and ROW labor input dropping substantially, as these large flows into the ROW allow them to consume at a high level while reducing labor input at the same time. Thus, removing impediments to Asian capital flows has very large general equilibrium effects that impact the world economy nearly nearly as much as they impact the Asian economy.

The Latin American international wedge also has a very large impact on the world economy. Figure 12 shows the counterfactual international wedge compared to the estimated planners actual wedge, and Figures 13-14 shows the results of this change. The counterfactual wedge increases gradually over time, whereas the actual international wedge is initially a subsidy to capital inflows, and then increases in the 1980s and afterwards. The counterfactual wedge induces an initial and significant capital outflow from Latin America. This reflects the fact that Latin American capital productivity and growth substantially lagged behind most other countries in the 1950s, and that the observed capital inflow would not have occurred in the absence of the estimated subsidy to importing capital to Latin America. This capital outflow occurs through the 1980s, followed by a significant capital inflow to Latin America that reflects Latin America building up a large and positive net foreign asset position. By the 1990s, Latin American consumption under the counterfactual is as much as 15 percent higher than in the data, and hours worked is as much as 10 percent lower. During the 1950s and 1960s, ROW consumption and hours worked are about 5 percent higher, and 3 percent

Figure 9: No International Wedge in Asia - Net_Exports

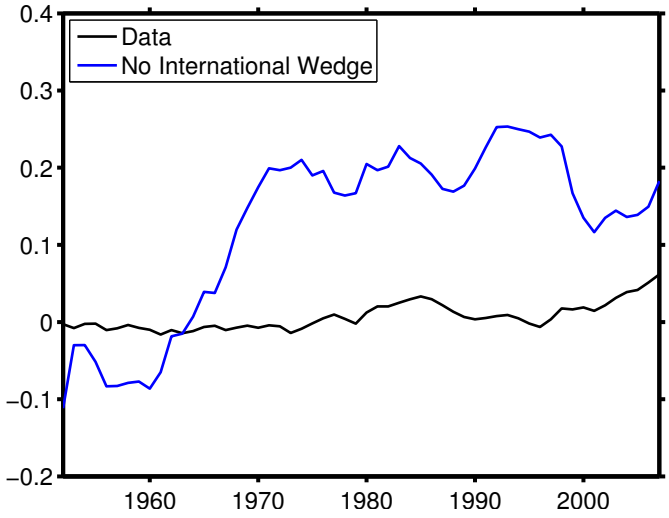


Figure 10: No International Wedge in Asia - Other Variables

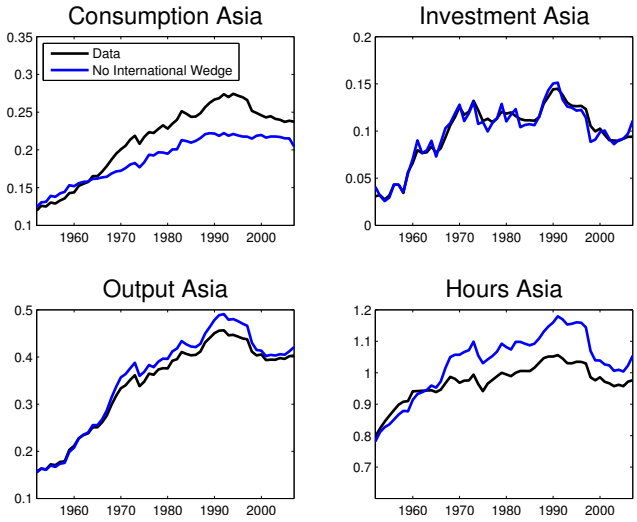
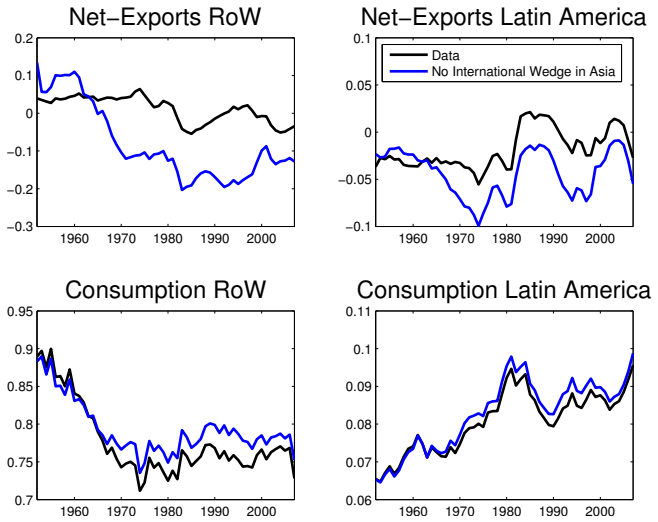


Figure 11: No International Wedge in Asia - Effect of RoW and Latin America



lower respectively, compared to the data, but then reverses after the 1970s when Latin America receives substantial capital inflows, with consumption about 3 percent lower than the data, and hours worked about 2 percent higher than the data. Thus, this fairly modest change to the Latin American international wedge also has large general equilibrium effects on the world economy.

We next treat the Asian and Latin American labor wedges parametrically and fix their values over time. Following Chari, Kehoe, and McGrattan (2007) we fix these wedges to their initial values and keep those initial values over time. First, we fix the East Asian labor wedge to its initial value, which is equivalent to a comparatively high tax on labor income, as this wedge decline by about 35 percent over time. By fixing this wedge at this highly distorted value, this reduces labor input which in turn reduces the incentive to invest in Latin America. As a result output and labor input falls considerably through the 1990s compared to the data, and Asia receives considerable capital inflows which it uses to support its consumption. These capital inflows begin to decline by the mid 1990s as at that time Asian productivity is very high, and Asian output and labor input begin to recover. Consumption for the ROW is lower by as much as five percent, as imposing such a severe labor tax on Asia depresses world output, hours, and consumption. (See Figure 15 and 16 for the results for the counterfactual Asian labor wedge).

In contrast to the Asian labor wedge, the Latin American labor wedge in the initial period is low compared to its values later. Thus, fixing the Latin American labor wedge at its initial level increases effectively reduces the price of labor and increases the incentive to produce in Latin America. Consequently, Latin American hours worked, capital, and output all rise in this counterfactual by as much as 16 percent, and con-

Figure 12: Planners International Wedge vs. Counterfactual Path, Latin America

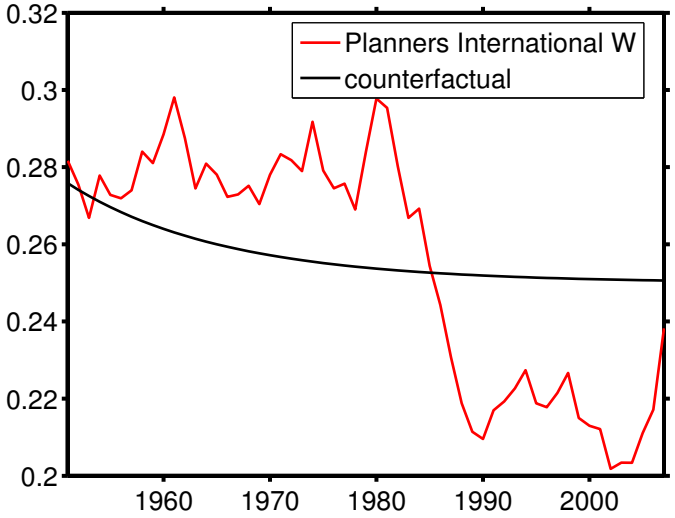


Figure 13: Counterfactuals for Latin America - Net_Exports

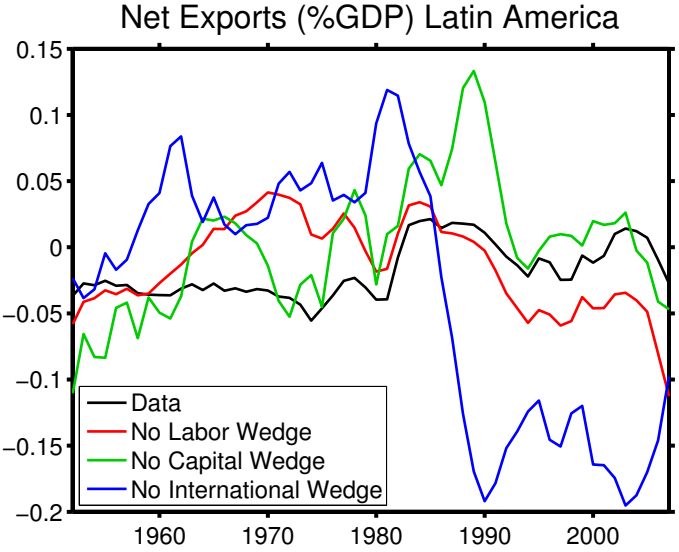


Figure 14: Counterfactuals for Latin America - Other Variables

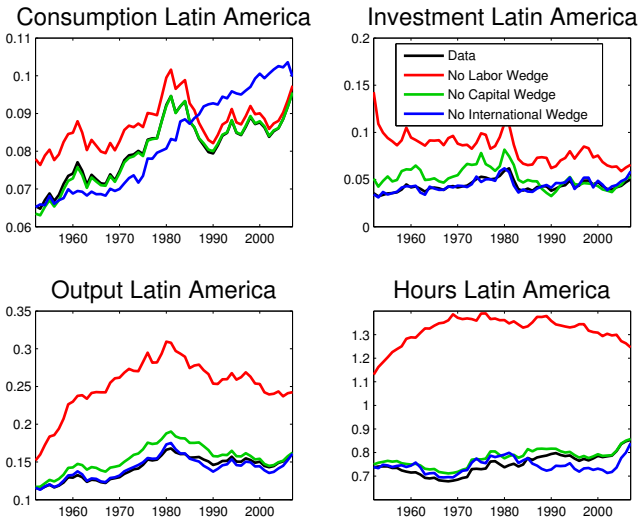


Figure 15: Counterfactuals for Asia - Net_Exports

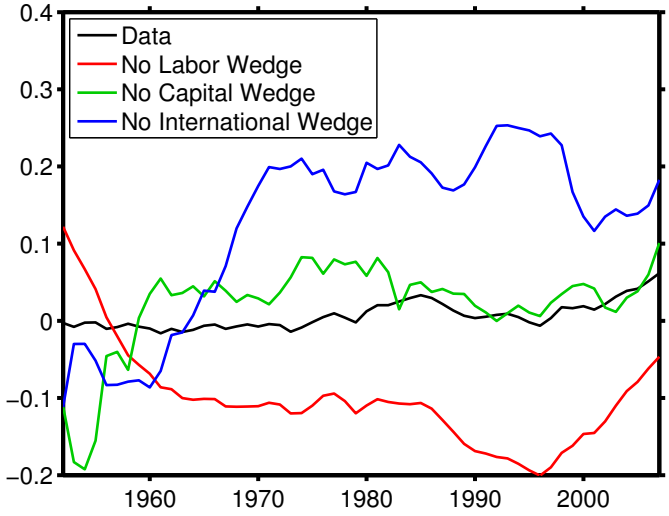
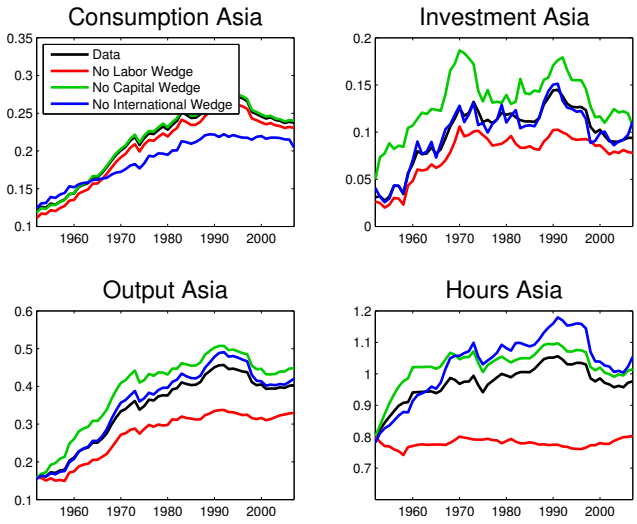


Figure 16: Counterfactuals for Asia - Other Variables



sumption rises modestly. This counterfactual also benefits the rest of the world, which have slightly higher consumption and slightly lower hours worked in the 1950s - 1970s. (See Figure 13 and 14 for the results for the counterfactual Latin American labor wedge)

Our final counterfactual is with the domestic capital wedges. Figure 15 and 16 show the results for the counterfactual Asian capital wedge, and figures 13 and 14 show the results for the Latin American capital wedge. As in the case of the labor wedges, we follow Chari, Kehoe, and McGrattan (2007) and set the values of the Asian and Latin American wedges to their initial values and keep them there. For Asia, the initial labor wedge is low relative to its value for the rest of the 1950s through the 1970s. This increases the incentive to invest in Asia, which in turn leads to a period of large capital inflows, higher labor input, and higher output for Asia, as much as 10 percent. Consumption for Asia is modestly higher, and hours worked for Asia in this counterfactual is as much as 15 percent above the data. Output is about five percent lower in the ROW, reflecting the reallocation of production to Asia, while consumption is modestly higher for the ROW.

The pattern of the capital wedge in Latin America is very similar to that in Asia, with the initial value being lower than values for the remainder of the 1950s through the 1980s. This means that the cost of capital is lower in Latin America, which in turn leads to a reallocation of capital to Latin America through large capital inflows, and Latin American hours worked rise considerably, with output under the counterfactual Latin American capital wedge rising as much as 15 percent relative to the data. Consumption is moderately higher for the ROW, and labor drops in the ROW as capital begins to flow out of Latin America to the ROW following the initial decades of inflows.

In summary, we find that both international and domestic wedges have had very

Table 1: Summary of Decompositions, Asia

	1950s	1960s	1970s	1980s	1990s	2000s
Data	−0.01	−0.01	0	0.02	0.01	0.04
No Labor W	−0.00	−0.05	−0.07	−0.09	−0.13	−0.13
No Capital W	−0.06	0.03	0.04	0.01	0.00	0.01
No Labor & Capital W	−0.06	−0.02	−0.03	−0.08	−0.13	−0.12
No International W	−0.04	0.02	0.12	0.11	0.16	0.11

Table 2: Summary of Decompositions, Latin America

	1950s	1960s	1970s	1980s	1990s	2000s
Data	−0.03	−0.03	−0.04	0.01	−0.01	−0.00
No Labor W	−0.01	0.03	0.05	0.00	−0.02	−0.06
No Capital W	−0.03	0.03	0.02	0.02	0.02	−0.01
No Labor & Capital W	−0.05	0.07	0.08	0.03	0.00	−0.06
No International W	−0.01	0.06	0.07	0.02	−0.08	−0.16

large impacts on the world economy. Table 1 and 2 show the decomposition of these wedges by decade. Note that these counterfactuals generate large changes not only during the 1950s and 1960s when Latin America, and particularly Asia, were very underdeveloped, but there are also large impacts in the 1990s and 2000s for the labor wedge and the international capital wedge.

5 Conclusions

This paper applied an open economy business cycle accounting framework to analyze the size and pattern of domestic and international wedges and their impacts on the world economy. To our knowledge, this is the first systematic quantitative measurement of international capital market wedges, which is facilitated by the application of standard neoclassical growth theory. We find that domestic and international wedges are large, and that even modest differences in their evolution over time would have had very large impacts on capital flows, the location of production, and allocations.

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