NON-TRADED GOODS AND CAPITAL FLOWS TO DEVELOPING COUNTRIES

by

Jacek Rothert
United States Naval Academy

&

Jacob Short
Western Ontario University
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Jacek Rothert                        Jacob Short†
U.S. Naval Academy                  University of Western Ontario
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Abstract

We analyze the quantitative impact of the non-tradable sector and structural change on international capital flows. We argue that the allocation puzzle (Gourinchas and Jeanne (2013)) reflects the difference in the magnitudes rather than the direction of net capital flows predicted by the one sector model and those observed in the data. We show that the introduction of a non-tradable sector can reconcile much of the differences between the predictions of the model and the empirical observations, and account for as much as 54% of the allocation puzzle. Complementarity in consumption between tradable and non-tradable goods, as well as structural change, as measured by the movement of labor from agriculture and manufactures (tradable) to services (non-tradable), play a central role in accounting for the relatively low magnitudes of capital flows observed in the data.

Keywords: allocation puzzle, capital flows, savings wedge, structural change;

JEL Codes: F21, F43, O41;

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†Corresponding author; University of Western Ontario, Social Science Centre, 4033, London, Ontario, Canada N6A 6K4; e-mail: jacob.short@uwo.ca; phone: +1-519-661-2111 ext. 85302; fax: +1-519-661-3666
1 Introduction

The international flows of capital have long been a focal point of open economy macroeconomics. However, the canonical one-sector neoclassical growth model, often used to study growth and dynamics of a closed economy, when applied to open economies produced several irregularities with observations on international capital flows in the post war period. Most recently, Gourinchas and Jeanne (2013) argued the pattern of long-run capital flows across developing countries has been the opposite of theoretical predictions, as the fastest growing countries experienced capital outflows, while the slowest growing countries experienced capital inflows (the “allocation puzzle”).

We argue that the allocation puzzle is primarily the large discrepancy in the magnitudes between the predicted and observed capital flows. For the period 1980 to 2000, the one-sector model predicts cumulative net capital inflows (relative to initial GDP) which range from $-13.5$ to $11.4$ compared to the much lower observed magnitudes which range from $-6.1$ to $1.5$. Furthermore, we argue that explaining the relatively low magnitudes is central to accounting for the allocation puzzle, and that the most common interpretation of the allocation puzzle - the correlation between capital inflows and productivity growth - is less important.

First, we confirm that the Gourinchas and Jeanne (2013) finding of the negative relationship between net capital inflows and productivity growth is highly sensitive to the inclusion of public flows (see e.g. Aguiar and Amador (2011)), particularly foreign aid. We also show it is driven by a few outliers. Second, we analyze in detail the savings wedge that Gourinchas and Jeanne (2013) introduced and calibrated, so that the one-sector model would match the observed net capital flows. We argue that the strong negative correlation between productivity growth and the calibrated savings wedge ($-0.97$) is driven by the large discrep-
ancy between the *magnitudes* of theoretical and observed capital flows, rather than by the discrepancy between *direction* of the theoretical and observed flows. That is, the allocation puzzle, characterized by the negative correlation of savings wedge and productivity growth, is still present even if the correlation between capital inflows and productivity growth is positive, consistent with the predictions of the one-sector model.

Focusing on the small size of net flows, we show that introducing a non-traded sector, as well as accounting for structural change in an otherwise standard small open economy model, drastically reduces predicted capital flows. Specifically, the sum of squared errors between the empirically observed cumulative capital inflows (relative to initial GDP), and those predicted by a model, drops by 61% when we introduce a non-traded sector and account for structural change. This improvement over the one-sector model’s predictions is the most striking for the fastest and the slowest growing countries. As a result, the model with the non-traded sector accounts for 54% of the cross-country variation in the savings wedge in the sub-sample of countries studied by Gourinchas and Jeanne (2013) (31% world-wide).

The result is driven by two factors. First, following much of the literature (Duernecker and Herrendorf (2015), Mendoza (1995), Stockman and Tesar (1995), Kehoe and Ruhl (2009), Herrendorf et al. (2013b)), we assume that traded and non-traded goods are complements in consumption. The complementarity limits the marginal utility from importation of tradable goods, and therefore, limits the consumption smoothing motives which are very strong in the one-sector model. Second, accounting for structural change matters, because it affects the production of non-tradeable goods in the economy, thus affecting marginal utility from consumption of tradables.

To see why accounting for small size of capital flows goes a long way in accounting for the cross-country variation in the savings wedge, consider the following example: The one sector model predicts capital inflows of 11 times initial GDP for a fast growing country, such as
Cyprus, compared to the relatively small observed capital inflows of 1.54 times initial GDP. Therefore, a substantial savings subsidy (i.e., a negative savings wedge of $-3.12$ percent), is required to reconcile the considerable gap in the size of capital flows. This drives the high negative correlation between the savings wedge and productivity catch-up found by Gourinchas and Jeanne (2013). The two sector model predicts capital inflows of 2.46 times initial GDP for Cyprus, which accounts for 90% of the discrepancy in the capital flows of the one sector model and data. The savings wedge required for the one sector model to match the capital flows the two sector model predicts for Cyprus is $-2.80$ percent. Thus, explaining nearly all of the negative savings wedge.

Understanding why and the degree to which the standard model fails to have consistent predictions for goods/capital flows is important for understanding whether there is a role and/or the impact of potential policy which could improve the efficiency of outcomes and increase global income. Many important studies have been motivated by the understanding the reasons for the inconsistencies and apparent low degree of international capital mobility (Caselli (2007), Baxter and Crucini (1993) are among many). Our paper suggests that the tempered reallocation of labor from the tradable to the non-tradable sector is a central factor in the small size of capital flows.

Our paper is related to numerous studies that try to account for the puzzles in international capital flows which can be broadly categorized as either: (i) relying on fundamentals, or (ii) relying on capital markets imperfections. The first group focuses on problems such as: omitted factors of production, government policies, different productivities across sectors, or difference in sizes of countries (see e.g. Causa et al. (2006), Hsieh and Klenow (2007), Baxter and Crucini (1993)). The latter group explored problems of sovereign risk (Reinhart and Rogoff (2004)), asymmetric information (Portes and Rey (2005)), poor institutional quality (Alfaro et al. (2008)), or incomplete markets (Bai and Zhang (2010)). Our study adds quan-
quantitatively important pieces to the story based on fundamentals, complementarity between tradable and non-tradable goods, and market imperfections, the slow reallocation of labor from the tradable to non-tradable sector. We are closely related to Causa et al. (2006), who argue that the existence of non-traded sector helps to account for the Lucas Puzzle. We show that the introduction of a non-traded sector, along with accounting for structural change, drastically reduce the size of net capital flows and accounts for much of the Allocation Puzzle. Most importantly, we do not rely on any imperfections in international capital markets, thus the marginal products of capital in our model are equated across all countries (Caselli (2007) provide a convincing argument that they are also equated in the data).

Our paper is one of many on capital flows to fast-growing, emerging economies. In the last 10 years, the major focus in the literature has been on the current account surpluses of East Asian countries, and the role of financial markets imperfections, or government policies driving them. This idea was explored in Song et al. (2011), Mendoza et al. (2009), Buera and Shin (2009), Carroll and Jeanne (2009), Caballero et al. (2008), and Michaud and Rothert (2014). We differ along two dimensions: First, our paper does not rely on imperfections in international capital markets. In fact, we present a fully deterministic, laissez-faire economy without externalities, and measure the extent to which the existence of a non-traded sector affects international capital flows. Second, we do not focus on a few (albeit important) economies, but instead account for a more general pattern observed in a wider set of countries.

We are also closely related to studies that address the robustness of the Allocation Puzzle. Aguiar and Amador (2011) point out the negative correlation between capital inflows and productivity growth is driven by public flows (i.e. the allocation of private flows is consistent with the standard model). Reinhardt (2010) also argues that the direction of FDI flows is consistent with standard economic theory. We focus on the result in Gourinchas and
Jeanne (2013) that is more robust: the negative correlation between calibrated savings wedge and productivity growth, and we show that a model without any frictions in international borrowing and lending accounts for a large portion of the savings wedges\textsuperscript{1}.

The rest of the paper is structured as follows: In Section 2, we explain the importance of the magnitudes of capital flows in generating the allocation puzzle of Gourinchas and Jeanne (2013). In addition, we provide evidence on the structural change that rapidly growing countries undergo, and discuss how it may impact capital flows. Section 3 describes the model that we use for our quantitative analysis. Section 4 discusses the results of the benchmark model and provides some sensitivity analysis. Lastly, section 5 summarize our main findings and suggest paths for further research.

2 Empirical Motivation

We start by documenting empirical regularities on international capital flows and structural change. First, we compare the magnitudes of net capital flows observed in the data and compare them to those predicted by the standard one-sector model, and argue that the large discrepancy between those magnitudes is what drives the most robust result in the allocation puzzle of Gourinchas and Jeanne (2013). Second, we document the empirical regularities on reallocation of labor towards a non-traded sector among fast growing economies, and discuss the implications this would have for the magnitudes of capital flows.

Data sources and construction of empirical statistics Following Gourinchas and Jeanne (2013), the data on National Income and Product Accounts is from Penn World Tables, version 6.3. Current Account data used to compute cumulative capital flows is from

\textsuperscript{1}In a related study, Rothert (2015) analyzes a small open economy model with exogenous limits on international borrowing and lending.
the Balance of Payments of the IMF. The value of the initial next external debt is taken from Lane and Milesi-Ferretti (2007). In Section 2.1 we limit our analysis only to countries studied by Gourinchas and Jeanne (2013). We also consider the same time period for each country as they do (1980-2000, for most countries). The main statistic of interest is the ratio of the cumulative capital inflows to initial GDP. We follow Gourinchas and Jeanne (2013) exactly and construct this statistic as the present value of the sum of the negative of the current account, PPP-adjusted.²

In Section 2.1, we expand our analysis to all countries for which we can observe employment shares in agriculture, manufacturing and services. Unfortunately, the data on employment shares does not allow us to decompose the categories further, therefore, we assign agriculture and manufacturing to the tradable sector and services to the non-tradable sector. This leaves us with 32 countries that overlap with the sample in Gourinchas and Jeanne (2013), and additional 22 (mostly more developed) for the total of 54 countries. The data is from the World Bank’s World Development Indicators.

### 2.1 Magnitudes of Capital Flows

The standard one-sector growth model vastly over-predicts the magnitude net capital flows. Over the time period 1980-2000, the cumulative sum of net capital inflows (relative to a country’s initial GDP) varied between -2.5 and 2 (see the Y-axis of Figure 2 on page 11). The range for the same statistic implied by a one-sector model with total factor productivity path taken from the data, is about 10 times larger, and varies between -19 and 11 (see second column in Table 2.1.2).

The primary motives driving capital flows in a standard model where growth is driven

²See Appendix B in Gourinchas and Jeanne (2013).
³As in Gervais and Jensen (2013) which uses detailed data from the United States, or Duarte and Restuccia (2015) which uses cross-country input-output and expenditure data, but not employment.
by productivity are well known and twofold: First, rising TFP implies higher marginal 
product of capital in the future, which increases today’s investment expenditures (investment 
margin). Second, rising TFP implies higher income in the future. Under usual assumptions 
where consumption smoothing is desirable, rising income will imply more borrowing and 
less saving by the households (saving margin). Therefore, rising income must imply capital 
inflows.

2.1.1 Matching empirical magnitudes in the 1-sector model - wedges

Gourinchas and Jeanne (2013) decompose the contributions of the investment and savings 
margins to the allocation puzzle by augmenting the deterministic small open economy one-
sector growth model with two exogenous, country-specific distortions: (i) a capital wedge, 
$\tau_k$, and (ii) a saving wedge, $\tau_s$. With the introduction of these wedges, the budget constraint 
of a representative household in their model becomes:

$$C_t + K_{t+1} = (1 - \tau_s)(R_t(1 - \tau_k)K_t - R^* D_t) + D_{t+1} + N_t(w_t + z_t)$$

The capital wedge, $\tau_k$ acts like a tax on investment - the gross return on capital no longer 
equals the world interest rate: $R^* = R_t(1 - \tau_k)$, where $R_t = MPK_t + 1 - \delta$. The savings 
wedge acts like a tax on savings. In the budget constraint above $w_t$ is wage (per household), 
z_t is a lump-sum tax/transfer (per household), and $N_t$ is the number of households in the 
economy. For each country, the pair $(\tau_k, \tau_s)$ is calibrated to match: (i) the average investment/GDP ratio, and (ii) the cumulative capital inflows in years 1980-2000. The analysis 
of the augmented model with wedges suggests the savings wedge is crucial in understanding 
the “allocation puzzle”. Figure 1 plots the calibrated values of $\tau_s$ against the cumulative 

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41980-2000 is the time frame for vast majority of the countries they analyze. A few countries have a start 
year as late as 1985, and the end year as early as 1995.
catch-up of total factor productivity relative to the United States in each country.\footnote{The cumulative catch-up is defined as: $\pi = \frac{A_{2000}}{A_{1980}} - 1$} The result is striking: the correlation is -0.97\footnote{Due to the use of PWT 6.3 rather than PWT 6.1, this correlation differs slightly from Gourinchas and Jeanne (2013).}.

![Figure 1: Savings Wedge and Productivity Catch-Up](image)

### 2.1.2 Savings wedge is driven by the size of net flows

The strong correlation found by Gourinchas and Jeanne (2013) is driven by the large magnitudes of capital flows predicted by the model. For example, table 2.1.2 compares predictions of capital flows in the one-sector model, measured as cumulative capital inflows relative to initial GDP, to the observed capital flows in the data, alongside the estimated savings wedge for several fast and slow growing countries. Cyprus and Venezuela are included in table 2.1.2 along with Korea, China and Jordan to emphasize that the direction of observed capital flows is not important. Korea, China, and Jordan have observed capital flows which are counter to the predictions of the one-sector model, however, the savings wedges among fast growing
countries (Korea, China, and Cyprus) and slow growing countries (Jordan and Venezuela) are similar.

<table>
<thead>
<tr>
<th></th>
<th>Capital Inflows</th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Growth Data</td>
<td>One-Sector Model</td>
<td>(\tau_s)</td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td>6.31 -0.66</td>
<td>11.2</td>
<td>-3.57</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>7.66 -0.73</td>
<td>10.1</td>
<td>-3.47</td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td>3.87 1.54</td>
<td>11.4</td>
<td>-3.12</td>
<td></td>
</tr>
<tr>
<td>Jordan</td>
<td>-1.59 0.34</td>
<td>-19.9</td>
<td>3.61</td>
<td></td>
</tr>
<tr>
<td>Venezuela</td>
<td>-0.76 -0.42</td>
<td>-11.3</td>
<td>3.51</td>
<td></td>
</tr>
</tbody>
</table>

For fast growing countries, such as Korea, China and Cyprus, the predicted capital flows from the one sector model range from 10.1 times initial GDP to 11.4 times initial GDP\(^7\). However, the observed capital flows are near zero, relatively speaking, ranging from -0.66 to 1.54 times initial GDP. The savings wedges required for the standard model to match the relatively low capital flows range from -3.57 to -3.12 percent. That is, these countries require substantial negative savings wedges to lower the predicted capital inflows. In Cyprus’ case, the observed capital inflows are positive (consistent with the standard model), however, the magnitude is lower than the predicted flows and requires a large negative savings wedge. For slow growing countries, such as Jordan, the model predicts capital outflows of near 20 times initial GDP, whereas the observed capital inflows are only 0.34, implying a significant positive savings wedge. Comparing Cyprus and Venezuela suggest that it is not the direction of the predicted and observed capital flows which are important, but the deviation in their magnitudes.

\(^7\)Predicted capital flows are those from the one sector model with the capital wedge. These are the relevant capital flows which need to be accounted for by the savings wedge.
To show that the allocation puzzle depends on the stark difference in the magnitudes between predicted and observed capital flows, we calibrate the investment and savings wedges in the one sector model using only private capital flows. That is, we remove the government and foreign aid components of the capital flows in the data. As figure 2 shows, the correlation between capital inflows and growth is 0.163, suggesting that the directions may not be at odds with theory. However, the magnitudes of the private flows remain relatively small compared to the predicted flows. We re-calibrate the savings wedge to match the private capital flows and find that the correlation between productivity catch-up and the savings wedge is unchanged at −0.97. Figure 3 shows both the calibrated savings wedge using the private and total capital inflows. The private flows still reveal a significant discrepancy between the observed and theoretical magnitudes of capital flows which results in the negative correlation between productivity catch-up and the savings wedge. For example, Botswana, a country catching up, has private capital inflows of 1.16 of initial GDP (compared to total flows of −2.53). However, there is a required savings wedge of −1.87 percent to reconcile the still much larger predicted flows with the private inflows data. The correlation of the calibrated savings wedges using the private flows suggests that there is still a considerable puzzle to be solved, although not pertaining to the correlation of the direction of flows with growth, but regarding the magnitudes.

Lastly, we consider hypothetical capital flows for which the direction (sign) of the capital flows are consistent with the one sector model, but the magnitudes (absolute value) of the flows are the same as the data. That is, for countries with positive productivity catch-up and negative capital inflows (i.e. outflows), we assign them hypothetical capital inflows equal to the absolute value of their observed capital inflows. Similarly, for countries falling behind

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8The sample of countries is reduced to 57 for which we can observe the private capital flows.
9Essentially, we confirm the argument made in Aguiar and Amador (2011).
with positive capital inflows, we assign them capital inflows equal to the negative value of their observed capital inflows (i.e. outflows). Figure 4 shows both the actual and hypothetical capital inflows versus the productivity catch-up. By construction, these hypothetical capital inflows...
inflows have a strong positive correlation with productivity catch-up (0.67). Yet, even with the strong positive correlation between productivity catch-up and net capital inflows, the correlation of the calibrated savings wedges with productivity catch-up is nearly unchanged: −0.96 (Figure 5), emphasizing the central role of the magnitudes in generating the allocation puzzle. Once again, consider the example of Korea which experienced rapid growth, but had capital inflows of −0.66 (and a calibrated savings wedge of −3.57). The hypothetical inflows for Korea of 0.66 times initial GDP, although positive, are still far lower than the predicted flows of 11 times initial GDP. Therefore, the calibrated savings wedge using the hypothetical flows is −2.92, which results in the consistently high negative correlation with productivity catch-up. Thus, the allocation puzzle is strongly related to the difference in the magnitudes of the predicted and actual capital inflows, rather than their correlation with productivity growth.

![Figure 4: Hypothetical Capital Inflows and Productivity Catch-Up](image)
2.2 Capital flows and the non-traded sector

The non-traded sector and structural change can affect a country’s capital flows through both the savings and investment margins. First, if tradables and non-tradables are complements in consumption, the elasticity of the households’ savings supply (of tradable goods) with respect to the interest rate is reduced (the savings supply curve becomes steeper)\(^\text{10}\). The non-tradable characteristic limits the extent to which the supply of the non-tradable good can be increased. With complementarity between tradable and non-tradeable goods, the marginal utility from importing the tradable good will be limited, thus reducing the consumption smoothing motive. Indeed, if complementarity is high enough, future increases in the relative output of non-tradables, via structural change, can even induce higher savings, as consumers shift consumption of tradable goods towards future periods, in which non-tradables are in greater abundance and the marginal utility of tradable goods is higher. This channel is

\(^{10}\text{Herrendorf et al. (2013b) provide evidence from U.S. data which supports preferences close to Leontief in agriculture, manufactures and services; Stockman and Tesar (1995) estimate the elasticity of substitution between traded and non-traded goods to be 0.44; Mendoza (1995) estimates it to be 0.74.}\)
amplified by the movement of labor out of the tradable and towards the non-tradable sector reduces the marginal product of capital in the tradable sector. Such reallocation of a factor of production complementary with capital lowers the investment demand, resulting in smaller capital inflows. As a result of these two influences, for a given level of the world interest rate (relative to the country’s autarky rate), the net flows are reduced.

The non-traded sector in shaping capital flows can be particularly large in growing countries, because its share in GDP is expanding. The structural change literature documents the large increase in the fraction of labor force employed in the service sector in growing economies (Baumol (1967), Ngai and Pissarides (2007), Kongsamut et al. (2001))\textsuperscript{11}. The data from our sample of countries exhibits this shift of labor towards the service sector in both developed and developing countries. The left panel of figure 6 presents the cross-country correlation between the share of employment in the non-tradable and the level of GDP per capita for our sample in 2000. The correlation for the sample is 0.71. We also find a strong positive correlation (0.63) between the level of GDP per capita and the output of services as a share of GDP in 2000 (the right panel of figure 6). This evidence suggest that as countries develop, the relative size of their service sector increases.

If we examine the correlation between the average change in the fraction of labor employed in the non-tradable sector and average real GDP per capita growth between 1980 and 2000, we find a correlation of 0.22 (see table 1 and figure 7). Furthermore, comparing the fastest growing countries (top 20%) in our sample to the slowest (bottom 20%), we see that the fraction of labor in the non-tradeable sector grew at nearly twice the rate over the period 1980 to 2000 in the fastest growing countries. The top 20% of countries grew at an average rate of 4.9 percent and the fraction of labor in the non-tradable sector grew at an average

\textsuperscript{11}For the United States, between 1950 and 2000, this fraction has increased from 57 to 75 percent (Lee and Wolpin (2010)).
rate of 1.9 percent. By comparison, the slowest growing countries’ average growth in real GDP was −0.4 percent and the fraction of labor employed in the non-tradable sector, at only 1 percent, rose at nearly half that of fast growing countries (table 1). Table 1 indicates that countries with faster growth experienced a larger increase in the fraction of labor employed in the non-tradable sector. Similarly, if we look at the productivity catch-up and changes in employment shares, we find a correlation of .31 (the right panel of figure 7) and that the change in employment in the non-traded sector of the top 20% is twice that of the bottom
Table 1: RGDP growth and labor reallocation

<table>
<thead>
<tr>
<th></th>
<th>( g - 1 )</th>
<th>( \ell_{2000}^N/\ell_{1980}^N - 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom 20</td>
<td>-0.004</td>
<td>0.010</td>
</tr>
<tr>
<td>Top 20</td>
<td>0.049</td>
<td>0.019</td>
</tr>
<tr>
<td>( \rho(\Delta\ell^N, g) )</td>
<td>0.292</td>
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</tr>
</tbody>
</table>

20% (2.1% and 1.1%, respectively).

There are two key empirical regularities that shape our analysis. First, the cross-country variation in the savings wedge appears to be largely driven by the discrepancy between net size of capital flows in the data and in the one-sector model. Second, productivity growth is correlated with the reallocation of resources towards the non-traded sector. In the next section we will evaluate the quantitative impact of such reallocation on the size of capital flows in a small open economy.

3 Model

We include a non-traded sector in an otherwise standard model of a small open economy. Both tradable and non-traded sectors use labor as inputs into production, and total factor productivity is sector specific. Capital is only used in the production of the tradable good.\(^{12}\) The technologies for producing output in each sector are the following:

\[
Y_t^N = A_t^N \left( N_t \ell_t^N \right)^{1-\alpha}
\]

\[
Y_t^T = A_t^T K_t^\alpha \left( N_t \ell_t^T \right)^{1-\alpha},
\]

\(^{12}\)Including capital goods used in, and produced by the non-traded sector would affect the quantitative results in a direction that is not clear a-priori. If investment is only produced by the traded sector, but capital is used also in the non-traded sector, our results would be weakened. However, if the capital that is used in the traded sector requires capital goods produced by the non-traded sector (e.g. construction), our results would be strengthened. We abstract from these issues to keep the analysis clearer.
where $N_t$ is the size of labor force, $\ell^N$ is fraction of labor force employed in the non-tradeable sector, $\ell^T_t = 1 - \ell^N_t$ is the fraction of the labor force employed in the tradeable sector, $K$ is the aggregate capital stock, and $A^T$ and $A^N$ are sector-specific total factor productivities. Along the balanced growth path, both $A^N_t$ and $A^T_t$ will grow at a constant rate $g^*$, which is the growth rate of the world’s technology frontier. Factor markets are assumed to be perfectly competitive and factors are paid the value of their marginal product.

**Aggregate consumption, investment, and resource constraints** The non-tradable good is used for consumption purposes, and the tradable good is used for both consumption and investment.

The aggregate consumption good is a constant elasticity of substitution (CES) composite of tradables and non-tradables:

$$C_t = \left[ \omega_c C^N_t \frac{\eta - 1}{\eta} + (1 - \omega_c) C^T_t \frac{\eta - 1}{\eta} \right]^{\frac{\eta}{\eta - 1}}, \quad \omega_c \in (0, 1), \eta > 0 \quad (3.1)$$

where $\eta$ denotes the elasticity of substitution between tradables and non-tradables ($\eta < 1$ implies tradeable and non-tradeable consumption to be gross complements). The parameter $\omega_c$ determines the expenditure share of non-tradable goods in aggregate consumption.

The aggregate capital stock evolves according to the following law of motion:

$$K_{t+1} = (1 - \delta)K_t + X_t, \quad (3.2)$$

where $X_t$ is the aggregate investment. The output of tradable goods is divided into consumption of tradables ($C^T_t$), investment ($X_t$), and the trade balance ($NX_t$):

$$C^T_t + X_t + NX_t = Y^T_t \quad (3.3)$$
The output of non-tradable goods is only used for consumption:

\[ C_t^N = Y_t^N \]  \hspace{1cm} (3.4)

Preferences and household’s budget constraint  Following Gourinchas and Jeanne (2013), a stand-in household has preferences over the aggregate consumption per-capita of the following form:

\[ \sum_t \beta_t^{c_t^{1-\sigma}} N_t, \]  \hspace{1cm} (3.5)

where \( c_t = C_t/N_t \) is aggregate consumption per capita. The household owns the capital stock and inelastically supplies one unit of labor each period. The household is able to borrow and lend with the rest of the world at a fixed gross real (in units of the tradable good) interest rate \( R^* \). The price of tradables is normalized to 1 and the price of non-tradables is denoted \( p^N \). The household’s sequential budget constraint (in per-capita terms) is:

\[ p_t^N c_t^N + c_t^T + x_t + R^* d_t \leq w_t (L_t^T + L_t^N) + r_t k_t + d_{t+1} (1 + n_t) + \pi_t + z_t \]  \hspace{1cm} (3.6)

where \( n_t = N_{t+1}/N_t - 1 \) is the growth rate of the population in period \( t \), \( \pi_t \) is profit of firms in the two sectors, and \( z_t \) is a lump-sum transfer/tax from the government.\(^{13}\) The capital law of motion (in per-capita terms) is:

\[ (1 + n_t) k_{t+1} \leq (1 - \delta) k_t + x_t \]  \hspace{1cm} (3.7)

\(^{13}\)In equilibrium only firms in the non-tradeable sector earn profits.
The initial capital stock \( k_0 \) and debt \( d_0 \) are given. Lastly, the household’s borrowing is limited by the standard no-Ponzi condition:

\[
\sum_{t=\tau}^{\infty} \frac{d_{t+1}(1 + n_t) - R^* d_t}{R^*^{t-\tau}} \leq 0
\]

**Structural change: labor allocation wedge** In Section 2.2 we emphasized the empirical relationship between productivity growth and reallocation of resources towards a non-traded sector. Our hypothesis is that, such a reallocation can have important implications for international capital flows, as it affects (1) productivity of capital in the tradeable sector, and (2) the supply of non-traded good, complementary in consumption. To evaluate their quantitative importance, we incorporate these mechanisms in our analysis. In section 4.3.2 we evaluate capital flows in the absence of structural change.

We do not attempt to understand the sources of structural change. Instead, taking as given the observed reallocation of labor towards the non-traded sector, we quantify that reallocation’s quantitative impact on capital flows. To this end, we generate structural change in our model, by adding a time-varying labor allocation wedge, in the spirit of Chari et al. (2007)\(^{14}\). The wedge is introduced as an additional cost of employing labor in the tradeable sector. The profit maximization in the tradeable sector is thus:

\[
\max A^T_t k^\alpha^T_t (N_t \ell^T_t)^{1-\alpha^T_t} - w_t \ell^T_t - \tau^T_t w_t \ell^T_t,
\]

while in the non-traded sector it is:

\[
\max p^N_t A^N_t (N_t \ell^N_t)^{1-\alpha^N_t} - w_t \ell^N_t
\]

\(^{14}\)We use the term labor allocation wedge, so as not to confuse it with a wedge between intra-temporal condition equating marginal product of labor with marginal rate of substitution between consumption and leisure, usually referred to as the labor wedge (leisure does not enter the utility function in our model.)
A positive value of $\tau^\ell_t$ may indicate a number of things. First, it is isomorphic to a tax on employment in tradeable sector. Second, it can be a manifestation of various policies that either hinder employment in the tradeable sector, or encourage employment in the non-tradeable sector. Finally, it can be a manifestation of either market imperfections or “deep” frictions that make hiring labor in the tradeable sector disproportionately more costly than in the non-traded sector.

In order to focus only on the intra-temporal distortion introduced by the labor allocation wedge, we follow Chari et al. (2007), and model $\tau^\ell$ as a tax. The proceeds are rebated in a lump-sum fashion to households as a transfer payments $z_t$. The government budget constraint, in per capita terms, is:

$$z_t = \tau^\ell_t w_t \ell^T_t$$

**Labor market clearing** Since leisure does not enter the utility function, the share of employment in the traded and the non-traded sector must equal 1:

$$\ell^T_t + \ell^N_t = 1$$

**Rest of the World** Since the total factor productivity in the rest of the world grows at a constant rate $g^*$, and preferences are given by (3.5), the world gross interest rate is:

$$R^* = \frac{(1 + g^*)^\sigma}{\beta}$$

A country in the model is characterized by its initial per-capita capital stock $k_0$, initial per-capita stock of external debt $d_0$, sequences of TFP $\{A^i_t\}_{t=0}^\infty$ for each sector $i \in \{T, N\}$, and the sequence of labor allocation wedges $\{\tau^\ell_t\}_{t=0}^\infty$. In the quantitative analysis, we will have to calibrate each of these characteristics for each country.
3.1 Characterization - prices and real GDP

Our calibration targets the average change in the real exchange rate, and the average change in real GDP. Since these two variables can be affected by movements in the price of non-traded goods, we need to characterize the determination of prices in our model.

We define the real exchange rate as the price of domestic aggregate consumption divided by the price of aggregate consumption in the rest of the world, \( p^* \):

\[
rer \equiv \frac{p}{p^*}.
\]

Since the rest of the world is assumed to be in a balanced growth path, \( p^* \) will be constant. Therefore, the change in real exchange rate is:

\[
\frac{\Delta rer}{rer} = \frac{\Delta p}{p}.
\] (3.8)

Given the relative price of a non-tradable good \( p^N \), the price of aggregate consumption is the minimum unit expenditure:

\[
p = \min_{c^N, c^T} p^N c^N + c^T
\]

subject to:

\[
\left[ \omega_c C^N \eta + (1 - \omega_c) \omega_c C^T \eta \right]^\frac{\eta - 1}{\eta} = 1
\]

The solution to the above problem yields the following expression for the price of aggregate consumption good:

\[
p = \left[ \omega_c^\eta + (1 - \omega_c)^\eta \cdot p^{N1-\eta} \right]^{\frac{1}{1-\eta}}
\]

The price of non-traded goods is also used in the computation of real GDP, which is given
by:

\[ GDP_t = Y_t^T + p_t^N \cdot Y_t^N. \] (3.9)

4 Empirical Analysis

We solve our model over a finite time horizon, \([0, T]\), with a sample of 54 economies, 32 of which overlap with the economies studied in Gourinchas and Jeanne (2013). The sample is restricted due to the lack of observations on changes in employment shares by sectors. We include all of the countries for which we observe changes in the employment shares in agriculture, manufactures and services. Following Gourinchas and Jeanne (2013), we focus on the period 1980 to 2000, or the longest possible period available for a given country within that time frame.

We assume that between \(t = 0\) and \(t = T\) the total factor productivity in each sector grows at a country and sector specific rate: \(A_{t+1}^N = A_t^N \cdot (1 + g^N)\) and \(A_{t+1}^T = A_t^T \cdot (1 + g^T)\), for \(t = 0, 1, 2, ..., T - 1\). For \(t \geq T\), both sectors grow at the constant rate \(g^* = 0.017\) which equals the average TFP growth in the United States between 1980 and 2000.

The model is solved using Newton-Raphson algorithm. We derive equations that characterize the equilibrium path of the economy. We impose the economy reaches the balanced growth path at \(t = T + 60\).\(^\text{15}\) Since we set \(T = 20\), we solve the system of \(2 \times 80\) equations.

4.1 Parameter values

Table 2 presents details of our parameter choices. The elasticity of substitution between tradable and non-tradable consumption goods (\(\eta\)) is set to 0.5, following Kehoe and Ruhl

\(^{15}\text{We verified 60 periods were enough for each model economy to reach its balanced growth path.}\)
Following Gourinchas and Jeanne (2013) we set the inter-temporal elasticity, $\sigma$, to one, the capital intensity of both sectors to 0.30, and the depreciation to 0.06. The non-tradable share in consumption, $\omega_c$, is set to 0.42, following Corsetti et al. (2008). A period in the model is assumed to be one year and the discount factor is $\beta = 0.96$. Finally, the world gross interest rate is set to $R^* = (1 + g^*)\gamma/\beta$, to ensure the existence of a balanced growth path.

Table 2: Model parametrization

<table>
<thead>
<tr>
<th>Parameter description</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elasticity of substitution in aggregate consumption</td>
<td>$\eta = 0.50$</td>
<td>KR</td>
</tr>
<tr>
<td>Intertemporal elasticity of substitution</td>
<td>$\sigma = 1.00$</td>
<td>GJ</td>
</tr>
<tr>
<td>Non-tradables share in consumption</td>
<td>$\omega_c = 0.42$</td>
<td>CDL</td>
</tr>
<tr>
<td>Capital intensity in tradables</td>
<td>$\alpha_T = 0.30$</td>
<td>GJ</td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta = 0.96$</td>
<td>GJ</td>
</tr>
<tr>
<td>Growth rate of the world frontier</td>
<td>$g^* = 0.0175$</td>
<td>GJ</td>
</tr>
<tr>
<td>Capital depreciation</td>
<td>$\delta = 0.06$</td>
<td>GJ</td>
</tr>
</tbody>
</table>


4.1.1 Calibration

The country-specific parameters and initial conditions that we calibrate are: population growth $n$, initial capital per worker $k_0$, initial debt $d_0$, two sectoral growth rates of TFPs, $g^T$ and $g^N$, and the time path of the labor allocation wedge $(\tau^\ell_t)_{t=1}^T$.

Population growth and initial conditions  The population growth $n$ for each country is set to the average annual growth rate of working age population from the World Development Indicators. The initial values of TFPs are normalized to 1. The initial debt $d_0$, capital stock $k_0$, and initial value of the labor allocation wedge $\tau^\ell_1$ are jointly calibrated by assuming that

---

There is broad support for complementarity in consumption, see Stockman and Tesar (1995), Herrendorf et al. (2013b), and Mendoza (1991)
initially the economy is on the balanced growth path, with the ratio of net foreign asset position to GDP the same as in the initial year in the data. The initial fraction of labor employed in the non-traded sector is matched with the fraction of labor employed in services. In other words, we use two data targets, $\frac{NFA}{GDP}$ and $\ell_1^N$, and solve for the initial values of $d_0$ and $\tau_0^t$, with $k_0$ being an endogenous steady-state variable.

**Labor Allocation Wedge** Structural change plays a central role in our analysis. To match the long-term movement of labor between the two sectors, we require the fraction of labor employed in the non-tradeable sector in the first and in the last period be the same as in the data. During the transition, we assume a linear movement between the two sectors, i.e.: $\ell^N_t = \ell^N_1 + (t - 1) \cdot \frac{\ell^N_T - \ell^N_1}{T-1}$ for $1 < t < T$. The main reason behind this assumption (as opposed to taking the sequence of labor allocations straight from the data) is that for many countries we lack the complete time series for the allocation of labor across sectors (i.e. there are gaps in the data). Therefore, we simply take the earliest and the latest available date. Since we focus on long-run movements of factors of production, we believe this to be a rather innocuous assumption.

To match the observed structural change, the time path for the labor allocation wedge, $(\tau^t_1)_{t=1}^\infty$, is calibrated by setting the nominal wages in the two sectors equal to each other:

$$
(1 - \alpha^T) A^T_t k^T_t (\ell^T_t)^{-\alpha^T} = (1 + \tau^t) p^N_t (1 - \alpha^N) A^N_t (\ell^N_t)^{-\alpha^N}
$$

By construction, the labor allocation wedge that satisfies (4.1) generates long-run reallocation of labor identical with the data. This reallocation could be modeled using labor adjustment costs, as in Kehoe and Ruhl (2009), who introduce quadratic labor adjustment costs to match labor flows between tradable and non-tradable sectors for Mexico from 1994 to 1998. Alternatively, additional assumptions on technology (e.g. more complicated input-output
structure, as in Kehoe et al. (2013)) and/or preferences, such as non-homothetic preferences commonly used in the structural change literature (e.g. Herrendorf et al. (2013b)), could be used to model the structural change. However, the introduction of the labor allocation wedge allows us to match the observed structural change in a parsimonious way while remaining relatively close to the assumptions of the canonical one-sector model. Similar to Ngai and Pissarides (2007) our calibration implies differential productivity growth for the first $T$ periods, which generates a structural shift in the labor allocation. However, unlike Ngai and Pissarides (2007) our economy is open, therefore, the economy can substitute domestic production of tradable goods with foreign goods. As a result, the movement of labor towards the non-tradable occurs much faster than the observed flows. We discuss these counter factual labor flows in greater detail in Section 4.3.2.

**Total Factor Productivities** Two exogenous variables that are crucial for the return to capital in the model are the paths of productivity in each sector. Initial values of TFPs are normalized to 1. The growth rates of sectoral TFPs during the transition period are jointly calibrated to match two moments in the data: (i) average growth rate of real GDP per capita and (ii) average change in the real exchange rate. In the calibration we solve the following problem (for each country):

$$\min_{g^T,g^N} \left( \sqrt{T} \frac{\text{GDP}_{T \text{model}}}{\text{GDP}_{T \text{model}}} - \sqrt{T} \frac{\text{GDP}_{T \text{data}}}{\text{GDP}_{T \text{data}}} - 1 \right)^2 + \left( \sqrt{T} \frac{\text{RER}_{T \text{model}}}{\text{RER}_{T \text{model}}} - \sqrt{T} \frac{\text{RER}_{T \text{data}}}{\text{RER}_{T \text{data}}} - 1 \right)^2$$

(4.2)

where $\sqrt{T} \frac{\text{GDP}_{T \text{model}}}{\text{GDP}_{T \text{model}}} - 1$ is the average annual growth rate of real GDP between $t = 1$ and $t = T$, and $\sqrt{T} \frac{\text{RER}_{T \text{model}}}{\text{RER}_{T \text{model}}} - 1$ is the average annual change in real exchange rate, where an increase in the real exchange rate corresponds to real appreciation. Given the sequence of labor allocations (which ensures the structural change in the model is the same as in the data), both targets
in the model are functions of \((g^T, g^N)\) only.

Figures 8 and 9 show the fit of the model for the average change in the real exchange rate and the average growth of real GDP per capita, respectively. Overall, the model fits the changes in the real exchange rate and average growth of real GDP per capita quite well. Only three countries—Iran, India, and Poland—are substantial outliers, with very large changes in the real exchange rate in the data (−12.8%, 7.2%, and 10% respectively).

![Figure 8: Model Fit on Real Exchange Rate](image)

The calibrated TFP growth rates for tradable and non-tradable sectors are consistent with findings that the productivity in the tradable sector tends to increase more than the productivity in the non-tradable sector (Herrendorf et al. (2013a), Ngai and Pissarides (2007), Duernecker and Herrendorf (2015), Kehoe et al. (2013)). Figure 10 shows the relationship between the calibrated relative TFP growths and average real GDP per capita growth in the model. TFP growth in tradables tends to be higher than non-tradables, and the difference is greater for higher growth countries. Comparing our calibrated TFP growth rates for the United States with those estimated by Kehoe et al. (2013), we find that our calibration for
the United States is consistent with their growth accounting. For the period 1992 to 2011, Kehoe et al. (2013) measure labor productivity growth in goods, services and construction to be 4.6%, 1.4% and −1.3%, respectively. Our calibrated TFP growth for the United States in the tradable sector is 2.3% and the TFP growth in non-tradables is −1.2%.

4.2 Results

To evaluate the two sector model’s ability to account for small international capital flows, we examine the following: (1) the reduction in squared errors between the model and the observed capital inflows, comparing to the one-sector model, and (2) we calibrate savings wedges in the one-sector model to match the capital flows generated by the two sector model (denoted, $\tau_{s}^{benchmark}$), and measure how much of the cross-country variation in the savings wedges calibrated to match the data (denoted, $\tau_{s}^{data}$) is captured by $\tau_{s}^{benchmark}$. The former measures the two sector model’s improvement in explaining the capital flows, relative to the one sector model. The latter measures the extent of the two sector model’s ability to
explain the savings wedges found by Gourinchas and Jeanne (2013). We find that the two sector model reduces the sum of squared errors by 64% and the correlation between the two savings wedges to be .56. Therefore, the two sector model can explain nearly two-thirds of the discrepancy between the one-sector model and observed capital flows, and captures nearly one-third (31%) of the cross-country variation in the savings wedge.

4.2.1 Non-traded sector reduces the size of net flows

The impact of the non-traded sector on the size of net capital flows can be clearly seen in Figure 11, which shows the predicted capital inflows of the one-sector and two-sector models, as well as the observed capital inflows. The magnitudes predicted by the one sector model range from $-13.5$ to $11.4$ times initial output, whereas the data and the two-sector model predictions range from $-6.1$ to $1.54$ and $-5.98$ to $5.69$, respectively (see Table 3). The range of the predictions generated by the two sector model is much closer to the data than the one-sector model predictions.
Next, we look at mean capital inflows for countries with positive and with negative productivity catch-up. Among the countries with positive productivity catch-up, the ratio of average cumulative capital inflows to initial GDP was: 4.38 in the one-sector model; 1.16 in the two-sector model; and −0.20 in the data. For countries which are falling behind, these numbers were, respectively: −3.60; −2.16; and .27 (see Table 3).

Overall, our measure of the improvement (over the one-sector model) in accounting for the observed low capital flows is the reduction in the sum of squared errors between the model predictions and the data. We compute the following statistic, using capital flows from the data and capital flows generated by both the one- and the two-sector model:

\[
SSE_{model} = \sum_{j=1}^{J} (CI_{j}^{data} - CI_{j}^{model})^2
\]

where \(CI_{j}\) is the capital inflows relative to initial real GDP for country \(j\). Table 3 presents the sum of squared errors for the two- and one-sector models. The predicted capital flows of the two sector model are a considerable improvement from those of the one sector model. The two sector model reduces the sum of squared errors by 64% relative to the one sector model, explaining much of the relatively low magnitudes. The maximum squared error is reduced from 295 to 79\(^{17}\). In addition, it can be seen in Figure 11 that the improvement of the two sector model tends to be the greatest for those countries which are experiencing the fastest and the slowest productivity catch-up.

4.2.2 Data- vs. model-implied savings wedge

We now analyze the strongest and the most robust result presented in Gourinchas and Jeanne (2013): the strong and negative correlation between productivity growth and the

\(^{17}\)The maximum squared error in the one- and two-sector model corresponds to Singapore, which has predicted capital inflows of 11.05 and 2.79, respectively, compared to the observed capital inflows of −6.12.
Figure 11: Capital Inflows and Productivity Catch-Up

For each country, we calibrate the savings wedge required for the one-sector to match the capital flows generated by our two sector model. The correlation between productivity growth and the savings wedge is $-0.64$ (see figure 12). While the correlation is not as high as the savings wedge generated by the capital flows from the data, there is a clear allocation puzzle present in the flows generated by the two sector model. That is, observing the capital flows generated by the two sector model, Gourinchas and Jeanne (2013) would find a similar allocation puzzle as they do using the actual flows. Furthermore, the two sector model explains 31% of the cross-country variation in the savings wedges calibrated by Gourinchas and Jeanne (2013). For the sub-sample of countries in Gourinchas and Jeanne (2013) sample for which we observe labor flows, the model explains over half (54%) of the cross country variation in the savings wedge.

Figure 13 compares the savings wedge calibrated to match the flows generated by the

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18This is the correlation generated by our sample of countries for which we observe sectoral labor. The sample includes both developed and developing countries.
two sector model with the savings wedge calibrated to match the observed capital flows. The correlation between the two savings wedges is 0.56 (for the subset of countries which overlap with the sample used in Gourinchas and Jeanne (2013) the correlation is 0.73). The high correlation is a result of the two sector model’s ability to generate relatively low capital flows. That is, the large discrepancy in the magnitudes, which generates the high correlation between the productivity catch-up and the savings wedge associated with the observed capital flows, is precisely what generates the same high correlation between the productivity catch-up and the savings wedge associated the flows predicted by the two sector model. For example, Cyprus requires a calibrated savings wedge of $-2.8$ to match the two sector model’s predicted flows of 2.60 times initial output, which is well below the one sector model’s prediction of 11.4, and much closer to the observed flows of 1.54 (the matching of which requires a savings wedge of $-3.12$). Conversely, Venezuela requires a calibrated savings wedge of 2.68 to match the two sector model’s predicted flows of $-3.45$ times initial output, which is (in absolute terms) well below the one sector model’s prediction of $-11.34$, and much closer to the observed flows of $-0.42$ (the matching of which requires a savings wedge of 4.06). Hence, the high correlation between the two savings wedges.

The correlation between the capital flows and the productivity catch-up does not seem to matter for our results. The correlation for the two sector model is 0.66; far lower than the one sector model’s 0.93; however, not near as low as the correlation in the data of $-0.28$. Yet, the savings wedges associated with the two sector model are highly correlated with both productivity catch-up and the savings wedges associated with the data, emphasizing the important role of the magnitudes of net flows. Overall, the complementarity and structural change present in the two sector model generate much lower predicted capital flows, accounting for 64% of the discrepancy between the one sector model and observed capital flows. It also accounts for 31% of the cross-country variation in the savings wedge (54% for
the 32 countries in Gourinchas and Jeanne (2013) sample for which we observe labor flows).

Table 3: Benchmark Results

<table>
<thead>
<tr>
<th>Model</th>
<th>Min</th>
<th>Max</th>
<th>Mean ((\pi &lt; 0))</th>
<th>Mean ((\pi \geq 0))</th>
<th>SSE</th>
<th>Capital Inflows w/ (\pi)</th>
<th>Correlations w/ (\tau_S^{data})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>-6.12</td>
<td>1.54</td>
<td>0.27</td>
<td>-0.20</td>
<td>-</td>
<td>-0.28</td>
<td>1</td>
</tr>
<tr>
<td>GJ sub-sample only</td>
<td>-6.13</td>
<td>1.54</td>
<td>0.37</td>
<td>-0.33</td>
<td>-</td>
<td>-0.29</td>
<td>1</td>
</tr>
<tr>
<td>Two Sector model</td>
<td>-5.98</td>
<td>5.69</td>
<td>-2.17</td>
<td>1.16</td>
<td>654</td>
<td>0.66</td>
<td>0.56</td>
</tr>
<tr>
<td>GJ sub-sample only</td>
<td>-5.98</td>
<td>5.69</td>
<td>-2.99</td>
<td>1.72</td>
<td>558</td>
<td>0.68</td>
<td>0.73</td>
</tr>
<tr>
<td>One Sector model</td>
<td>-13.51</td>
<td>11.43</td>
<td>-3.60</td>
<td>4.38</td>
<td>1817</td>
<td>0.93</td>
<td>-</td>
</tr>
<tr>
<td>GJ sub-sample only</td>
<td>-13.51</td>
<td>11.43</td>
<td>-5.13</td>
<td>6.16</td>
<td>1660</td>
<td>0.93</td>
<td>-</td>
</tr>
</tbody>
</table>

*\(\pi\) denotes productivity catch-up.
Figure 13: Model- vs. data-generate savings wedge ($corr = 0.56$)

4.3 Sensitivity analysis

4.3.1 Elasticities of Substitution

With the benchmark results established, we now examine the sensitivity of the results to changes in key parameters. In addition, this analysis helps to illuminate the important margins, complementarity and consumption smoothing, within the two sector model.

Complementarity between tradeables and non-tradeables While there is broad support for the assumption of complementarity between non-traded and traded goods, there are differences in the empirical estimates of the elasticity of substitution. Stockman and Tesar (1995), using a cross-country regression of relative expenditures on relative prices and GDP per capita, estimate an elasticity of substitution of 0.44. Herrendorf et al. (2013b) provide evidence from U.S. data suggesting Leontief, whereas Mendoza (1991), following Stockman and Tesar (1995) for a set of developed countries, estimates a higher elasticity of 0.74. The
elasticity of substitution in the benchmark model is 0.50, which is also the elasticity used by Kehoe et al. (2013).

We consider two additional values for the intra-temporal elasticity of substitution between tradeables and non-tradeables: 0.25 and 0.75. Table 4 shows the results for the low and high elasticities, as well as for the benchmark model. Stronger complementarity between tradable and non-tradable goods results in lower predicted capital inflows, and greater explanatory power of the two sector model.

Specifically, with the intra-temporal elasticity of substitution of 0.25, the two sector model predicts average capital inflows of −.21 times initial GDP for countries with positive productivity catch-up (−0.04 for countries falling behind), with a range similar to the data of −6.0 to 3.44. Furthermore, the reduction in the sum of squared errors is 80% from that of the one sector model predictions (it was 64% for the benchmark value of η = 0.5). In regards to the savings wedge, the two sector model with low intra-temporal elasticity accounts for 75% of the cross-country variation in the savings wedge. Not surprisingly, the two-sector model with the higher intra-temporal elasticity of substitution (η = 0.75) generates higher average capital flows (6.00 for countries with positive catch-up, and 0.66 for those falling behind). It also accounts for less of the cross-country variation in the savings wedge (20%). The above results are graphically depicted in Figure 14. The figure shows, for the different levels of elasticity of substitution, the predicted capital flows against the productivity catch-up.

Table 4: Sensitivity Analysis: Intra-temporal Elasticity of Substitution

<table>
<thead>
<tr>
<th>Model</th>
<th>∆ Debt / initial GDP</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td></td>
<td>w/ π</td>
<td>w/ π</td>
</tr>
<tr>
<td>Low Elasticity (η = .25)</td>
<td>-4.59</td>
<td>2.62</td>
</tr>
<tr>
<td>Benchmark (η = .50)</td>
<td>-5.97</td>
<td>5.68</td>
</tr>
<tr>
<td>High Elasticity (η = .75)</td>
<td>-5.30</td>
<td>10.30</td>
</tr>
</tbody>
</table>
Figure 14: Sensitivity analysis: intra-temporal elasticity of substitution
Benchmark: parameters as in Table 2 ($\eta = 0.5$).
Low elasticity: $\eta = 0.25$ (high complementarity between tradeables and non-tradeables).
High elasticity: $\eta = 0.75$ (low complementarity between tradeables and non-tradeables).
Aggregate consumption smoothing  The results are less sensitive to changes in the inter-temporal elasticity of substitution. The benchmark elasticity is set to 0.50, therefore, we consider a lower elasticity of 0.33, where $\sigma = 3$. Increasing the consumption smoothing motive, while maintaining the intra-temporal complementarity, does not impact the predicted capital flows very much. Table 5 compares the results for the benchmark and low inter-temporal elasticity of substitution. Stronger consumption smoothing actually leads to slightly lower average capital inflows, however, among the fast growing countries the capital inflows tend to increase (.2 on average). Figure 15 compares the capital flows in the two-sector model with the two different values of the inter-temporal elasticity. As for the correlations, the lower intertemporal elasticity strengthens slightly the relationship between capital inflows and productivity growth, and explains roughly the same cross-country variation in the savings wedge.

Table 5: Sensitivity Analysis: Intertemporal Elasticity of Substitution

<table>
<thead>
<tr>
<th>Model</th>
<th>$\Delta \text{ Debt} / \text{ initial GDP}$</th>
<th>$\text{Correlations}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Low Elasticity ($\frac{1}{\sigma} = .33$)</td>
<td>-5.07</td>
<td>5.14</td>
</tr>
<tr>
<td>Benchmark ($\frac{1}{\sigma} = .50$)</td>
<td>-5.97</td>
<td>5.68</td>
</tr>
</tbody>
</table>

4.3.2 Accounting for Structural Change Matters

We now turn our focus to the re-allocation of labor between the tradable and non-tradable sector. This will highlight the important role the allocation of labor plays in determining capital flows, and provide justification for the use of the labor allocation wedge in matching the observed structural change. We present the predicted capital flows and labor allocation of the two sector model without the labor allocation wedge, and compare them to the benchmark model and the data.
The allocation of labor between the two sectors can have important implications for the capital inflows. With frictionless labor markets, allocating labor into the non-tradable sector allows the economy to increase output of the non-tradable good, while making up the reduction in tradable output via imports. Considering the complementarity between tradable and non-tradable goods, the ability to expand production of the non-tradable good increases the marginal utility of the tradable good and allows for greater consumption smoothing. For rapidly growing countries, the greater consumption smoothing means larger capital inflows when labor markets are frictionless. However, the predicted labor allocation of the two sector model with frictionless labor markets is counter to the labor allocation and structural change observed in the data. Recall, figures 6 and 7 in Section 2.2 highlight that fast growing countries undergo structural change in which labor shifts *gradually* towards the non-tradable sector as the countries develop. That is, there are positive correlations between the level of employment in the non-tradable sector and the level of real GDP per capita, as well as,
between the change in the employment share in non-tradables and the change in real GDP per capita (growth).

Figure 16 shows that in a model without the labor allocation wedge, there is a strong negative correlation between productivity catch-up and the change in employment in non-tradeable sector. Without the labor allocation wedge, countries that are catching up with the frontier, experience, on average, a decrease of 1% annually in the employment share of non-tradable goods. In the data, these countries experience, on average, an increase of .7% annually in the employment share of non-tradable goods.

Figure 16: Average Change in Employment in Non-tradables

Figure 17 explains the reason behind the counter-factual correlation from Figure 16. It compares the first-period allocation of labor in the non-tradeable sector, relative to that same allocation in the model with the labor allocation wedge (i.e. also relative to the data). For countries with high productivity growth, there is a significant (up to 5 times the observed employment share) increase in the share of employment in the non-tradable sector in the first period. That is, the model economies undergo drastic and rapid structural change in the first period, rather than the slow tempered change observed in the data.
Figure 17: First Period Allocation of Labor to Non-tradables
Flexible labor: model without labor allocation wedge.
Data/benchmark: model with calibrated labor allocation wedge (same as data)

Figure 18: First Period Movement of Labor into Non-tradables
Model without labor allocation wedge. The measure on the Y-axis is: \( \frac{\ell_N}{\ell_0} - 1 \), where \( \ell_0^N \) is the initial steady-state allocation, same as the allocation in the initial year in the data.
Not surprisingly, the rapid structural change predicted by the model with flexible labor tends to be larger for faster growing countries. Figure 18 shows the first period change in the labor allocated to the non-tradable sector (i.e. $\ell^N_1 - \ell^N_0$, where $\ell^N_0$ is the initial steady-state allocation) versus productivity catch-up. Wishing to smooth consumption, these countries allocate a large share of their labor to the non-tradable sector to increase the non-tradeable output, and therefore, increase the marginal utility of tradable goods. Imports of tradable goods make-up for the reduction due to the shift of labor, as well as smooth consumption in anticipation of higher future income.

The effect on capital inflows is significant and can be seen in the very strong positive relationship between the initial change in employment in the non-tradable sector and capital inflows over the period. The left panel of Figure 19 plots the capital inflows against the change in employment in the non-tradable sector in the first period. The correlation is 0.94. The impact on capital inflows from the initial shift of employment into non-tradable goods, and the subsequent decline, can be clearly seen in the predicted magnitudes. The magnitudes of the capital inflows are much higher in the case of flexible labor markets, ranging from $-5.14$ to $13.6$ of initial output. The right panel shows the immediate consequence of that initial rapid reallocation for the relationship between capital inflows and the change in non-tradeable employment during the transition. Without labor allocation wedge, fast growing countries, having initially reallocated labor to non-tradeables, receive huge capital inflows and gradually shift labor back towards the tradeable sector - a vastly counter-factual prediction.

Table 6 shows the predicted magnitudes and correlations of the two sector model with flexible labor markets in comparison to the one sector model, benchmark model, and data. Overall, the counterfactual predictions about labor allocation in the two sector model with frictionless labor markets lead to greater magnitudes in the capital inflows, especially for fast growing countries, and explain less of the observed capital flows, as well as, the cross-country
Figure 19: Capital Inflows and Non-tradable Employment: model w/o labor allocation wedge
Left panel X-axis: % change in $\ell^N$ in the first period
Right panel X-axis: average % change in $\ell^N$ between first and final period

variation in the savings wedge. This highlights the strong role of the observed structural change in explaining the relatively small capital inflows in the data, and the importance of matching the structural change in the two sector model when using it to evaluate capital flows.

Table 6: Flexible Labor Results

<table>
<thead>
<tr>
<th>Model</th>
<th>$\Delta$ Debt / initial GDP</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Data</td>
<td>-6.12</td>
<td>1.54</td>
</tr>
<tr>
<td>Two Sector model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benchmark</td>
<td>-5.98</td>
<td>5.69</td>
</tr>
<tr>
<td>Flexible Labor</td>
<td>-5.14</td>
<td>13.63</td>
</tr>
<tr>
<td>One Sector model</td>
<td>-13.51</td>
<td>11.43</td>
</tr>
</tbody>
</table>

*\(\pi\) denotes productivity catch-up.
5 Conclusions

In this paper, we studied the behavior of the cumulative capital flows in a sample of 54 economies during the period 1980 to 2000. We quantify the role of non-tradable goods and structural change in accounting for observed net capital flows in a two sector — tradable and non-tradable — deterministic small open economy growth model.

Introducing a non-tradable sector and accounting for the structural change in an otherwise standard small open economy, can generate capital flows which are much closer (in magnitude) to the data than the predictions of the one-sector growth model. Overall, we account for (i) 64% of discrepancy between empirically observed capital flows and predictions of a one-sector model, and (ii) 54% of the cross-country variation in the savings wedge in the sub-sample of countries studied by Gourinchas and Jeanne (2013) (31% world-wide).

In order to match empirical movements of labor between tradeable and non-tradeable sector, we introduced and calibrated a time-varying labor allocation wedge. We showed the existence of such wedge is important in accounting for small net international capital flows. This leads us to a similar conclusion to Restrepo-Echavarria et al. (2015): domestic frictions can be an important factor affecting international capital flows. Of course, this conclusion depends on the interpretation of labor allocation wedge as a friction to labor reallocation. Further studies should explore whether the wedge we calibrated is a manifestation of market imperfections, or fundamental characteristics that we omitted in our framework (e.g. the fact that large part of investment expenditures is on non-traded goods).

References


