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Capital's Long March West: Saving and Investment Frictions in Chinese Regions

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Abstract

While China has been pivotal in discussions and academic research on global imbalances, little is known about macroeconomic external imbalances among Chinese regions and the factors driving them. We use aggregate regional data and estimate provincial total factor productivity growth over 1984-2010. We observe that provinces that caught up relatively to national TFP had capital outflows while those that fell behind had capital inflows: there seems to be a *capital allocation puzzle* at the regional level inside China. We follow up by identifying the drivers of this pattern using the methodology developed in Gourinchas and Jeanne (2013) to compute regional investment and saving wedges. By relating those frictions with TFP catch-up parameters, we find an investment and a saving puzzle: regions that caught up relative to the rest of China seem to have lower investment rate (higher investment tax) and higher saving (lower saving tax) relative to the prediction of the neoclassical model. We exploit Chinese cross-regional variation in key characteristics suggested by the literature and find robust explanatory variables of the wedges: factors related to the ownership type, the level of integration into the world economy and the economic structure are highly correlated with the identified frictions.

JEL classification: F21, F36, F40, F43
Keywords: China, Chinese provinces, Wedges, Frictions, Saving, Investment, Regional capital flows, Global imbalances, Capital allocation puzzle

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1 Introduction

Since the mid-2000s, global imbalances have been a resurgent topic in academics and occasionally shaped the political agenda. The far-reaching implications of that issue fostered sustained research. While imbalances undoubtedly came down since the Great Recession, the fundamental factors driving them are still subject to debate. Understanding to which extent external imbalances are symptomatic of differences in underlying economic structure and policies is key to assess when—and under which conditions—a convergence towards more sustainable patterns would be possible. Over the last decade, the literature disproportionately discussed that issue through the lens of US interests. At the onset of the "Great Rebalancing", observers and experts increasingly laid the focus on China.

The driving forces of Chinese imbalances are increasingly well-understood. Since Jiabao's famous 2007 speech acknowledging the unsustainability of the Chinese growth model, the awareness that rebalancing is a decisive step towards sustainable economic development has established itself. With tremendous growth experienced over three decades, continental Chinese regions begin to matter. Some already are GDP equivalent to big developing countries in terms of PPP international dollar.[1] More developped coastal regions long have the weight of small industrialized countries (e.g. Switzerland, Austria or Ireland). On top of that, they have become highly integrated with the world supply chain, for example in terms of total exports value. These regions thus play an important role in the world economy. Moreover, their contribution to global imbalances is substantial, as is their potential impact on future adjustments.[2]

While Chinese external imbalances have been largely discussed by practitioners, the academic literature on global imbalances rather focused on theoretical explanations. This paper is a first try in bridging the gap between both. We discuss potential frictions in saving and investment that emerged during the transition from a largely agricultural and planned to an industrial and more market-based economy. We relate capital flows (i.e. cumulated net exports) to regional productivity in a formal framework. We show that a *capital allocation puzzle* is present inside China: provinces that caught up relative to national productivity had surpluses of saving over investment (capital outflows) while the opposite is observed for provinces that benefited less from economic reforms. This result is reminiscent of the findings of Gourinchas and Jeanne (2013) at the international level.

Starting from that empirical finding, we follow up by identifying the drivers of that pattern using a standard neoclassical model with two frictions in the mould of Gourinchas and Jeanne. The first friction (the investment wedge) enters at the aggregate level of the economy and influences capital accumulation. It affects gross returns on aggregate capital and is identified by matching

[1] For instance, as of 2010, Sichuan overtook Malaysia, Yunnan was roughly comparable to Vietnam and Henan reached the level of Thailand. The output of Guangdong in the *Pearl River Delta* is expected to overtake Indonesia's one in the coming years.

[2] Jiangsu exports roughly as much as Taiwan while Zhejiang is comparable to Thailand. The province of Guangdong is on the same scale as South Korea in total export terms.

an empirical with a theoretical decomposition of investment rate. We find an investment puzzle: regions that caught up relative to the rest of China seem to have higher wedge (lower investment rate), while provinces that fell behind implicitly subsidized investment. This is a first blow to the baseline neoclassical framework and stands in sharp contrast with international patterns.

The second friction (the saving wedge) is comparable to a tax on capital income of households. It is identified in matching an empirical with a theoretical decomposition of cumulated relative capital flows (i.e. net exports). As on the international level, we find a saving puzzle: the relationship between productivity catch-up and saving wedges is negative and very significant. Provinces that caught up are the ones that implicitly subsidized saving, causing a saving glut that translates into capital outflows. This is a second blow to the neoclassical model. As opposed to investment wedges, saving frictions are the main driver of the *capital allocation puzzle*.

In a next step, we investigate whether the estimated long run wedges are related to usual suspects proposed by the literature. The regional cross-sectional variability of the wedges seems useful in shedding light on the general patterns of capital flows. Some characteristics related to the investment structure of the economy robustly account for a high part of the cross-regional variation in investment wedges: a high share of the state in investment in fixed assets or in construction gross output value and a marked presence of the formal, state-near financial sector—loans in financial institutions—seem to foster investment.

Turning to saving wedges, there seems to be an ubiquitous effect of the state's involvement in the economy (e.g. state-owned share of gross industrial output value) in repressing saving. By contrast, a greater importance of multinational firms, privately-owned enterprises and a large industrial sector are all associated with higher saving compared to the neoclassical model. Financial development—deposits and loans in financial institutions—seems to put a dent on saving.

We conclude that the *capital allocation puzzle* is driven by both the visible hand (the state) and the private sector. By constructing non-state net exports, we show that more marketized regions with rapid TFP growth and a strong presence of private and international firms (i.e. the East Coast) have large non-state saving surpluses while other regions have balanced non-state net exports on average. The neoclassical model would predict the opposite pattern. In addition to that, we find that massive state net exports deficits are largely responsible for large capital imports (i.e. negative saving - investment balance) in the Chinese hinterland.

The paper is structured as follows. First of all, we briefly review the assumptions of the model and discuss data issues in Section 1. Second, in Section 2, we establish the existence of a capital allocation puzzle inside China and investigate to which extent discrepancies in external balance arise from frictions in aggregate investment or aggregate saving. Then, in Section 3, we relate the wedges to a large number of "usual suspects" put forward in the literature and compute state and non-state net exports. In a next step in Section 4, bearing in mind that the data are known to be noisy, we discuss the effects on our general results of alternative data. Eventually, Section 5 concludes.

1.1 Related literature

Since the mid-2000s, the issue of global imbalances has been largely discussed. Given the large set of factors determining saving, investment as well as financial and physical capital flows, it is no surprise that a vast theoretical and empirical literature has emerged and proposed many—mostly non-exclusive—explanations of the phenomenon. In this paper, we focus on the Asian side of the coin (i.e. Bernanke's "saving glut").

A considerable part of the literature invokes differences in financial development, for example countries' ability to produce financial assets (Caballero et al., 2008), differences in the enforceability of financial contracts (Mendoza et al., 2009), access to credit of high-productivity private firms (Song et al., 2011) or lack of liquid assets to finance production (Bacchetta and Benhima, 2010). More broadly, the complex financial repression regime is seen as a potential cause of external imbalances in China (Johansson, 2012) and seems to be strongly related to current account surpluses at the international level (Johansson and Wang, 2012).

Since the seminal work of Hsieh and Klenow (2009), the issue of capital allocation in China has increasingly attracted attention. Brandt et al. (2012) measure the impact on aggregate TFP of distortions in factor allocation across provinces and sectors. They find that capital misallocation between the state and the non-state sector, rather than labor frictions, has been driving the recent increase in distortions. They considerably impact on aggregate TFP growth. A 2005 firm survey conducted by Dollar and Wei (2007) finds that private firms have difficulties to finance their working capital and rely more on retained earnings and informal channels. Interestingly, returns on capital increase with decreasing state share. Other studies on capital allocation focus on the relationship between provincial saving and investment and generally find a low capital mobility (e.g. Li, 2010; Xu, 2008).

In their extensive analysis of capital mobility in China, Boyreau-Debray and Wei (2004) find that provinces with low capital productivity were the ones that experienced capital inflows between 1984 and 2001. As opposed to non-state and international investment, investment made through government budget and (state-owned) financial institutions seem to react negatively to an increase in the marginal productivity of capital. They suggest that the strongest determinant of capital allocation in China is the prominence of SOEs (state-owned enterprises) in local economies. As shown in Chen and Yao (2011), there seems to be a crowding-out effect of government infrastructural investment on private consumption in Chinese regions.

The capital allocation issue is obviously related to global imbalances. Gourinchas and Jeanne (2013) observe that developing countries whose productivity grew faster had capital outflows between 1980 and 2000. By introducing an investment and a saving wedge in an otherwise standard small open economy model, they identify saving wedges as the key driver of this pattern. The finding of Song et al. (2011) that regions with faster growth in private employment seem to have larger external surpluses and higher GDP per capita growth rate suggests the existence of a

similar pattern inside China. The Gourinchas and Jeanne puzzle is less marked once one accounts for public aid flows and reserve accumulation because current account typically is a poor proxy to adequately capture capital flows (Alfaro et al., 2011). Private capital indeed seems to behave more in accordance with the standard model.

An increasing number of studies using household sample surveys try to identify factors driving high savings in China. Aziz and Cui (2007) point to the progressive decline in households' disposable income and their decreasing labor share in the economy. Chamon and Prasad (2010) rely on annual household survey data and find that savings rate increased in all demographic groups as a consequence of the *"breaking of the iron rice bowl"*.[3] In another study, Chamon et al. (2013) establish that the last decades saw an increase in income uncertainty and a decline in pension replacement rate.

These results contrast with household studies focusing exclusively on demographic factors, for example life-cycle motives (Modigliani and Cao, 2004; Curtis et al., 2011). This hypothesis does far better if one includes motivation to invest in housing (Chao et al., 2011). Demographic gender structure seems to matter as well, for instance because of differences in elderly support (Banerjee et al., 2010) or intensified competition in the marriage market due to the gender gap (Du and Wei, 2010).

Apart from households, government and particularly corporate saving rate have contributed to imbalances as well (Ma and Yi, 2011; Yang et al., 2011; Kuijs, 2006). In addition to private firms (Song et al., 2011), state-owned firms in resources and heavy industries may have played a particular role in the recent surge in Chinese current account in the 2000s (Anderson, 2009).

The massive surpluses could be related to the trade and production structure of the Chinese economy (Jin, 2012). Johansson and Wang (2011) suggest that the slow Chinese structural change from secondary to the tertiary sector may be a byproduct of financial repression. The importance of processing trade implies that the current account is expected to be robust against fast appreciation as China's exports are part of a quite persistent chain of production (Girardin and Owen, 2011).

Export-led growth policy is another potential explanation for the capital allocation puzzle. Aizenman and Lee (2010) introduce learning by doing externalities in exports in a growth model. Practitioners argue that the importance of exports in value-added terms seems to be modest (Anderson, 2007). For some export-led growth cases in point like Japan, South Korea and China, Aizenman and Lee (2008) find evidence for financial mercantilism (i.e. financial repression and heavy state involvement in capital allocation) rather than monetary mercantilism (i.e. real exchange rate manipulation). Aizenman and Lee (2007) show that exposure to potential financial crisis and sudden stops seems to be more decisive than exchange rate manipulation for explaining reserve accumulation.

[3] Shift of expenditures on education, housing and health care from state-owned enterprises to households during reforms.

At last, the quality of institutions and the legal system could potentially play an important role too. Aguiar and Amador (2011) show that external surpluses and asset accumulation can be obtained as political economy outcome of a limited commitment toward non expropriation of international investment position and competition for political power.

1.2 Model set-up

The baseline version of the small open economy model used in this paper is similar to the one developed in Gourinchas and Jeanne (2013). Time is discrete and there is no uncertainty. A single homogeneous good is produced.
The production function is of the Cobb-Douglas type:

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}$$

Factor markets are competitive. The aggregate *BC* of the economy is

$$Y_t = C_t + I_t + R^* D_t - D_{t+1}$$

where R^* is the world gross interest rate and D the external debt.
Capital inflows (i.e. an increase in debt) correspond to the gap between investment and saving:

$$\begin{aligned} D_{t+1} - D_t &= C_t + I_t + R^* D_t - Y_t - D_t \\ &= I_t - \underbrace{(Y_t - C_t - D_t(R^* - 1))}_{S_t} \end{aligned}$$

The dynamics of capital over time is

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

Gourinchas and Jeanne introduce an investment or capital wedge (τ_k) that impacts on gross return (R_t):

$$(1-\tau_k)R_t = R^*$$

The marginal product of capital net of depreciation is

$$R_t = \alpha(k_t/A_t)^{\alpha-1} + 1 - \delta$$

where k is capital per capita. Plug the former into the latter expression to find the capital stock per efficient unit of labor:

$$\tilde{k}_t = \frac{K}{AN} = \left(\frac{\alpha}{\frac{R^*}{1-\tau_k} + \delta - 1}\right)^{\frac{1}{1-\alpha}} = \tilde{k}^*$$

Countries have an exogenous productivity path bounded from above by the world productivity frontier, which grows at rate g^*:

$$A_t \leq A_t^* = A_0^* g^{*t}$$

For a finite period of time, a country's TFP could grow faster than world TFP. The evolution over time of domestic relative to world productivity is captured by the technology catch-up parameter (i.e. a positive π means that a country catches up relative to the world):

$$\pi_t = \frac{A_t}{A_0 g^{*t}} - 1$$

Representative households maximize a *CRRA* utility function:

$$\begin{aligned} U_t &= \sum_{s=0}^{\infty} \beta^s N_{t+s} u(c_{t+s}) \\ u(c_t) &= \frac{c_t^{1-\gamma}}{1-\gamma} \end{aligned}$$

subject to the following budget constraint

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

Wages (w) are equal to the marginal product of labor. The saving wedge (τ_s) can be interpreted as a tax on capital income. Revenues generated by the wedges ($z_t = \tau_k R_t k_t + \tau_s R^* (k_t - d_t)$) are redistributed in a lump-sum fashion.

The Euler equation is

$$\begin{aligned} c_t^{-\gamma} &= \beta R^* (1-\tau_s) c_{t+1}^{-\gamma} \\ &= \beta (1-\tau_k) R_t (1-\tau_s) c_{t+1}^{-\gamma} \end{aligned}$$

It is assumed that the rest of the world is composed of steady-state advanced economies with the same preferences and no saving wedge:

$$R^* = \frac{g^{*\gamma}}{\beta}$$

1.3 General remarks

When not mentioned otherwise, data used in this paper are from the *National Statistical Yearbooks* of the People's Republic of China and from the *Provincial Statistical Yearbooks* of the 22 provinces, 5 autonomous regions and 4 municipalities of Mainland China.[4] The *China Data Center* (CDC) of the University of Michigan provides electronic access to the yearbooks and made main statistics conveniently available.[5] For most provinces, our online access only covers regional statistical yearbooks in the 1990s and 2000s. Thus, it happens that the data are sometimes incomplete. We will primarily rely on data directly retrieved from recent online yearbooks and complete possible gaps with CDC sheets. This allows us to take account of revisions as much as possible.

It has been suggested that Chinese current account data are not reliable. Large measurement errors driven by hidden capital inflows—underestimated returns on foreign investment and misreporting of exports/imports—are supected since the mid-2000s (Zhang, 2008). Against such a background, it should not come as a surprise that China is a natural suspect in explaining why the world has been running current account surpluses over the past few years (Economist, 2011).

The quality of provincial and aggregate Chinese *National Accounts* data is an important issue explored in Cudré (2012), where we extensively focus on some stylized facts and discuss the quality and aggregation properties of the data. This analysis revealed large discrepancies between aggregate statistics and the sum of provincial statistics. For example, the sum of province-level GDPs was about 11 percent higher than the officially published national value in 2010. The bulk of this large error stems from an excess of regional over national investment, which has been widening since the mid-1990s. Conversely, the discrepancy between cumulated provincial saving and national saving shows no clear trend over time. Still, the sum of province-level saving overestimated national values by round 7 percent of China's GDP in 2010. This suggests that, since the mid-2000s, the sum of province-level net exports will generally be lower than the corresponding official aggregate statistics. Whether regional data are worse than national ones is an open question (e.g. the *2004 Economic Census* validated provincial GDP data and invalidated national ones (Holz, 2008)).

But while there is considerable uncertainty concerning the levels of aggregate and regional statistics, our exploratory analysis also shows that that the sum of province-level aggregates is generally highly correlated with movements in national statistics. Even though yearly level data are noisy, our empirical analysis focuses on cross-sectional patterns over three decades of economic reforms. For that reason, we are reasonably confident that our province-level data

[4] The autonomous regions are Tibet, Xinjiang, Guangxi, Inner Mongolia and Ningxia. The cities of Beijing, Tianjin, Shanghai as well as the region of Chongqing are municipalities. Thereafter, the term province will be used as general qualifier.

[5] `http://chinadataonline.org/`. The CDC reports values as soon as they are published in the corresponding yearbook. Although data have sometimes been subject to official revisions in later years, the CDC did not systematically adapt past values.

capture important aspects of long run external balances in China's regions. Tibet is excluded for data availability reasons. Information on the computation of capital stock (Section A.2.1), productivity (Section A.2.2) and capital flows (Section A.2.3) is available in appendix.

2 Regional investment and saving wedges

2.1 Productivity catch-up

Regional abbreviations used in the graphics as well as employment growth rates and productivity catch-up parameters are available in Table 1 (Results). The geographical distribution of catch-up parameters is best appreciated using a map where provinces are classified per quartile (Figure 1). Catch-up values range from -0.45 to 0.86. We observe a high heterogeneity in TFP with 18 regions having a negative value and 12 a positive one.

As expected, more open coastal regions—where preferential policies were implemented first—generally have a positive catch-up parameter relative to China's productivity growth.[6] In the *Pearl River Delta*, Guangdong is known to have benefited from foreign investments and a shift of productive capacities from Hong-Kong and Macau. It has the lead with a value of 0.86. Bordering Taiwan, Fujian recorded a high growth of productivity over the sample period as well (0.34). Likewise, the regions of the *Yangtze Delta* like Jiangsu (0.51) and Zhejiang (0.17) have been catching up with the exception of a slight decrease for Shanghai (-0.17). The last cluster of emerging provinces locates around the *Bohai Sea*: Tianjin, Shandong and Hebei have values ranging between 0.12 and 0.34. Puzzlingly, Beijing has been falling behind (-0.26), possibly due to the presence of the non-productive state sector.

The northeastern "Chinese Rustbelt" (Manchuria), although known as being still relatively wealthy, benefited less from economic reforms with values between -0.30 and -0.08. In the South, with the exception of Chongqing (0.05), provinces fell behind relative to national productivity growth although already counting among the poorest regions at the time reforms started (e.g. Guizhou -0.45, Yunnan -0.26). Among western provinces, Xinjiang (0.06), Shaanxi (0.14) and Inner Mongolia (0.34) managed to improve their relative position while the rest experienced a deterioration (from -0.17 in Ningxia to -0.44 in Qinghai). In Central China the situation is heterogeneous as well with some provinces being roughly neutral (e.g. Henan (0.01) and Jiangxi (-0.04)) and others having negative value (Anhui (-0.33), Hubei (-0.26) and Hunan (-0.37)).

At this point, it is worth mentioning that all regions massively caught up compared to world TFP. To put it differently, the convergence of Chinese productivity to the world frontier is characterized by a concomitant internal divergence in regional TFP.

[6] We discuss the choice of the reference TFP growth rate in Sections A.2.2 and A.3.1.

2.2 China's internal capital allocation puzzle

In Figure 2, we plot the catch-up parameters discussed in the preceding section and in appendix (A.2.2) against the final relative change in capital flows (Section A.2.3). A clear pattern emerges: provinces that caught up relative to national TFP had capital outflows while those that fell behind had capital inflows. The relationship is highly significant. Thus, there seems to be a *capital allocation puzzle* at the regional level inside China. Remarkably Gourinchas and Jeanne found it to be a case in point of the puzzle: China happened to locate right on the international regression line (i.e. in the southeast quadrant).

Starting from that empirical fact, this paper focuses on the following set of broad issues:

1. What drives the internal *capital allocation puzzle*? Is it investment-driven, saving-driven or a mix of both? (rest of Section 2)

2. Are our estimated long run wedges related to usual suspects proposed by the literature on global imbalances? Is the regional cross-sectional variability of the wedges useful in shedding light on the general patterns of capital flows? (Section 3)

3. To which extent are the general results robust to alternative data (Section 4) and parameter assumptions (Section A.3)?

2.3 The Investment Puzzle

Gourinchas and Jeanne introduce an investment wedge on gross returns defined as

$$(1-\tau_k)R_t = R^*$$

where R corresponds to the marginal product of capital net of depreciation and $R^* = g^{*\gamma}/\beta$ by assumption.
The steady-state capital stock per efficiency unit of labor is

$$\widetilde{k}^* = \left(\frac{\alpha}{\frac{R^*}{(1-\tau_k)} + \delta - 1} \right)^{\frac{1}{1-\alpha}}$$

Thus, as they assume common parameters among provinces, differences in $\widetilde{k}^*$ exclusively arise from different τ_ks. To identify the wedges, they propose a decomposition of average investment over GDP of the following form :

$$i = \underbrace{\frac{1}{T}\frac{\tilde{k}^* - \tilde{k}_0}{\tilde{k}_0^{\alpha}}}_{convergence} + \underbrace{g^* \frac{\pi}{T} n \tilde{k}^{*(1-\alpha)}}_{catch-up} + \underbrace{(g^* n + \delta - 1)\tilde{k}^{*(1-\alpha)}}_{trend}$$

Investment is deflated using the same index as for gross fixed capital formation (GFCF): we use the consumer prices index (CPI) and the price of investment in fixed assets (PIFA) as soon as

available. GDP is deflated using CPI. By implementing a grid-search, the $\widetilde{k}^*$s (and related τ_ks*)* needed to match observed *i*s are identified.[7] From the decomposition formula, one can easily see that their methodology implies that provinces with high relative investment are attributed a high capital per efficient unit of labor.[8] Differences in $\widetilde{k}^*$ drive most of the variations in the three channels and determine investment wedges.

We are primarily interested in the wedge estimates rather than in the respective channels of investment. Thereafter, we talk of implicit returns or wedge-adjusted returns as $(1-\tau_k)R_t$ by holding R constant for convenience. For example, a province with a highly negative wedge is said to have high implicit return and high investment relative to the model. In fact, it is an abuse of language: the wedge-adjusted returns should always correspond to the reference return R^* because perfect capital mobility is assumed. Thus, in the preceding example, the negative wedge means that this region has a lower ex-ante home return R and a friction makes it higher in order for it to correspond to R^*. Either way, it can be interpreted as an investment subsidy.

Results of average investment rates and investment wedges are in Table 1 (Results). Investment wedges are mostly negative and range from -9.10 to 0.15%. In Figure 5, we provide a map of the wedges to make the discussion more convenient. The geographic distribution follows a clear pattern: the West and the Metropolises have the highest implicit rates of return (more negative wedges or, to put it differently, the lowest ex-ante returns) while the Center and the East Coast have far lower returns (less negative wedges or higher ex-ante returns). In fact, the spatial distribution resembles the one of average investment over GDP.[9]

In Figure 3, there is a noisy—but nevertheless positive—relationship between investment wedges and productivity catch-up: provinces with higher productivity growth have lower absolute distortions (less negative wedges), lower implicit returns and lower investment. In other words, regions growing faster implicitly subsidize less gross returns on capital. Thus, there seems to be an investment puzzle at the regional level in China (i.e. no negative relationship between investment wedges and productivity).[10]

At first sight, our results are somewhat counterintuitive. In Gourinchas and Jeanne, countries with negative catch-up parameter had lower average investment rate than richer countries. Thus, they were attributed a low $\widetilde{k}^*$ and a high τ_k, meaning that their implicit return was lower (i.e. their ex-ante return on domestic capital needed to be higher than the world interest rate). In our case,

[7] As in the original paper, we assume $\gamma = 1$, $\delta = 0.06$, $\alpha = 0.30$ and $\beta = 0.96$. Other variables are estimated from data.

[8] For example, the western region of Xinjiang with high investment rates has a bigger $\widetilde{k}^*$ than the more developed Guangdong (5.3 vs 2.1).

[9] Interestingly, the level of investment over GDP (i) is not related to productivity (π) *per se* (correlation of 0.01 vs 0.40 for the wedges). This is an important point: our approach seems to convey different information than raw investment rate data. As a results, it may enable us to identify the frictions that drive investment patterns away from the small open economy model.

[10] The positive slope coefficient of Figure 3 is significant at the 6% confidence level using jackknife standard errors. Note that it loses significance once Guangdong (*GD*, East Coast) is excluded from the sample. Excluding the second outlier as well (Hunan, *HA*) would preserve significance at the 5% level.

we find the opposite pattern. Some relatively poor provinces experienced high investment rates over the period. They were therefore attributed a high $\widetilde{k}^*$ and a low (more negative) τ_k.

In Table 2, we aggregate the frictions of the 30 regions into 6 larger areas. It confirms the broad geographical pattern that we identified: City-Provinces (Metropolises) and the West subsidize investment more while the East Coast and Manchuria have less negative values. We will discuss the possible determinants of investment frictions in Section 3.1.

This result is a first blow to the baseline neoclassical framework and stands in sharp contrast with Gourinchas and Jeanne where investment wedges were negatively related to development in productivity, following the intuitive mechanism that countries with less frictions—-à savoir less positive wedges and lower implicit taxes—-catch up in terms of TFP. Relative to the rest of the world, the positive relationship that we obtain should attenuate the positive correlation of the catch-up parameter and capital inflows predicted by the neoclassical model and thus make the *capital allocation puzzle* less stringent.[11]

At first blush, one would naturally suspect the strongly negative investment wedge value of some regions (e.g. Xinjiang, Qinghai, Ningxia or Inner Mongolia) to be a consequence of *Xibu Kaifa* ("Develop the Great West"). It consists in massive investment programs in infrastructures (mainly transportation, natural resources extraction and power generating facilities).[12] Indeed, Brandt et al. (2012) found an increasing infrastructure share of capital stock in hinterland regions. According to them, the bulk of investment ended up in (less productive) state-related enterprises. They argue that, even accounting for infrastructure investment, the increasing misallocation of capital made already high initial differences in TFP worse. Therefore, Brandt et al. convincingly made the point that *Xibu Kaifa* was the key driver of the increase in productivity distortions since the mid-1990s.

On the one side, this may explain why we find that regions that lose ground in terms of productivity seem to enjoy higher investment subsidies. On the other side, they find that internal (state vs non-state) misallocation—rather than the interregional one—contributed to the recent increase in distortions. As a matter of fact, they argue that interregional frictions were considerable but constant between 1985 and 2007, the lion's share of them originating in persistent labor misallocation. That may explain why the cross-regional correlation of investment frictions and productivity is not that salient. Furthermore, investment and capital intensity of these economies could already have been high before *Xibu Kaifa* due to the strong presence of the state.[13] The large and negative investment wedge value for Beijing, Tianjin and Shanghai is less surprising: they are geographically small, highly dynamic urban areas.

[11] We find that regions with high productivity tend to have higher investment wedges. Thus, they have lower investment rate, higher net exports and lower capital inflows (or more outflows).

[12] Officially launched in 2000, it actually encompasses the southern regions as well. In fact, all regions except the East Coast will be concerned: the CCP intended to follow a similar strategy for Manchuria (*Northeast Area Revitalization Plan*) and the Center (*Rise of Central China Plan*).

[13] In our subsample estimations of Section 4.1, we see that the positive correlation is strongest for the early period (1984-1997), before the *"Develop the Great West"* policy was implemented.

2.4 The Saving Puzzle

Gourinchas and Jeanne (2013) decomposed relative capital flows into four channels.[14] We implement a grid-search to identify the saving wedges required by the model to match empirical capital flows (i.e. so that the sum of the four channels corresponds to the cumulated relative flows data).[15]

As for investment wedges, we focus on frictions rather than discussing the importance of the channels. Capital flows and saving wedges are available in Table 1 (Results). They range from -3.50 (Guangdong) to 2.58% (Guizhou). By focusing on the geographical distribution of the identified saving wedges, an obvious pattern emerges (map in Figure 6): from Tianjin to Guangdong, the entire coastal area has a highly negative saving wedge. Paradoxically, most of these regions have been catching up compared to China and the rest of the world. Thus, households should have been borrowing to raise their consumption. The negative net exports resulting from lower saving would then be interpreted as capital inflows. However, it is not the case: these provinces have massive capital outflows. In order to make the model consistent with data, a large implicit saving subsidy (i.e. a negative saving wedge) is needed.

Some resource-abundant western provinces (e.g. Inner Mongolia, Xinjiang and Shaanxi) have a negative saving wedge as well. Central China, Manchuria, southern provinces as well as some western regions have roughly neutral or positive saving wedges (i.e. they tax savings). In Table 2, we provide results for average distortions over regional clusters. The East Coast provinces have the lowest saving wedges (GDP-weighted average of -2.73%), followed by the Metropolises (-0.93%). The Center and Manchuria have a low positive value. Savings in the West are implicitly subsidized on average (-0.85%) but there is no homogeneous geographical

[14] The convergence term captures the amount of capital necessary to reach the steady-state capital per efficiency unit of labor:

$$\frac{\Delta D^c}{Y_0} = \frac{\tilde{k}^* - \tilde{k}_0}{\tilde{y}_0}(ng^*)^T$$

External borrowing needed to finance domestic investment is captured by the investment channel (i.e. a region that is catching up necessitates more capital inflows):

$$\frac{\Delta D^i}{Y_0} = \frac{\tilde{k}^*}{\tilde{y}_0}(ng^*)^T \pi$$

The next term gathers the cumulated debt inflows required to hold the relative debt ratio constant (trend growth):

$$\frac{\Delta D^t}{Y_0} = \frac{\tilde{k}_0(ng^*)^T - \tilde{d}_0}{\tilde{y}_0} + \psi(\tau_s)\left[ng^*\phi(\tau_s)\right]^T \frac{\tilde{d}_0 - \tilde{k}_0}{\tilde{y}_0}$$

At last, the saving term captures the intertemporal consumption decision of households (given a positive catch-up parameter, they will borrow on international markets to raise consumption):

$$\frac{\Delta D^s}{Y_0} = \frac{\tilde{w} + \tilde{z}_k}{\tilde{y}_0}\frac{\psi(\tau_s)}{R^*}\left[ng^*\phi(\tau_s)\right]^T \sum_{t=0}^{T-1}\left(\frac{ng^*}{R^*}\right)^t \left[\phi(\tau_s)^{t-T}(1+\pi) - (1+\pi_t)\right]$$

[15] As in Gourinchas and Jeanne, we assume log utility ($\gamma = 1$). Section A.3.2 investigates the impact of alternative CRRA values. The $\tilde{k}^*$ identified in the investment wedge computation are used. Furthermore, $\pi = \pi_T$ and a linear convergence to the steady-state catch-up is assumed ($\pi_t = f(t)\pi$ with $f(t) = min(\frac{t}{T}, 1) \leq 1$).

pattern. For instance, Qinghai has a positive value while Shaanxi is found to be clearly negative. The South has the highest saving wedges on average (0.49%), with Chongqing being the only region subsidizing savings.

In Figure 4, as in Gourinchas and Jeanne, the *capital allocation puzzle* manifests itself through a highly significant negative relationship between productivity catch-up and saving wedges. Provinces that have been catching up are the ones that implicitly subsidize savings more, causing a saving glut that translates into capital outflows. There seems to be a saving puzzle at the regional level in China. Standard theory would predict provinces with high productivity to experience capital inflows (lower saving and positive saving wedge). Thus, all but four provinces are in the "wrong" quadrant.[16] The relationship between both variables is as marked as in Gourinchas and Jeanne, where China figured close to the international regression line in the southeast quadrant. The identified frictions are more correlated with productivity than cumulated capital flows (-0.94 vs -0.63). It makes us confident that these frictions are more useful—or at least convey different information—in explaining deviations from the baseline neoclassical model than raw capital flows data.

3 Beyond the wedges

We established the existence of an investment puzzle and a saving puzzle inside China. This *capital allocation puzzle* is reminiscent of the patterns found at the international level in Gourinchas and Jeanne. Importantly, investment wedges alone are not sufficient to turn the negative relationship between capital flows and productivity of Figure 2 into a positive one. As in the original paper, using our empirical estimates of investment wedges and switching off saving wedges—assuming them to be zero—leads to predicted capital flows being strongly positively correlated with TFP. Thus, as on the international level, saving frictions are the main driver of the puzzle.

In this part, we intend to investigate whether variables mentioned in the literature (Section 1.1) are related to the identified frictions. To start with, by regressing the wedges on a large number of "usual suspects", we aim at testing to which extent our estimates convey useful information. Moreover, their (limited) cross-sectional long run variability could suggest some important explanatory variables. In a first step, we discuss univariate regressions of the wedges. Next, we allow for one additional control to at least partly alleviate the omitted variable issue (the level of economic development proxied by real GDP per capita). In a third step, we account for the variability of the wedges using combinations of selected factors. At last, we estimate saving wedges for three subsamples and construct a panel of frictions. A list of the factors is available in appendix in Section A.1. At this point, it should be emphasized that this is only

[16] Jilin (Manchuria), Jiangxi (Center), Shanxi (West) and Shanghai (Metropolise) have negative catch-up and saving wedges. They are thus compatible with the prediction of the standard model that falling behind in terms of productivity implies capital outflows (higher saving).

an exploratory, mainly descriptive step towards better understanding external imbalances inside China. The limitations of our approach are manifold.[17]

3.1 Potential explanatory factors of investment wedges

Before starting to discuss the factors, one may wonder how the frictions are linked to the level of economic development (i.e. the average of real GDP per capita relative to national value).[18] It is *per se* not significantly correlated with the wedges but once its squared value is added, its coefficients turn out to be highly significant. The relationship is concave: economic development initially increasingly put a dent on investment but after a certain level (roughly 100% of national value), the relationship turns increasingly negative and investment is more and more subsidized relative to the baseline model.

Coefficients of explanatory factors of investment wedge normalized by their cross-sectional mean and jaccknife p-values are available in Table 3.[19] A summary of the factors is available in appendix in Section A.1. The ownership structure of investment in fixed assets (*SOInvFA*) seems to be highly negatively correlated with investment frictions. A larger share of state-owned investment in fixed assets has a strong negative effect on the wedges. The presence of the state thus seems to foster investment. The effect becomes larger once one controls for development level. The foreign and residual shares ($FOInvFA$ and $REInvFA$) have the opposite effect.[20]

This pattern repeats itself once one looks at a broader indicator of the presence of the state such as the state-owned gross industrial output value share ($SOGIOV$). Interestingly, more marketized regions ($Market$) seem to have higher investment wedges (lower investment) even when controlling for development. The presence of the state in the construction sector gross output value ($SOCGOV$) tends to magnify investment subsidies.

Indicators summarizing the economic structure of the regional economies seem to be related to frictions. The following factors are negative and highly significant: the share of the construc-

[17] 1.The model only delivers one long run wedge for each province over the entire sample period. Subsamples estimates allow us to construct a panel but the noisiness of data impairs the estimation quality of short time-length and the model's framework makes less sense. 2.Most factors used on the right-hand-side are not available over the entire period. What is more, changes in definition or recording methodology are observed over time. We thus focus on the 1997-2009 period for all factors (2010 is the steady-state and does not enter in the investment and capital flows indicator). 3.Our measure of flow is a rough approximation of current account using only goods and services. 4.The conceptual mapping from frictions to wedges is not straightforward and is a convolution of many frictions. 5.What makes sense on the microeconomic level does not necessarily mean that the cross-provincial variability is informative. 6.We ignore endogeneity issues but control for economic development to at least alleviate the omitted variable issue. 7.Expectations are ignored as we develop no structural model to justify the impact of explanatory factors on the wedges.

[18] We construct population data from multiple censuses and sample surveys available in regional and national yearbooks. See Cudré (2012) for more.

[19] We choose the HC3 heteroskedasticity correction for two reasons. First, in our sample, inference is far more conservative compared to other estimators of the variance-covariance matrix of the residuals. Second, it is a close approximation of the jackknife standard errors, a concept that is particularly appropriate in our framework.

[20] Collective-owned enterprises seem to exhibit the same patterns as private firms. In the early reform period, de facto private firms were still registered as collective ones to benefit from various privileges (Brandt and Rawski, 2008, chapter 1). Consequently, we merge both categories. The collective share of total investment is negligible anyway.

tion and tertiary sector relative to GDP (*SectorConst* and *SectorTert*), our indicator for sectoral economic concentration (*StructConc*) and the share of coal and oil extraction relative to GDP (*CoalOil*). All promote investment relative to the neoclassical model. In a similar fashion to private firms, the importance of the industrial sector relative to GDP (*SectorInd*) has a positive coefficient.

Indicators capturing the extent to which regions are integrated into the world economy do not seem to be systematically related to investment frictions. All have a positive sign. One of our indicators of financial development (*Loans*) is highly negatively correlated with the wedges. One may come to the conclusion that financially more developed regions seem to have higher investment (more negative investment wedge). However, interpreting this indicator as a proxy for financial development may be misleading. In our opinion, it primarily captures the presence of state-owned banks, which rationalizes the negative coefficient.[21]

In Table 4, more explanatory factors are available. Human capital indicators related to education (*TertiaryEduc*, *HighEduc*) or innovation (*Patents*) seem to foster investment, as is a higher social security coverage (*SOCSEC*). Most of these results are driven by Metropolises. Some demographic characteristics seem to matter for investment wedges: regions with high sex ratio imbalances (*SexRatio*) and high share of ethnic minorities (*EthnicShare*) have more negative wedges.

Even though the cross-sectional variability is limited, we try to include many variables in the same regression. We pick six factors that we consider may play a key role in investment frictions, one for each broad category of variables. In Table 5, the presence of the state in gross fixed capital formation (*SOInvFA*), the importance of loans in financial insitutions (*Loans*) and the size of the construction sector (*SectorConst*) are all strongly negatively related to the wedges and bias investment upward. These variables are mostly robust to the inclusion of other factors in the regression. In conclusion, it seems that the presence of state-owned firms and banks is strongly associated with investment frictions.

3.2 Potential explanatory factors of saving wedges

We follow the same exposition strategy as in the preceding section. Table 3 summarizes the effect of the factors on saving wedges. Economic development is associated with the wedges in a convex way: initially, saving frictions are increasingly negative as regions get more developed (i.e. they subsidize saving more and more). Then, at round 130% of national GDP, frictions start to increase and regions decrease implicit saving subsidies.

[21] The negative coefficient could reflect credit policies implemented by SOBs. In fact, this finding is not surprising: a substantial share of aggregate deposits and loans in China figures on big state banks' balance sheets. Even smaller banks are mostly close to local governments. Banks are thus largely owned by the state and closely work hand in hand with local authorities and SOEs. Thus, a high loans over GDP ratio could rather be suggestive of a strong government-led investment policy that biases investment frictions in the region downward rather than broad financial development. The fact that loans—rather than deposits—are particularly strongly negatively associated with investment wedges gives weight to that argument.

The independent variables are identical as in the preceding section and are described in appendix (Section A.1). Indicators related to investment ownership are correlated with saving frictions: the presence of the state (*SOInvFA*) seems to push up the wedges (lower saving) while private and collective firms (*REInvFA*) have the opposite effect. Foreign firms ($FOInvFA$) are not robust to the inclusion of development.

We expect broader indicators of the importance of the private economy to be highly correlated with saving frictions. It seems to be the case: state-owned firms in the industrial (*SOGIOV*) and construction sector (*SOCGOV*) put a dent on saving while more marketized regions (*Market*) seem to promote saving. At this stage, it seems that our results are compatible with the findings of Boyreau-Debray and Wei (2004) and Chen and Yao (2011).[22] The coefficient on private and self-employed employment share (*Empl Private*) has no stable sign over specifications.

In the economic structure category, the importance of the industrial sector over GDP (*Sector Ind*) is strongly negatively related to saving frictions. This is consistent with the idea that industry-intensive provinces export physical capital to the rest of the world and other regions. The tertiary sector (*SectorTert*) has an opposite effect. Higher housing price growth (*HousingPrice*) magnifies savings but is not robust.

All indicators of the integration of the economies with the world have a negative coefficient. More open regions in terms of international trade (*Openness*), provinces with higher share of multinational firms in international exports (*MNE*) or a bigger share of FDI compared to GDP (FDI) are all implicitly subsidizing saving. However, only *MNE* is robust to the inclusion of development.

Financial development (*Deposits* and *Loans*) is positively related to the wedges (i.e. it lowers saving). Note that interpreting loans as an indicator for the presence of the state would lead to results consistent with earlier findings.

In Table 4, human capital indicators correlate positively with saving wedges but the relationship is mostly not significant. Interestingly, once one controls for economic development, social security coverage (*SOCSEC*) seems to lower saving while its coefficient has an opposite sign as standalone. Of the demographic factors, only sex ratio (*SexRatio*) and urbanization rate (*UrbRate*) are significant. If anything, regions with more unbalanced male to female ratio and more urbanized regions seem to have lower saving relative to the neoclassical model.[23]

From results in Table 5, where we regress saving frictions on key factors summarizing regional characteristics, we observe that the presence of state-owned firms in the industrial sector

[22]The presence of state-owned firms in the industrial and construction sector is related to higher investment and lower saving, which is compatible with the findings of these papers that state-owned firms are related to capital inflows and infrastructural investment to lower private consumption.

[23]Wei and Zhang (2009) find a positive effect of sex imbalances on saving at the provincial level. However, there are many differences with respect to sample (theirs is 1980-2007), estimation (they use panel data and other controls) and definition of saving (they consider $Y - C$ while our net exports are $Y - C - G - I$) that make direct comparison hazardous.

(*SOGIOV*), the importance of the industrial sector (*SectorInd*) and the share in exports of international firms (*MNE*) seem to be particularly robust. Their coefficient is smaller than in the preceding specification but of the same sign. In this and later regressions, we do not include human capital indicators, social security and other demographic factors (apart from urbanization).[24]

3.3 A panel of saving frictions

Saving frictions are the driver of the internal *capital allocation puzzle* in China. Making them time-varying could give us more power to disentangle the importance of the respective factors discussed so far. We estimate the frictions for three subsamples (1984-1992, 1993-2001 and 2002-2010). Unfortunately, there are only a few variables for which we have reliable results for all subsamples, which restricts possibilities. In Table 6, we provide a panel regression with six factors that we think are representative of regional characteristics in a given province. We use two alternative variance-covariance matrices.[25]

As in preceding tables, the share of state-owned firms in the industry (*SOGIOV*) is strongly positively related to frictions. The share of private employment (*EmplPrivate*) has the opposite effect: it acts like a saving subsidy.[26] The available balance of funds in banks and financial institutions (the difference between deposits and loans normalized by provincial GDP) is not significant.[27] The size of the industrial sector (*SectorInd*) is another robust driver of saving frictions. Openness *per se* does not seem to have an impact on frictions but FDI does: regions that receive a higher share of FDI relative to their output (*FDI*) tend to promote saving more. Obviously, our results could be spurious (i.e. driven by the fact that there is a clear downward trend in saving wedges over our three time periods). We run the same specification but introduce time fixed-effects. The share of industry and FDI are still highly significant while the coefficients on the private/state sector become insignificant.[28]

[24] First, human capital indicators did not seem to be robust to the inclusion of other factors. Second, the literature provides no clear guidance regarding their potential effect. At last, there are highly endogenous. As for social security, its introduction and extension was politically-driven and started in targeted urban areas. The self-selection issue is too obvious. Moreover, we did not find comparable provincial data for earlier periods. While we do not deny that demographic factors could play an important role at the household level, our investigations led us to think that the cross-section of macroeconomic regional data is not very helpful in testing them.

[25] We provide heteroskedasticity and autocorrelation robust variance-covariance matrix estimates (Arellano) and clustered estimates on the regional level (Liang and Zeger). The Arellano standard errors are very similar to the uncorrected standard errors. In our sample, inference sometimes changes considerably by using clustered standard errors.

[26] The literature (notably Song et al. (2011)) has emphasized that the major distinction between private and state-owned firms is that the former are financially repressed whereas the latter have preferential access to bank credit. Our results are compatible with that hypothesis: the expanding private sector can only finance its growth from retained earnings. This may explain the negative coefficient.

[27] Another implication of Song et al. (2011) is that during the transition process, state firms shrink in favor of private enterprises. As the former's economic importance dwindles and investment opportunities dry out, regions with faster growing private sector have an increasing surplus of deposits compared to loans as the largely state-owned financial sector does not redirect funds to the emerging private sector.

[28] It is not surprising: the massive decrease in the share of state-owned firms in industry and the growing private employment share are typical stylized facts of the Chinese economy that have been observed in all regions. With such a low number of time periods (three), removing the trend inevitably makes these variables less informative.

3.4 Private and state net exports

If, as suggested by our former analysis, the presence of state-owned and international firms is essential in explaining the *capital allocation puzzle*, a decomposition of net exports for different regions should be informative. Indeed, there is a rich cross-regional variation in the level of state's presence and international integration. By using data on the composition of gross fixed asset investment and the share of state output from Brandt et al. (2012), we separate net exports into state and non-state component for the 1997-2012 period and normalize by regional output.[29]

In Figure 7 (above), we see that more marketized regions with a strong presence of private and international firms (i.e. the East Coast and the City-Provinces) have a large non-state saving surplus while other regions have balanced net exports on average. From that picture, we infer that non-state net exports have either been neutral or positive in most regions and thus partly responsible for the large capital outflows observed at the national level. In fact, households and firms in high productivity East Coast regions should have imported capital and hinterland regions exported capital. Once more, this table tells us the opposite story.

But this is only one side of the *capital allocation puzzle* coin. From preceding sections, we know that many hinterland regions have experienced large capital inflows and implicitly tax savings, while they have been falling behind in terms of productivity. In Figure 7 (below), it seems obvious that the state sector is the key driving force behind such a regional pattern: large state net exports deficits largely overturn small positive non-state ones, particularly in the West and in the South. Interestingly, increasing capital imports by the state sector annihilate rising large non-state savings in Metropolises. It explains their—initially surprising—neutral net export position observed in Cudré (2012).

In conclusion, this simple decomposition provides us with additional evidence that both the state and the non-state sector play an essential role in the emergence of the *capital allocation puzzle*.

4 Data robustness checks

4.1 Subsamples

Although the adopted model has to be thought of as a long run one, an estimation of subsamples may shed light on the variations in capital flows over decades and enable to get a handle on the emergence of the *capital allocation puzzle* observed in the preceding sections.

For the period leading up to the Asian crisis (1984-1997), our flow indicator is far lower (between -1.3 and 3.1) than for the entire sample (-20.4 to 20.7). Catch-up parameters are in

[29] We use data on investment in fixed assets by ownership and attribute the state- and collective-owned shares to the state. The rest is the non-state sector. The nominal (broad) state output share of Brandt et al. (2012) (non-agricultural sector) is applied to our GDP data assuming the 2000-2007 decline rate to be constant for 2008-2012. State net exports are constructed as $NX^S = Y^S - G - I^S$ and non-state net exports as $NX^P = Y^P - C - I^P$. All data are nominal.

a similar range.[30] While there is little change in the negative relationship between flows and productivity, the positive link between investment wedges and productivity is more marked and now highly significant. The strong negative pattern of saving wedge and productivity is similar.

Things change in the sample embodying the accelerated integration of China into the world economy (1998-2010). Due to the higher reference GDP level, flows are lower than for the entire sample (-4.1 to 7.1) but clearly larger than for the initial subsample. The flows-productivity relationship is not significant anymore. Thus, it seems that the *capital allocation puzzle* has disappeared. Remarkably, the change in pattern is due to some inner provinces such as Shaanxi, Inner Mongolia, Chongqing and Shanxi that have flipped from negative catch-up in the first subsample to a positive one in the second one while continuing importing physical capital. On the other side, while mostly still being capital exporters, some eastern regions started to fall behind relative to national values in terms of productivity (e.g. Zhejiang and Guangdong). Investment wedges are now unrelated to catch-up parameters. While our regression results for investment frictions are relatively similar, the strong positive effect of state-owned firms presence on saving frictions disappears. Indicators of international integration are less informative as well. The importance of the industrial and tertiary sector, housing prices and natural resources seems to play a bigger role in explaining saving frictions.

By comparing the geographical distribution of saving wedges between both subsamples, we observe that high saving subsidies have shifted inland. Inner Mongolia, Shanxi, Shaanxi and Chongqing now have among the most negative saving wedge. To a lesser extent, central provinces exhibit the same pattern. The distribution for the earlier subsample would rather correspond to the one of the full sample. Even though major inner regions' saving wedges have turned negative, they continue to massively import capital while they catch up in terms of productivity.

As a result, the *capital allocation puzzle* and the investment puzzle may be slowly disappearing. Still, the rising inner regions are no exception to the rule in terms of the saving puzzle: they replaced East Coast provinces in the sense that they subsidize saving and catch up relative to China. The crucial difference is that, even by doing so, they are the ones that end up importing physical capital. First 2011/2012 net exports figures confirm that trend. By contrast, the East Coast experienced capital outflows all along. On the one side, the much advocated rebalancing towards domestic consumption and inner provinces development may already have started. On the other side, there are some reasons to remain sceptical about the inland take-off in productivity.[31]

[30] Cumulated provincial instead of national values are used for the computation of the reference productivity growth rate. The reason is that due to data aggregation issues, large differences between national and provincial TFP may arise in subsamples.

[31] It seems worth mentioning that this productivity reversal may happen at high cost. Brandt et al. (2012) find that western regions particularly suffered from a decrease in realized TFP due to an increasing inefficiency of capital allocation between the state and non-state sector. In Section 3.4, we show that state net exports deficits and low non-state net exports drive capital inflows in these regions. Moreover, our findings may partly be driven by idiosyncratic data issues: in Cudré (2012), light data suggest that GDP growth could have been grossly overestimated (e.g. in Inner

4.2 A simple errors correction mechanism

The quality and properties of Chinese data have been intensively discussed in the literature. At this stage, we want to tackle three major issues that potentially put our results at risk.

First, any factor systematically biasing investment statistics could make the investment puzzle disappear. As we have seen in the empirical part, SOEs' presence in the economy seems to massively influence the patterns of investment rate. One may argue that large public gross fixed capital formation is better captured by the statistical system than (smaller) private projects. Furthermore, state-owned firms possibly have incentives to overreport investment (it is a key variable for monitoring). This would lead to a too low investment in regions where marketization is more advanced (typically the East Coast) and too high figures in the hinterland compared to reality. We capture this possibility by adopting the following investment error correction mechanism:

$$Z_t^{i,synth} = \left(1 - \left[\left(\frac{X_t^i}{median_t\left(X_t^i\right)} - 1\right) \times w\right]\right) Z_t^{i,data}$$

where Z would correspond to I and X to the share of state-owned firms in total investment in fixed assets. A province (i) with relatively high share of state-owned investment in fixed assets will have a $X/median(X)$ ratio higher than one. Given an adjustment weight w, synthetic investment will be lower than in official data.[32]

Second, relative saving of more developed regions is far higher than in the rest of the country. Any factor biasing consumption of those areas downward would artificially reinforce the *capital allocation puzzle*. It is often argued that the NBS underestimates private consumption across the board.[33] For urban and richer areas where an emerging middle-class has been triggering near double digit real consumption growth over the last decade, this could particularly bias net external balance upward. To account for that, we apply the same formula as for investment with Z being S and X the urbanization rate.

At last, we tackle aggregation issues. Provincial saving and investment figures do not add up to national values. Over the last decades, investment—and to a lesser extent saving—have been historically too high on the regional level compared to national data. We take that into account by multiplying them separately by a common adjustment ratio after the errors correction to get a perfect match between national and cumulated data.

Mongolia). Finally, alternative data from Brandt et al. (2012) in Section 4.4 suggest that some may have substantially lower productivity growth (e.g Xinjiang, Inner Mongolia and Shaanxi).

[32] For example, in 2010, Shaanxi exceeds the median by 45%. Given a weight of 0.40, the correction factor is of 0.18. Only 82% of investment is considered and this region has a substantial decrease in its investment rate from 0.68 to 0.55. Note that the 1997 values for X had to be used for the entire 1984-1997 period due to data availability issues.

[33] Key issues are a too low inputed housing consumption, the report of fringe benefits paid by companies as investment and the lack of representativity of the household survey (Jun and Tian, 2013). How they influence the relative distribution of saving is debatable: the first and third arguments suggest the more developed East Coast saving to be lower while the second one would rather decrease saving and investment in inner provinces as SOEs tend to give more privileges to employees.

We apply our correction method to aggregate investment and saving before deflating. New net exports and cumulated relative capital flows are derived from these "synthetic" figures. Thereafter, we discuss implications using $w = 0.40$. We compare the synthetic time series to the raw data (both adjusted to aggregate to national values). The average investment rate of the new time series is between 10 percentage points lower and 4 percentage points higher. For saving rate, average adjustments between -8pp and 11pp are recorded. The effects on external positions ($NX = S - I$) are large: relative average net exports are between 8pp lower (Liaoning) and 14pp higher (Gansu).[34]

Interestingly, even such large biases would not flip the relationship found between capital flows, investment wedges, saving wedges and catch-up parameters. In Figure 8, we compare raw data to the corrected ones and illustrate how the relationship between capital flows and productivity catch-up flattens out but still stays negative. Main results for saving wedges are robust to the discussed modifications but less so for investment wedges.

4.3 International capital flows

We focused on external balances at the regional level. An important issue is to apprehend whether our results hold for (exclusively) international capital flows. As showed in the literature (e.g. Alder et al., 2013), the integration of the Chinese economy into the world supply chain and the creation of special economic zones was a pivotal development step. One would expect provinces more active in international trade to have positive growth and TFP impulses. In fact, as discussed in the literature review, export-led growth is one of the hypotheses having the potential of rationalizing the *capital allocation puzzle*.[35]

Custom data for international exports and imports in dollar are provided by the *China Data Center* (from 1984 to 1991). We complete them with data on trade by place of destination/origin from the *Provincial Statistical Yearbooks* (available from 1992 to 2010). They are transformed into RMB using the implicit exchange rate used in national statistics. We refer to Cudré (2012) for more information on these data.

In Figure 9, we see that the *capital allocation puzzle* is still present. Some provinces are outlier due to huge capital outflows and relatively moderate catch-up (e.g. Fujian and Zhejiang). Strikingly, most regions are not heavily involved in international trade and only a few eastern provinces seem to drive the general pattern.[36] The link between frictions and catch-up is similar

[34] Values for City-Provinces are exceptionally high: they register a decrease of between 19 and 25pp in net exports due to their high urbanization rate.

[35] Empirical work at our Chair has showed that evidence for cointegration and Granger causality between GDP, exports and imports is weak and limited to some coastal provinces (Herzog, 2013). Still, we expect evidence to be far stronger at the local level (prefectures, counties and townships). The adoption of a broader view than trade, say the inclusion of associated gross fixed capital formation, technology transfer and other positive externalities (e.g. increased competitivity of the domestic sector) could make the relationship between growth and exports more potent, even on the provincial level.

[36] Without the high value of Hainan (South), Beijing (Metro), Zhejiang, Fujian, Guangdong and Jiangsu (East Coast), the negative relationship would disappear.

as are most of the qualitative regression results.

4.4 Alternative data

The extent to which our results are robust to alternative (and better) data is relevant. In their paper on factor market distortions inside China, Brandt et al. (2012) carefully revised and assembled macroeconomic provincial time series.[37] We are particularly concerned about large systematic biases in official employment data, mainly because of the *Hukou* registration system and problems of primary and state-sector employment reporting (Brandt et al., 2012). Furthermore, we relied on official CPI while they constructed sectoral GDP deflators. A central difference is that they exclude the agricultural sector from their analysis.

Their sample ends in 2007. To fill the gap, we assume the growth rate of their data to be similar to ours for capital, employment and real GDP. The national time series are obtained by aggregating regional data. This should deliver sensible results as they already took care of aggregation properties during the data preparation process. Some provinces are excluded from their sample.[38] The national reference TFP growth rate (8.7%) is slightly higher than in our baseline version (7.07%). Their final capital to output ratio is lower than ours. Obviously, much of our capital increase has been absorbed in higher productivity growth in their data.

Their provincial TFP over the period is correlated with ours (0.64) and the general pattern is comparable although some regions experience a switch in catch-up parameter.[39] We relate the capital flow figures of this study to the new catch-up parameters and find the strong negative pattern to be robust (Figure 10). In fact, compared to the baseline graphic (Figure 2), data points are more equally distributed along the catch-up axis. The positive relationship between investment wedges and TFP is still positive but not significant anymore, while the pattern for saving wedges is preserved. Investment wedges from our baseline version are highly correlated with the alternative ones (0.95) but it is less the case for saving wedges (0.70). In Figure 11, where we compare the baseline to the new figures, one sees that there are some substantial shifts in saving wedge.[40]

There are some noteworthy changes at the supraregional level as well. In Table 2 (last column), we provide regional statistics using the new saving wedge (real GDP-weighted). The Metropolises now subsidize saving more than the East Coast. Central regions and Manchuria's

[37] We gratefully thank the authors for providing the data.

[38] Tibet, Hainan and Hunan have been excluded. Only Hunan is sizeable in terms of GDP. Another difference is that they merged Chongqing into Sichuan. We compare it to actual Sichuan and exclude Chongqing from the sample.

[39] The TFP pattern changes considerably for seven provinces. Shanxi, Liaoning, Jilin, Shanghai, Anhui and Hubei switch from negative to near zero or positive catch-up using their data. We found Xinjiang to be slightly positive and it turns out to be clearly negative according to theirs.

[40] Among substantial negative shifts in saving wedge, Beijing changes from to 0.54 to -0.61%, Liaoning from 0.04 to -0.75%, Anhui from 1.05 to -0.87% and Hubei from 0.15 to -1.75%. Conversely, Jiangxi turns from -0.69 to 0.62 and Xinjiang from -1.28 to 2.03%.

frictions are now clearly negative while they were slightly positive before. Importantly, the West does not seem to subsidize saving anymore. The positive wedge for the South is much bigger.

In spite of these changes, the econometric patterns discussed in the main sections are comparable. The effect of the presence of the state/private, international enterprises and economic structure on the frictions even seems larger.

5 Conclusion

This paper presents a first systematic analysis of external imbalances inside China. We estimate regional total factor productivity growth over three decades of economic reforms (1984-2010). By plotting productivity against the final relative change in capital flows approximated by net exports, we observe that provinces that caught up relatively to national productivity had capital outflows (i.e. positive net exports). Thus, there seems to be a *capital allocation puzzle* inside China reminiscent of the findings of Gourinchas and Jeanne (2013) at the international level.

Starting from that empirical finding, we follow up by identifying the drivers of that pattern. The methodology developed in Gourinchas and Jeanne is adopted to identify frictions affecting investment and saving in Chinese regions. A small-open economy model is augmented with two wedges. The first one (the investment wedge) affects gross returns on aggregate capital. It is identified in matching an empirical with a theoretical decomposition of investment rates. By relating investment wedges to productivity, we find an investment puzzle: regions that caught up relative to the rest of China seem to have higher wedge (lower investment rate), while provinces that fell behind implicitly subsidized investment. This is a first blow to the baseline neoclassical framework and stands in sharp contrast with international patterns.

The second friction (the saving wedge) is comparable to a tax on capital income of households. It is identified in matching an empirical with a theoretical decomposition of cumulated relative capital flows (i.e. net exports). As in Gourinchas and Jeanne at the international level, we find a saving puzzle: the relationship between productivity catch-up and saving wedges is negative and very significant. Provinces that caught up are the ones that implicitly subsidized saving, causing a saving glut that translates into capital outflows. This is a second blow to the neoclassical model as standard theory would predict that provinces with high productivity would experience capital inflows (positive saving wedge and lower saving). As opposed to investment wedges, saving frictions are the main driver of the *capital allocation puzzle*.

We relate the wedges to a large number of "usual suspects" typically suggested by the literature. The cross-regional long run variation in frictions suggests some robust explanatory variables. Characteristics related to the investment structure of the economy robustly account for a high part of the cross-regional variation in investment wedges: a high share of the state in investment in fixed assets or in construction gross output value robustly acts as an investment subsidy (i.e. it lowers investment wedges). The share of state-owned firms in gross industrial output

value magnifies investment as well. In terms of economic structure, a higher share of the construction sector relative to GDP pushes up investment rate relative to the neoclassical model. A marked presence of the formal, state-near financial sector—loans in financial institutions—seems to foster investment.

Saving wedges are correlated with a large number of variables. There seems to be an ubiquitous positive effect on saving wedge of the state's involvement in the economy (i.e. it lowers saving), independently of whether one considers investment in fixed assets or gross industrial output value. On the other side, a greater importance of foreign- and privately-owned enterprises increases saving compared to the neoclassical model. Among particularities linked to economic structure, the share of the industrial sector has a similar effect. Integration into the world supply chain is another important factor: FDI and the presence of multinational enterprises impact negatively on saving wedges (i.e. it implicitly subsidizes saving). Financial development—deposits and loans in financial institutions—seems to put a dent on savings.

The *capital allocation puzzle* is driven by both the visible hand (the state) and the private sector. By constructing non-state sector net exports, we show that more marketized regions with a strong presence of private and international firms (i.e. the East Coast and the City-Provinces) have a large non-state saving surplus while other regions have balanced non-state net exports in average. In fact, massive state net exports deficits are largely responsible for large capital imports (negative saving - investment balances) in the Chinese hinterland.

Being aware of the noisiness of Chinese statistics, we discuss the effects on our general results of alternative data. In terms of subsamples, the general patterns seem to be more pronounced for the initial reform period (1984-1997). Due to a surge of productivity growth in some hinterland regions, the *capital allocation puzzle* disappears in the more recent period (1998-2010). Then, we propose a simple errors correction mechanism by acting on three dimensions: account for the fact that large public gross fixed capital formation is potentially better captured by the statistical system than smaller private projects, embed the assumption that consumption has been underestimated (particularly in urban and richer areas) and finally adjust regional data so that they aggregate to national official figures. Even assuming substantial errors would not invalidate our results. What is more, our patterns are robust to the use of (exclusively) international physical capital flows (i.e. trade balances). We use improved regional macroeconomic time series from Brandt et al. (2012) and find our results to be robust as well, even though productivity and saving wedges strongly differ for some regions.

Table 1: Results, 1984-2010

ID	Name	Employment growth (%)	TFP catch-up	Investment over GDP	Investment wedge (%)	Capital flows over GDP	Saving wedge (%)
BJ	Beijing	3.30	-0.26	0.58	-7.95	2.89	0.54
TJ	Tianjin	1.26	0.12	0.55	-6.75	-1.62	-2.40
HB	Hebei	1.56	0.34	0.39	-2.64	-7.51	-2.40
SXI	Shanxi	1.55	-0.12	0.49	-6.20	1.30	-0.63
IM	Inner Mong.	1.39	0.34	0.54	-5.61	8.43	-2.51
LN	Liaoning	1.11	-0.21	0.36	-3.07	-1.80	0.04
JL	Jilin	1.41	-0.08	0.42	-3.64	6.37	-0.41
HG	Heilongjiang	1.29	-0.3	0.38	-4.32	-2.47	0.59
SG	Shanghai	0.76	-0.17	0.54	-7.95	-3.22	-1.24
JG	Jiangsu	1.57	0.51	0.45	-3.93	-9.26	-3.21
ZJ	Zhejiang	2.23	0.17	0.43	-3.6	-8.73	-2.00
AH	Anhui	1.98	-0.33	0.37	-3.37	0.11	1.05
FJ	Fujian	2.66	0.34	0.42	-2.22	-4.89	-2.23
JX	Jiangxi	1.62	-0.04	0.40	-3.68	0.66	-0.69
SD	Shandong	1.79	0.29	0.45	-4.25	-5.77	-2.44
HE	Henan	2.30	0.01	0.43	-3.65	0.25	-0.98
HBI	Hubei	1.35	-0.26	0.45	-5.3	-0.06	0.15
HA	Hunan	1.57	-0.37	0.32	-0.59	0.49	1.29
GD	Guangdong	3.06	0.86	0.36	0.15	-20.35	-3.50
GX	Guangxi	1.96	-0.19	0.39	-2.50	5.84	0.24
HN	Hainan	2.11	-0.37	0.52	-7.07	2.24	0.99
CQ	Chongqing	1.22	0.05	0.41	-4.23	6.72	-0.73
SA	Sichuan	1.22	-0.25	0.40	-4.47	1.98	0.41
GZ	Guizhou	2.43	-0.45	0.42	-5.05	11.47	2.58
YN	Yunnan	2.15	-0.26	0.40	-4.22	8.12	0.97
TB	Tibet	-	-	-	-	-	-
SAI	Shaanxi	1.47	0.14	0.44	-4.59	5.82	-1.33
GS	Gansu	1.76	-0.37	0.43	-5.52	3.99	1.51
QH	Qinghai	1.96	-0.44	0.63	-9.10	12.52	2.04
NG	Ningxia	2.54	-0.17	0.61	-8.17	20.69	0.47
XJ	Xinjiang	1.64	0.06	0.55	-7.97	3.34	-1.28

Catch-up parameter computed relative to national TFP. Investment, GDP and capital flows are adjusted for initial price level using an expenditure basket by Brandt and Holz (2006). Investment is deflated using consumer price index (CPI) and the price of investment in fixed assets (PIFA) since 1992. GDP is deflated by CPI. Investment wedges are obtained by matching empirical average investment rate. Capital flows are the sum of external provincial surplus/deficit ($NX = S - I$) normalized by initial real output and deflated by the last period price level as in Gourinchas and Jeanne (2013). The deflator of capital flows is CPI and, since 1997, the producer price index of manufactured goods (PPI). Saving wedges are obtained by matching empirical relative capital flows.

Table 2: Investment and saving wedge for larger regions, 1984-2010

	Real GDP	Investment wedge (%)		Saving wedge (%)		
	share (2000)	unweighted	weighted	unweighted	weighted	section 4.4
Metropolises	0.07	-7.55	-7.70	-1.03	-0.93	-2.05
East Coast	0.43	-2.75	-2.77	-2.63	-2.73	-1.84
Center	0.19	-3.32	-3.40	0.16	0.06	-0.95
Manchuria	0.10	-3.68	-3.59	0.07	0.13	-0.32
West	0.08	-6.74	-6.11	-0.25	-0.85	-0.01
South	0.12	-4.59	-4.18	0.74	0.49	3.07

Average values over six larger macroeconomic regions. Weighted version with 2000 real GDP. Metropolises: Beijing, Tianjin and Shanghai. East Coast: Hebei, Shandong, Jiangsu, Zhejiang, Fujian and Guangdong. Center: Henan, Hubei, Hunan, Anhui and Jiangxi. Manchuria: Liaoning, Jilin and Heilongjiang. West: Shanxi, Inner Mongolia, Shaanxi, Ningxia, Gansu, Qinghai and Xinjiang. South: Chongqing, Sichuan, Yunnan, Guangxi, Guizhou and Hainan.

Table 3: Factor regressions of investment and saving wedge (I)

	Investment wedge				**Saving wedge**			
	Univariate		Ec.Dvpt control		Univariate		Ec.Dvpt control	
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Investment Str.								
SOInvFA	-5.2	0.01	-8.3	0.00	4.7	0.00	3.4	0.03
FOInvFA	0.5	0.55	1.5	0.14	-1.0	0.01	-0.4	0.50
REInvFA	7.3	0.00	7.4	0.00	-3.9	0.04	-3.6	0.03
State vs Private								
SOGIOV	-1.4	0.09	-2.6	0.01	1.8	0.00	1.4	0.01
EmplPrivate	-1.3	0.12	-3.1	0.16	-1.3	0.14	1.7	0.09
Market	2.6	0.13	7.7	0.00	-3.2	0.00	-2.5	0.08
SOCGOV	-1.8	0.07	-3.0	0.01	2.4	0.00	1.6	0.05
Economic Str.								
SectorPrim	0.8	0.52	0.7	0.79	1.6	0.01	0.1	0.94
SectorInd	3.3	0.08	4.8	0.00	-5.1	0.00	-3.9	0.02
SectorConst	-3.5	0.16	-6.3	0.01	2.6	0.03	0.6	0.76
SectorTert	-5.7	0.02	-6.5	0.03	1.2	0.35	5.8	0.00
StructConc	-0.6	0.00	-0.6	0.00	0.2	0.07	0.4	0.07
HousingPrice	-0.1	0.98	0.6	0.80	-2.4	0.03	-1.1	0.41
CoalOil	-0.7	0.07	-0.8	0.05	0.1	0.55	-0.1	0.61
International								
Openness	0.1	0.90	0.8	0.70	-0.7	0.00	-0.4	0.70
MNE	0.7	0.42	2.3	0.01	-1.6	0.00	-1.4	0.03
FDI	0.1	0.84	0.7	0.63	-0.9	0.03	-0.3	0.64
Financial Dvpt								
Deposits	-2.2	0.23	-2.4	0.20	0.4	0.47	1.7	0.00
Loans	-4.5	0.02	-4.8	0.01	1.2	0.12	2.8	0.00

Cross-sectional OLS regressions with 30 observations. First regression with constant and factor, second with control for level of economic development (average of real GDP per capita relative to national values). Coefficients in %. Factors normalized by their cross-sectional mean. P-values based on heteroskedasticity-robust standard errors HC3 (jackknife approximation). The dependent variable is the investment/saving wedge estimated for the 1984-2010 sample. The independent variables are the mean over 1997-2009 of the respective factor. See Section A.1 in appendix for a description of the factors.

Table 4: Factor regressions of investment and saving wedge (II)

	Investment wedge				**Saving wedge**			
	Univariate		Ec.Dvpt control		Univariate		Ec.Dvpt control	
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Human Capital								
TertiaryEduc	-1.1	0.01	-1.9	0.01	-0.4	0.67	1.7	0.01
HighEduc	-1.2	0.11	-1.8	0.13	-0.7	0.52	1.6	0.19
Patents	-0.2	0.61	-0.1	0.94	-0.4	0.22	0.9	0.20
Social Security								
SOCSEC	-1.3	0.06	-3.0	0.02	-1.1	0.09	1.6	0.08
Demographics								
OldDepRatio	3.1	0.37	5.2	0.13	-1.8	0.32	0.9	0.66
SexRatio	-1.4	0.14	-1.6	0.07	1.5	0.04	1.0	0.14
UrbRate	-1.6	0.19	-4.5	0.10	-1.6	0.12	4.3	0.01
EthnicShare	-0.7	0.05	-0.9	0.01	0.5	0.15	0.3	0.38

Cross-sectional OLS regressions with 30 observations. First regression with constant and factor, second with control for level of economic development (average of real GDP per capita relative to national values). Coefficients in %. Factors normalized by their cross-sectional mean. P-values based on heteroskedasticity-robust standard errors HC3 (jackknife approximation). The dependent variable is the investment/saving wedge estimated for the 1984-2010 sample. The independent variables are the mean over 1997-2009 of the respective factor. See Section A.1 in appendix for a description of the factors.

Table 5: Factor regressions of investment and saving wedge (III)

	Investment wedge				**Saving wedge**		
	Coeff.	P-value			Coeff.	P-value	
	%	HC2	HC3		%	HC2	HC3
SOInvFA	-4.4	0.04	0.07	SOGIOV	0.9	0.07	0.12
Loans	-2.2	0.07	0.14	EmplPrivate	-0.7	0.40	0.48
HousingPrice	-2.0	0.31	0.40	HousingPrice	0.0	0.97	0.97
SectorConst	-3.8	0.05	0.11	SectorInd	-2.7	0.00	0.00
FDI	0.2	0.77	0.82	MNE	-0.9	0.02	0.03
UrbRate	-2.5	0.15	0.24	UrbRate	1.3	0.15	0.21

Cross-sectional OLS regressions with 30 observations. Coefficients in %. P-values based on heteroskedasticity-robust standard errors HC2 and HC3 (jackknife approximation). The dependent variable is the investment/saving wedge estimated for the 1984-2010 sample. The independent variables are the mean over 1997-2009 of the respective factor. See Section A.1 in appendix for a description of the factors.

Table 6: Panel factor regression of saving wedge for three subsamples

	No time fixed-effects			**With time fixed-effects**		
	Coeff.	P-value		Coeff.	P-value	
	%	AR	LZ	%	AR	LZ
SOGIOV	6.3	0.02	0.00	-0.9	0.82	0.43
EmplPrivate	-12.3	0.01	0.00	-4.1	0.45	0.01
DepMinLoans	0.9	0.67	0.17	1.6	0.50	0.03
SectorInd	-21.1	0.00	0.00	-11.4	0.07	0.00
Openness	1.0	0.63	0.12	0.6	0.80	0.40
FDI	-35.2	0.01	0.00	-41.1	0.03	0.00

Pooled OLS estimates with province fixed-effects. Coefficients in %, not comparable with cross-sectional regressions (i.e. not normalized by cross-sectional mean). P-values based on Arellano's heteroskedasticity and autocorrelation robust standard errors (AR) and clustered by province based on Liang and Zeger (LZ). The dependent variable is saving wedge estimated for three subsamples (1984-1992, 1993-2001 and 2002-2010). Independent variables are the mean over 1984-1991, 1993-2000 and 2002-2009 of the respective factor. EmplPrivate is in year level (1992, 2001 and 2010) because no value is available before 1992. See Section A.1 in appendix for a description of the factors.

Figure 1: Technology catch-up (π), 1984-2010

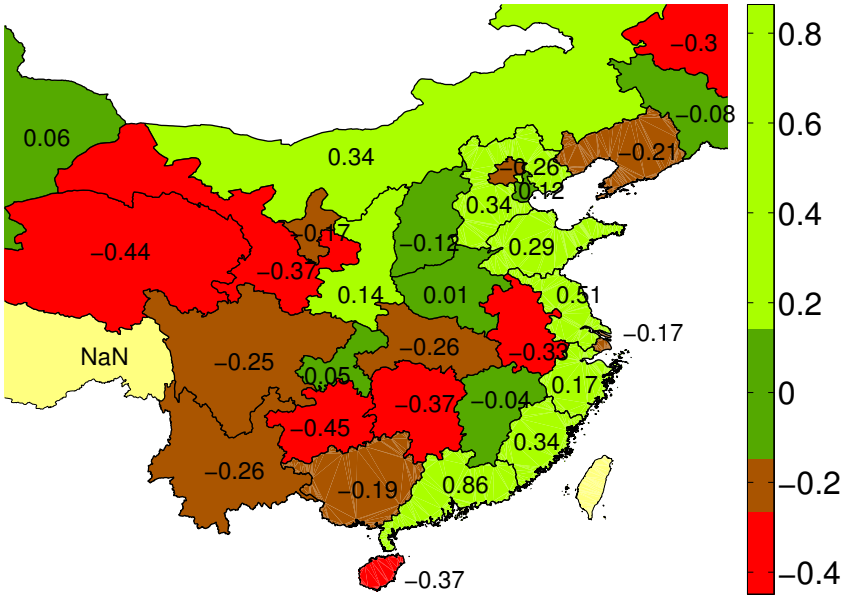


Figure 2: Capital flows vs productivity catch-up, 1984-2010

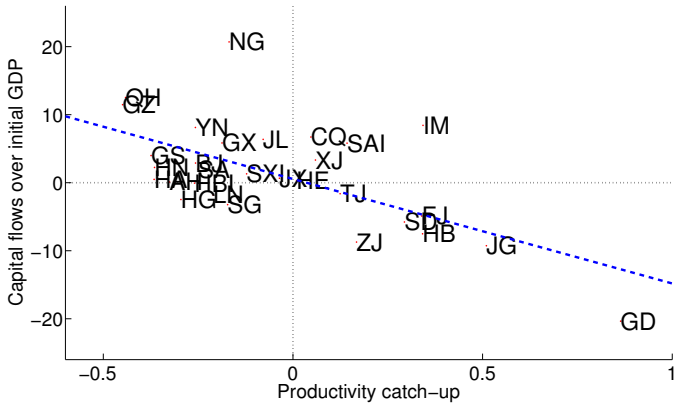


Figure 3: Investment wedge vs productivity catch-up, 1984-2010

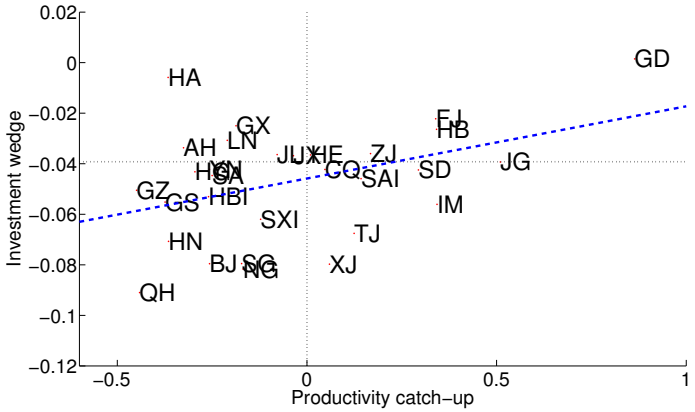


Figure 4: Saving wedge vs productivity catch-up, 1984-2010

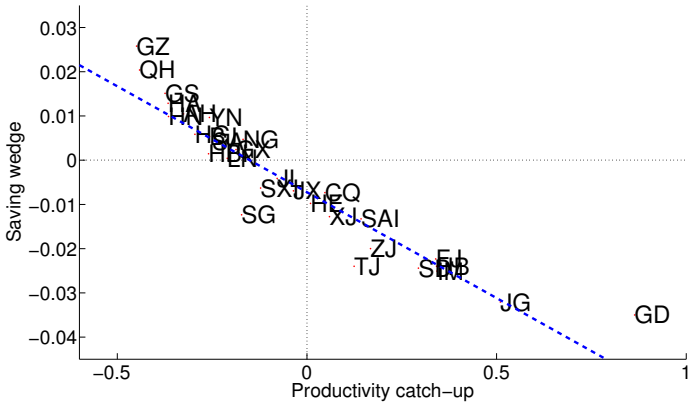


Figure 5: Investment wedges (τ_k), 1984-2010 (in %)

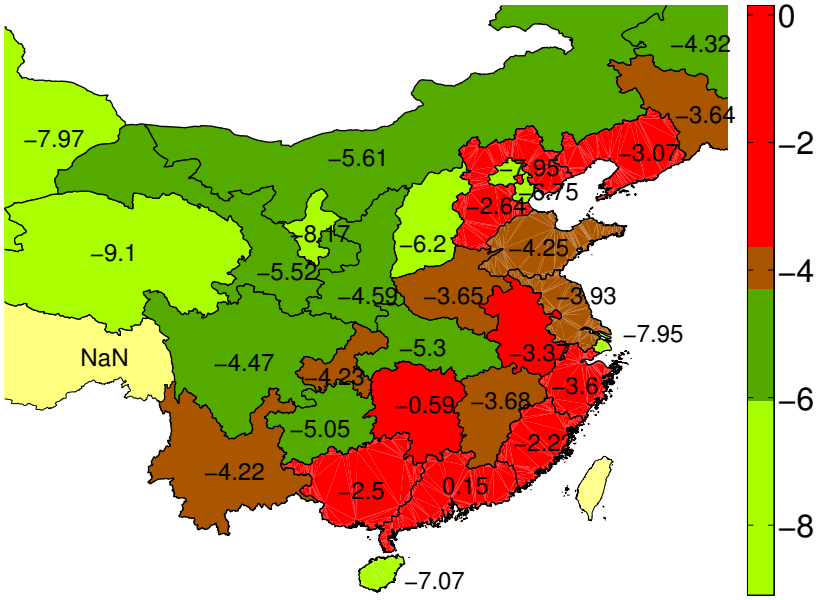


Figure 6: Saving wedges (τ_s), 1984-2010 (in %)

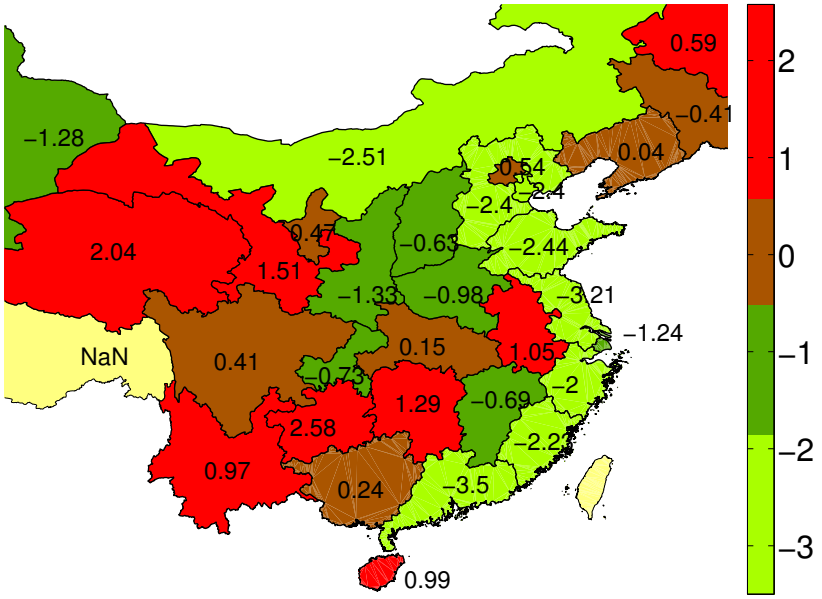


Figure 7: Non-state vs state net exports over total GDP for larger regions, 1997-2012

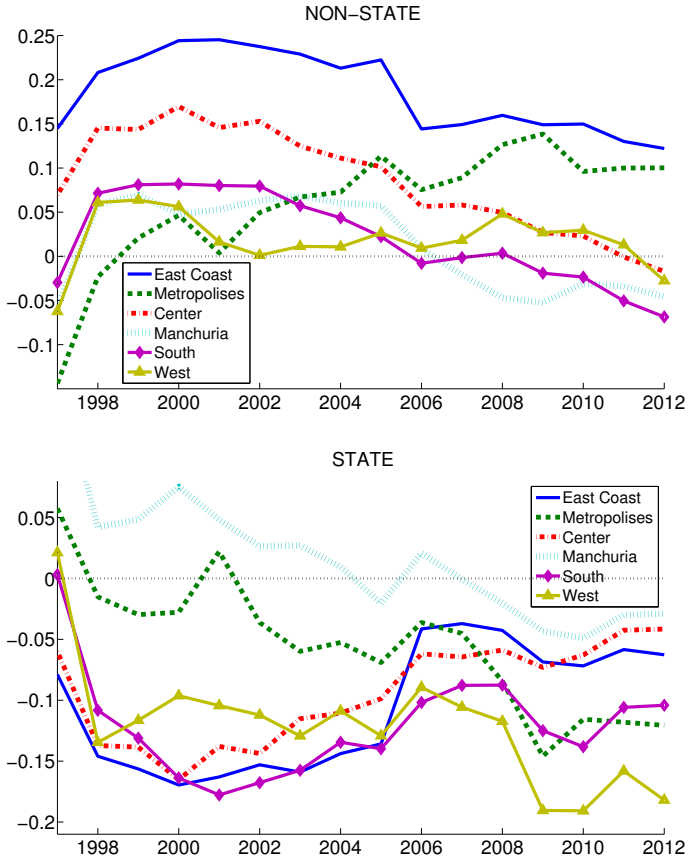


Figure 8: Productivity catch-up vs original (dashed) and errors corrected (red) capital flows

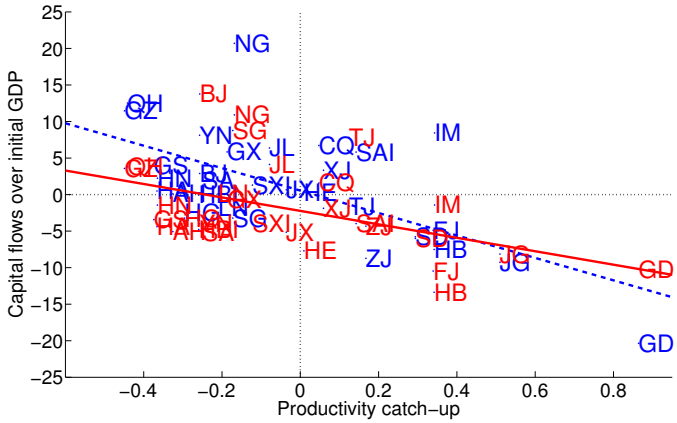


Figure 9: International trade flows vs productivity catch-up, 1984-2010

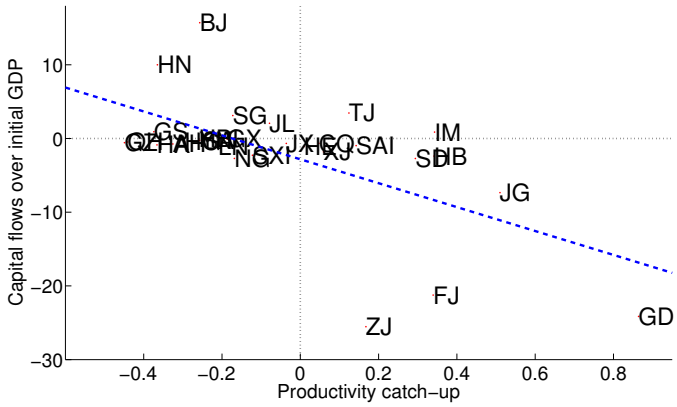


Figure 10: Capital flows vs productivity catch-up (alternative data from Brandt et al. (2012))

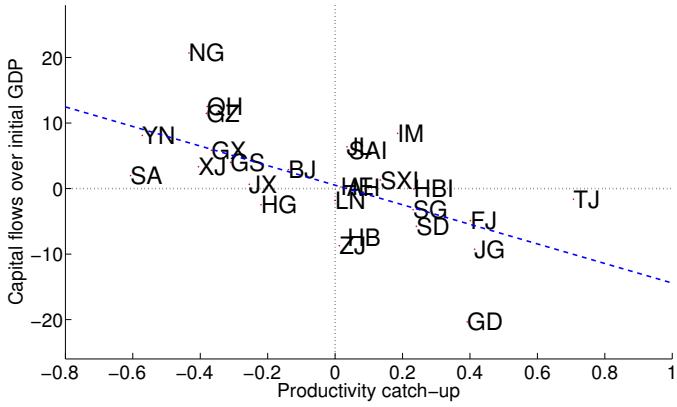
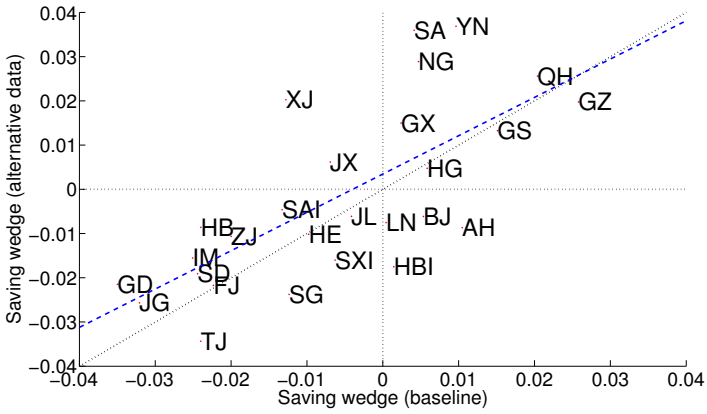


Figure 11: Saving wedge: baseline vs alternative data (Brandt et al. (2012))



References

Aguiar, M. and M. Amador: 2011, 'Growth in the Shadow of Expropriation'. *The Quarterly Journal of Economics* **126**(2), 651–697.

Aizenman, J. and J. Lee: 2007, 'International reserves: precautionary versus mercantilist views, theory and evidence'. *Open Economies Review* **18**(2), 191–214.

Aizenman, J. and J. Lee: 2008, 'Financial versus Monetary Mercantilism: Long-run View of Large International Reserves Hoarding'. *The World Economy* **31**(5), 593–611.

Aizenman, J. and J. Lee: 2010, 'Real exchange rate, mercantilism and the learning by doing externality'. *Pacific Economic Review* **15**(3), 324–335.

Alder, S., L. Shao, and F. Zilibotti: 2013, 'The Effect of Economic Reform and Industrial Policy in a Panel of Chinese Cities'. *CEPR Discussion Paper* (3).

Alfaro, L., S. Kalemli-Ozcan, and V. Volosovych: 2011, 'Sovereigns, Upstream Capital Flows and Global Imbalances'. *NBER Working Paper*.

Anderson, J.: 2007, 'Is China export-led'. *UBS Investment Research Asian Focus* **27**.

Anderson, J.: 2009, 'The myth of Chinese savings'. *Far Eastern Economic Review* **172**(9), 24–30.

Aziz, J. and L. Cui: 2007, 'Explaining China's low consumption: the neglected role of household income'. *IMF Working Papers* pp. 1–36.

Bacchetta, P. and K. Benhima: 2010, 'The demand for liquid assets, corporate saving, and global imbalances'. *Département d'économétrie et d'économie politique*.

Banerjee, A., X. Meng, and N. Qian: 2010, 'The life cycle model and household savings: Micro evidence from urban china'. *mimeo*.

Bernanke, B.: 2007, 'Global Imbalances: Recent Developments and Prospects'. *Bundesbank Lecture speech*.

Boyreau-Debray, G. and S. Wei: 2004, 'Can China grow faster? A diagnosis of the fragmentation of its domestic capital market'. *IMF Working Papers*.

Brandt, L. and C. Holz: 2006, 'Spatial price differences in China: estimates and implications'. *Economic Development and Cultural Change* **55**(1), 43–86.

Brandt, L. and T. G. Rawski (eds.): 2008, *China's Great Economic Transformation*. Cambridge University Press.

Brandt, L., T. Tombe, and X. Zhu: 2012, 'Factor market distortions across time, space and sectors in China'. *Review of Economic Dynamics*.

Brandt, L. and X. Zhu: 2010, 'Accounting for China's growth'. *Institute for the Study of Labor (IZA) Discussion Paper*.

Caballero, R. J., E. Farhi, and P.-O. Gourinchas: 2008, 'An equilibrium model of "global imbalances" and low interest rates'. *The American Economic Review* **98**(1), 358–393.

Chamon, M., K. Liu, and E. Prasad: 2013, 'Income uncertainty and household savings in China'. *Journal of Development Economics* **105**, 164–177.

Chamon, M. D. and E. S. Prasad: 2010, 'Why are saving rates of urban households in China rising?'. *American Economic Journal: Macroeconomics* pp. 93–130.

Chao, C., J. Laffargue, and E. Yu: 2011, 'The Chinese saving puzzle and the life-cycle hypothesis: A revaluation'. *China Economic Review* **22**(1), 108–120.

Chen, B. and Y. Yao: 2011, 'The Cursed Virtue: Government Infrastructural Investment and Household Consumption in Chinese Provinces*'. *Oxford Bulletin of Economics and Statistics* **73**(6), 856–877.

Cudré, S.: 2012, 'Regional External Imbalances in China: Data and Stylized Facts'. *mimeo*.

Curtis, C., S. Lugauer, and N. Mark: 2011, 'Demographic Patterns and Household Saving in China'. *NBER Working Paper*.

Dollar, D. and S. Wei: 2007, 'Das (wasted) Kapital: firm ownership and investment efficiency in China'. *NBER Working Paper*.

Du, Q. and S. Wei: 2010, 'A sexually unbalanced model of current account imbalances'. *NBER Working Paper*.

Economist, T.: 2011, 'Exports to Mars'. *The Economist* **November 12th**.

Fan, G., X. Wang, and L. Zhang: 2001, 'Annual report 2000: Marketization index for China's provinces'. *China & World Economy (5)*.

Girardin, E. and R. Owen: 2011, 'Global Trade Imbalances, Structural Change and China: What Scope for Fundamental Adjustment?'. *Working Paper*.

Gourinchas, P.-O. and O. Jeanne: 2013, 'Capital flows to developing countries: The allocation puzzle'. *The Review of Economic Studies* **80**(4), 1484–1515.

Herzog, F.: 2013, 'Multivariate Test of the Export-Led Growth Hypothesis in Chinese Regions'. *Bachelor Thesis* **University of Zurich**.

Holz, C.: 2008, 'China's 2004 economic census and 2006 benchmark revision of GDP statistics: more questions than answers?'. *China Quarterly, London* **193**, 150.

HSBC: 2012, 'China Inside Out'. *Global Research*.

Hsieh, C. and P. Klenow: 2009, 'Misallocation and manufacturing TFP in China and India'. *The Quarterly Journal of Economics* **124**(4), 1403–1448.

Jin, K.: 2012, 'Industrial structure and capital flows'. *The American Economic Review* **102**(5), 2111–2146.

Johansson, A. and X. Wang: 2011, 'Financial repression and structural imbalances'. *China Economic Research Center Working Paper* **19**.

Johansson, A. and X. Wang: 2012, 'Financial repression and external imbalances'. *China Economic Research Center Working Paper* **20**.

Johansson, A. C.: 2012, 'Financial Repression and China's Economic Imbalances'. *Rebalancing and Sustaining Growth in China* p. 45.

Jun, Z. and Z. Tian: 2013, 'Chinese consumption grossly underestimated'. *Global Times*.

Kuijs, L.: 2006, 'How will China's saving-investment balance evolve?'. *World Bank Policy Research Working Paper No. 3958*.

Li, C.: 2010, 'Savings, investment, and capital mobility within China'. *China Economic Review* **21**(1), 14–23.

Ma, G. and W. Yi: 2011, 'China's high saving rate: myth and reality'. *Economie internationale* (2), 5–39.

Mendoza, E. G., V. Quadrini, and J.-V. Rios-Rull: 2009, 'Financial integration, financial development, and global imbalances'. *Journal of Political Economy* **117**(3), 371–416.

Modigliani, F. and S. Cao: 2004, 'The Chinese saving puzzle and the life-cycle hypothesis'. *Journal of Economic Literature* **42**(1), 145–170.

Shen, J.: 2006, 'Estimating Urbanization Levels in Chinese Provinces in 1982-2000'. *International statistical review* **74**(1), 89–107.

Song, Z., K. Storesletten, and F. Zilibotti: 2011, 'Growing like China'. *The American Economic Review* **101**(1), 196–233.

Wei, S.-J. and X. Zhang: 2009, 'The competitive saving motive: Evidence from rising sex ratios and savings rates in China'. *NBER Working Paper*.

Xu, X.: 2008, 'Consumption Risk-Sharing in China'. *Economica* **75**(298), 326–341.

Yang, D., J. Zhang, and S. Zhou: 2011, 'Why are saving rates so high in China?'. *NBER Working Paper*.

Zhang, Z.: 2008, 'Dark Matter in China's Current Account'. Unpublished manuscript, International Monetary Fund.

A Data appendix

A.1 Factors

Investment structure:

SOInvFA state-owned share of investment in fixed assets (by status of registration/ownership).

FOInvFA: foreign-owned share of investment in fixed assets (HK, TW and MO included).

REInvFA: residual share of investment in fixed assets (contains collectively-owned, private and self-employed).

State vs Private:

SOGIOV: state-owned share in gross industrial output value.

EmplPrivate: private and self-employed employment share.

Market: mean of marketization index (1997-2005 average). Scale 0-10. Factors: government and market, ownership structure, goods market dvpt, factor market dvpt and legal framework. See Fan et al. (2001).

SOCGOV: state-owned share in construction gross output value.

Economic structure:

SectorPrim: share of primary sector in GDP (production approach).

SectorInd: share of industrial sector in GDP (production approach)

SectorConst: share of construction sector in GDP (production approach).

SectorTert: share of tertiary sector in GDP (production approach).

StructConc: Index of structural economic concentration using primary, industrial, construction and tertiary sector.

HousingPrice: growth of housing prices 1999-2010 (selling price of commercialized buildings, includes business and residential use, in RMB/sq.m).

CoalOil: coal and crude oil production value over GDP (using world prices for 1984-1988 and national price indices for non-ferrous metal and raw material/fuel for 1989-2010).

International:

Openness: international exports + imports over GDP (by place of destination and origin).

MNE: share of multinational enterprises in provincial international exports, mean of 1996 and 2008, from Girardin and Owen (2011).

FDI: share of used FDI over GDP.

Financial Dvpt:

Deposits: deposits in banks and financial institutions over GDP.

Loans: loans in banks and financial institutions over GDP.

Human Capital:

TertiaryEduc: enrollment in tertiary school over population.

HighEduc: enrollment in higher education over population.

Patents: patents granted per 10 000 habitants.

Social Security:

SOCSEC: index of social security coverage. Mean of pension insurance (average of urban contributors over urban employment 2005-2010 and rural contributors over rural employment 2005-2009, mixed using urbanization rate), unemployment insurance 2000-2010 (average of contributors over employment) and medical insurance 2000-2010 (average of contributors over population).

Demographics:

OldDepRatio: people 65 and more over population, mean of 2000 and 2010 Censuses.

SexRatio: nb of men for 1 woman, mean of 2000 and 2010 Censuses.

UrbRate: urbanization rate (Shen, 2006 and *National Statistical Yearbooks*).

EthnicShare: share of non-Han relative to population. 2000 Census.

A.2 Data

A.2.1 Capital stock

National and regional capital stocks are estimated using the perpetual inventory method. Business cycles are removed from the initial value by taking the mean of f (real gross fixed capital formation, GFCF) adjusted for its growth rate.[41] In accordance with the model's notation, 1984 is $t = 0$ and 2010 is $t = T = 26$.
The initial gross fixed capital formation (F_0) is

$$F_0 = \frac{1}{T+1} \sum_{t=0}^{T} \frac{f_t}{((\frac{f_T}{f_0})^{\frac{1}{T}})^t}$$

To transform data into real terms, we use Brandt and Holz (2006)'s consumption basket expenditure for the initial price level, the regional consumer price index (CPI) for 1984-1991 and the regional price index of investment in fixed assets (PIFA) for 1992-2010 (i.e. as soon as available).[42]

The initial capital stock (K_0) is

$$K_0 = \frac{F_0}{\delta + k}$$

where δ is the yearly depreciation rate of capital and k is the growth rate of capital. As in Gourinchas and Jeanne, a value of $\delta = 0.06$ is assumed. The choice of a region-specific k is more controversial. Usually, a mean of past growth rates is used. Unfortunately, this method is impossible to apply to all regions due to the lack of data on GFCF and CPI for the pre-1984 period. As an alternative, we use the mean value for the 1984-2010 period.[43] By using the initial capital stock and real gross fixed capital formation, we obtain provincial and national time series for capital stock.

In 1984, the initial capital stock to real output ratio is on average 1.2 with values between 0.6 and 2.1. At the end of the sample (2010), values for relative capital stock range between 1.6 and 3.8 with a mean of 2.4. Average provincial relative capital stock more than doubled between 1984 and 2010. The 2010 value for China (2.3) is in line with estimates found in the literature and on the private research market (HSBC, 2012, Dragonomics). Nevertheless, our estimation strategy has some shortcomings.[44]

[41] We are thankful to Prof. Dr. Woitek for suggesting that approach.

[42] We thus take into account differences in inflation as well as initial differences in price level. The reference is the price level for Chinese national value in 1984 Renminbi.

[43] In the literature, the growth of output of past periods is sometimes used as a proxy for capital growth. Here again, the poor output data for some provinces before 1984 refrain us from giving it a try. Using post 1984 output growth would lead to a roughly similar k compared to using GFCF growth. For China, real output growth over the sample period has been of 10% while real gross fixed capital formation growth has been of 12%.

[44] Intuitively, relatively rich provinces should have a higher 1984 K/Y ratio than less developped ones. In our case, this is generally true (e.g. Shanghai 1.4 vs Guangxi 0.7). There are some important exceptions: although being below

A.2.2 Technology catch-up

The time path of total factor productivity (A) is estimated using a labor share ($1-\alpha$) of 0.70.[45] Real output (expenditure approach) is in 100 million Renminbi for Y. We use Brandt and Holz (2006) consumption expenditure basket price data and official CPI to convert nominal into real output.[46] The exactness of GDP figures in China is highly controversial. For a general discussion of aggregation properties and quality, we refer to Cudré (2012). The model assumes that labor supply is exogenous and equal to population. For L, Gourinchas and Jeanne used working-age population. We refrain from using regional active population because of data issues and take employed persons in million as a proxy for L.

As population, Chinese employment measurement is an issue of its own: bad aggregation properties as well as biases arising from migration and erroneous sectoral reporting in the agricultural and state sector are common. Keeping that in mind, we assemble our own employment dataset using provincial and national statistical yearbooks. In Section 4.4, we address that issue by using data from Brandt et al. (2012). The fact that we are primarily interested in capturing long run trends and the smoothing of the TFP series should minimize potential biases. In order to get rid of transitory fluctuations, we use the Hodrick-Prescott filter.[47] The annual growth rate of TFP is then obtained using filtered data (i.e. $g^* = \left(A_T^{trend}/A_0^{trend}\right)^{1/T}$). In contrast to Gourinchas and Jeanne, we adopt a new definition of g^* as being the growth of the Chinese productivity frontier instead of the world.[48]

The last value of the catch-up parameter is defined as the steady-state one ($\pi_T = \pi$), which is used for the estimation of the wedges. Our empirical value for China is $g^* = 7.07\%$. Compared to values obtained in recent studies, our estimate appears to be an upper bound. It seems to make sense to the extent that we do not control for other potential factors inside TFP (e.g. human capital).[49]

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average in terms of wealth, western regions like Xinjiang (2.1), Qinghai (1.5) and Ningxia (1.6) start with relatively high initial value. The reason is that many less developed western provinces started with low output and experienced huge capital formation flows (i.e. high F_0) relative to their economic size.

[45] Our labor share is similar to Gourinchas and Jeanne but may be slightly too high compared to the aggregate value of 0.60 suggested by Brandt and Zhu (2010). Our results would not be seriously affected by such a change. Assuming the same factor elasticities for all regions is not controversial: Brandt et al. (2012) found them to be very similar.

[46] GDP deflators are not directly available at the provincial level and would have to be inferred from the real growth of the agriculture, manufacturing and service sector (see Brandt and Zhu, 2010). We use their productivity figures in Section 4.4 as a robustness check.

[47] Gourinchas and Jeanne used a value of 1600 that filters out more than 70% of cycles lower than 32 years. Although it certainly fits within the long run focus of the model, we stick to the usual macroeconomic value of 100. The reason is specific to the huge transformation of the Chinese economy: the steep rise in TFP experienced in most provinces causes the filter to start with a value far below initial data points. As a consequence, TFP growth would be unrealistically high. Furthermore, we are not convinced of using such a heavy filter on our short time series. In the end, it primarily affects the absolute value of the catch-up parameters rather than their distribution across provinces.

[48] To be conceptually correct, one should compute the catch-up values not relative to national figures but to a mix of world and local TFP growth as provincial net exports contain international as well as interprovincial flows. In fact, compared to the rest of the world, all regions have extremely large catch-up values. We find it more convenient to refer to national values to look at cross-sectional patterns. We motivate our approach in Section A.3.1 and show that taking alternative values of g^* does not invalidate our main conclusions.

[49] Note that, unlike in the literature on growth accounting where TFP is defined as Solow residual, TFP is labor-

A.2.3 Capital flows

In the baseline version of the estimation procedure, we refrain from using estimates of the initial debt position.[50] Still, we discuss the effects of considering a synthetic initial debt in Section A.3.3. For that reason, we keep the methodology as general as possible and already include initial debt in the discussion.

In Gourinchas and Jeanne, the change in external position over the sample (ΔD) was approximated by using a measure of initial net external debt as well as the sum of negative current accounts and net overseas assistance.[51] We could in principle approximate the initial external positions by using (negative) net exports from 1952 to 1983 and deflate them using the cumulated CPI inflation of China over the period:[52]

$$D_0^n = -\sum_{t=1952}^{1983} \frac{NX_t}{CPI_{1983}^{nat}}$$

Define Q as the regional deflator. Thereafter, we stick to Gourinchas and Jeanne and start with the external accumulation equation and some definitions:

$$\begin{aligned} D_T^n &= D_0^n - \sum_{t=0}^{T-1} CA_t^n \\ \frac{D_T^n}{Q_T} &= D_T^r \\ \frac{D_0^n}{Q_0} &= D_0^r \end{aligned}$$

which gives

increasing and can thus can *de facto* be interpreted as a mix of human capital and TFP. Without accounting for human capital, Brandt and Zhu (2010) found an average Solow residual growth of 3.05% over 1988-1998 and 4.58% for 1998-2007.

[50] First, transfers between the central government and regions are conceptually not comparable to movements in international assets as they could be unlimited and free of interest. Second, data availability issues do not allow us to include income flows and transfers in the net exports measure.

[51] For initial debt, they used the difference between the opposite of net international investment position (NIIP) and cumulated errors and omissions.

[52] Many regions lack CPI data before 1984. As for net exports, we had no choice but to infer the entire 1952-1983 values from 1978-1983 for Jiangxi, Guangdong, Sichuan and Ningxia. Note that as initial periods were quite flat in terms of net exports, we chose to consider only half the obtained amount. The value for Hainan is set to zero corresponding to the first available values between 1984 and 1986. A gap for Chongqing in 1957 is ignored.

$$
\begin{aligned}
D_T^r Q_T &= D_0^n - \sum_{t=0}^{T-1} CA_t^n \\
D_T^r &= D_0^n/Q_T - \sum_{t=0}^{T-1} CA_t^n/Q_T \\
D_T^r - D_0^r &= D_0^n\left(\frac{1}{Q_T} - \frac{1}{Q_0}\right) - \sum_{t=0}^{T-1} \frac{CA_t^n}{Q_T}
\end{aligned}
$$

We use net exports instead of current account as, to our knowledge, no income flows statistic on the regional level is available over the sample period. Ideally, the deflator Q should capture the evolution of the price of traded goods. Gourinchas and Jeanne used the price of investment goods as a proxy due to data restriction. Our deflator for cumulated net exports and debt (PTG) is a combination of regional CPI (1984 to 1996) and of the regional producer price index of manufactured goods (PPI) (1997-2010) as a proxy for the price of tradable goods. Thus, our final expression for relative capital flows from 0 to $T-1$ is

$$
\frac{\Delta D^r}{Y_0} = \frac{D_0^n}{Y_0}\left(\frac{1}{PTG_T} - \frac{1}{PTG_0}\right) - \frac{\sum_{t=0}^{T-1} NX_t^n/PTG_T}{Y_0}
$$

It is normalized by initial real GDP based on regional CPI ($Y_0 = Y_0^n/CPI_0$). The initial debt or asset position enters our flow indicator with the following reasoning: provinces with initial debt position—positive D_0^n or negative cumulated net exports in the past—will experience capital outflows depending on the pace of price level growth as they hold their debt ratio constant. Regions with initial assets will experience capital inflows.

A.3 Sensitivity analysis

A.3.1 Reference productivity growth rate

The reference rate of productivity growth (g^*) is an important parameter of the model as it determines the benchmark against which provinces catch-up or fall behind in TFP terms. It directly influences the reference interest rate.[53] While the authors of the initial paper chose US TFP growth (1.7%), we used our estimated value for China (7.07%). Obviously, this high national rate only plainly makes sense when the focus lies on intranational capital flows. The purely international and mixed flows should be discussed using a productivity reference rate rather similar in value to world TFP growth rate. In the past sections, we refrained from it.[54]

[53] In the baseline model, the assumption that $R^* = g^{*\gamma}/\beta$ is used.

[54] Four arguments can be made to justify that choice. 1.The interpretation of results is more intuitive using zero-centered saving wedges. 2.All regions without exception massively caught up relative to the world technology frontier. As a consequence, we would end up with abnormally high π. For a given set of extreme parameters, the model has difficulties to match precisely the data and to identify the frictions. 3.As discussed in Cudré (2012), much of the dynamics and discrepancies in external balances inside China seems to arise from interregional capital flows rather than purely international ones. 4.We are primarily interested in determining and understand the cross-regional pattern

A lower benchmark productivity value pushes the level of catch-up parameters up. For example, by using an hypothetical reference rate of 3%, the value range would expand from $[-0.45\ \ 0.86]$ to $[-0.51\ \ 4.11]$ but ranks would remain unchanged. We observe only minor variations in the rank of regional frictions. The general patterns are identical and the wedges using a 3% TFP would be highly correlated with their counterpart using national TFP estimates.[55] The saving wedge - TFP relationship becomes increasingly negative and remains significant as the reference rate grows. Qualitatively, econometric results are comparable.

A.3.2 Coefficient of relative risk aversion

Up to this point, the entire procedure has been run with log utility (i.e. unit intertemporal elasticity of substitution). Alternative risk aversion coefficients (γ) influence investment wedges in a near linear way: the entire distribution shifts down following a parameter increase. Changes in relative risk aversion affect saving wedges (the range and the cross-sectional variability in saving wedges increases with higher coefficient). The relationship with TFP becomes more and more negative. Minor changes in ranking are observed but the correlations with the baseline case remain high.[56]

A.3.3 Initial external position

Although the general capital flows concept has already been presented in Section A.2.3, we have refrained from assuming an initial debt or asset position in the wedges' computation yet. In this section, we include them in the analysis. The initial debt level enters the model via the capital flows estimation and the debt in efficiency units in the trend channel ($\Delta D^t/Y_0$) of the relative capital flows decomposition used to estimate saving wedge.

The initial position is estimated using half of cumulated negative net exports from 1952 to 1983 divided by the national CPI index. We observe that initial external positions are large. The Metropolises—Shanghai, Beijing and Tianjing—and to a lesser extent Manchurian regions had accumulated large assets over the pre-reform period and, as a consequent, experienced capital inflows from their net external position in the following periods. West and South China recorded large initial debt (i.e. subsequent capital outflows) while most of the Center was roughly neutral.

Even though the initial debt part reveals itself to be negatively correlated with the net exports part of our flow indicator, the latter primarily drives the pattern of the capital flows estimation. Our final flows measure is still nearly perfectly correlated with the one of the baseline case. The minor changes in the relative ranking of the flows do not translate into substantial changes in saving wedges.[57] Still, there are some major differences for Metropolises and West China.

of wedges rather than their absolute value.

[55] For investment wedges, the correlation is of 0.94 and the rank correlation 0.92, while corresponding values for saving wedges amount to 0.97 and 0.96.

[56] For $\gamma = 2$, the correlation of saving wedges is of 0.97 and the rank correlation of 0.96.

[57] The correlation and rank correlation between saving wedges of the baseline model and this version are 0.96.

Beijing, Tianjin and Shanghai accumulated large external assets of more than 200% of GDP before economic reforms. Implicit capital inflows over the next decades are automatically making their saving wedge more positive. The situation is reversed for some less developed western regions (e.g. Xinjiang) where high initial debt—and subsequent capital outflows—lowers the net inflows and the saving wedge.

These changes do not invalidate the *capital allocation puzzle*. If we let the weight on initial external position vary between 0 and 1, the negative correlation of saving wedge with productivity is maintained but the substantially affected regions that we mentioned end up on the flip side of the regression line without affecting much its slope and significance. All in all, taking net external position into account only influences the saving friction of a few provinces and does not affect our conclusions.