A provincial view of global imbalances: regional external adjustment in China

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Preliminary and incomplete

Abstract

We examine capital flows among Chinese provinces. Using a theory-based variance decomposition, we gauge the importance of various channels of external adjustments at the regional level: variation in intertemporal prices – real interest rate, real exchange rates and terms of trade fluctuations — and intertemporal variation in quantities (cash flows of output, investment and government spending). We find that our simple framework can account for around 80 percent of the variation in intra–national capital flows over the period 1984-2010. Our preliminary results also suggest that expected variation in prices is more important as driver of capital inflows in provinces that are more resources rich, financially more developed and more open to foreign direct investment. We expect our results to shed light on the sources of global imbalances in capital flows.

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Introduction

The empirical fact that international capital tends to flow uphill – from big emerging economies such as China to highly developed countries such as the US – has been an issue of intensive academic and policy debate over the last decade. This pattern is a theoretical challenge to neoclassical growth models and therefore has rightfully been dubbed a puzzle (Gourinchas and Jeanne (2011)). It is also often seen as the main symptom of a perceived imbalance in international capital flows that could distort exchange rates, interest rates and asset prices at a global level (Bernanke (2007)). Considerable research effort has therefore been given to explaining these patterns theoretically (Caballero, Farhi and Gourinchas (2008); Mendoza, Quadrini and Rios-Rull (2009); Song, Storesletten and Zilibotti (2011); Aguiar and Amador (2011)).

However, so far, we have relatively little evidence about the patterns of *intra*-national capital flows in the country that – with its persistent surpluses over the last decade – best exemplifies this capital allocation puzzle: China. We attempt to fill this gap in this paper. We study empirically the dynamics and determinants of net exports at the level of Chinese provinces. As we will argue, this 'cross-section' of China's net exports provides a useful disaggregated perspective on global imbalances and their origins.

Specifically, we model province-level net exports using a stylized intertemporal model of capital flows in which we allow for a simple form of financial frictions in the form of a 'savings wedge' in the mold of Gourinchas and Jeanne (2011). Our framework builds on Hoffmann (2012) and nests two broad channels of external adjustment in interprovincial capital flows: the first is variation in intertemporal prices which can further be disaggregated into variation in real interest rates, real exchange rates (i.e. the relative price of tradeable and non-tradeable goods) and variation in the terms of trade. The second is intertemporal variation in quantities – cash flows of output, investment and government spending. As we show, our simple model can account for up to 80 percent of the variation in a panel of province-level net exports over the period 1984-2010 . Of this, variation in cash flow explains on average 60 percent of external adjustment and intertemporal prices, on average, account for the remaining 20 percent.

However, these numbers mask considerable cross-provincial heterogeneity in the importance of adjustment channels. Our decomposition of provincial net exports puts us into a position to correlate province-level patterns of external adjustment with a host of regional characteristics. Our first results suggest that intertemporal variation in prices is more important as a channel of external adjustment for provinces that are financially more developed, more open to foreign investment and more dependent on mineral resources.

Conversely, rates of state-ownership or openness to trade *per se* do not impact these patterns significantly. Also, there has been no uniform change in province's external adjustment patterns following China's accession to the WTO.

At this stage, our empirical results are still preliminary. However, they illustrate the usefulness of a province-level decomposition of external adjustment channels for our understanding of global imbalances more generally: as we document empirically, China's provinces are characterizied by an internal capital allocation puzzle, with some of the most quickly growing provinces displaying the most persistent surpluses (see also Cudré (2012*a*)). Our framework here allows us to ask whether external adjustment channels differ between surplus and deficit provinces and to what extent these adjustment channels are a function of deeper regional characteristics. This will help us discriminate empirically between various theoretical mechanism that have been discussed in the literature and to obtain a taxonomy of their relative quantitative importance for capital flows.

The paper is structured as follows: section two introduces our theoretical and empirical framework. Section three describes the data. Section four presents first results.

The framework

Our analysis follows the tradition of the intertemporal approach to the current account (Sachs, Cooper and Fischer (1981); Bergin and Sheffrin (2000); Kano (2008); Hoffmann (2012)). However, to our knowledge, we are the first to extend and apply the empirical framework used in these studies to intra-national data and, in particular, to data from Chinese regions. Our setup here extends Hoffmann (2012) to allow us to study a cross-section of economies. It is based on rather minimal identifying assumptions since it builds on the log-linearized version of an intertemproal budget constraint, similar to Lettau and Ludvigson (2001); Gourinchas and Rey (2007). Our starting point is the law of motion of a province's claims on the rest of the world (including other provinces and other countries), here expressed in tradeable goods as

$$B_t^k = (1 + r_t^{kT})B_{t-1}^k + Y_t^k - I_t^k - G_t^k - C_t^k$$

where B_t^k is the stock of out-of-region assets and Y_t^k, I_t^k, G_t^k and C_t^k denote the province-level values of real output, investment, government consumption and private consumption respectively. The term r_t^{kT} denotes the interest rate (expressed in terms of tradeable goods) that the province obtains on its (end-of-last-period) holdings of out-of-province assets, B_{t-1}^{k}. We can then define the provincial net exports balance as

$$NX_t^k = \Delta B_t^k - r_t^{k,T} B_{t-1}^k = NO_t^k - C_t^k$$

where we use the notation $NO_t^k = Y_t^k - I_t^k - G_t^k$ to denote net output, i.e. the cash flow available for consumption to the province's residents.

We allow for interest rates to differ across provinces by introducing a wedge between the home (province-level) and the world (i.e. China- or world-wide) interest rate r_t^W so that

$$1 + r_t^{kT} = (1 + r_t^W)(1 - \tau_t^{ks}) \tag{1}$$

where τ_t^{ks} is a 'savings wedge' that we introduce to capture frictions in interregional capital flows. Gourinchas and Jeanne (2011) have argued very convincingly that such a 'savings wedge' – rather than frictions in the accumulation of capital – are important in explaining the capital allocation puzzle, i.e. the empirical fact that current accounts and GDP growth are positively correlated in a large cross-section of countries, particular among emerging economies[1]. Note that $\tau_t^{k,s}$ can take both positive and negative values: a positive value would be friction that deters saving (amounting to a tax on foreign income) whereas negative values of τ_s would amount to an implicit subsidy of savings. For China, as a prime example of a high-growth / high savings economy, we would expect negative values of τ^s on average. However, we would also expect that provinces differ in their

[1]Here, we derive the model solution under the assumption of a time-varying savings wedge. In our empirical implementation below, we follow Gourinchas and Jeanne (2011) and assume that $\tau^{k,s}$ is constant.

levels of financial development. Therefore, in our setup here, we allow wedges to vary across provinces.

Imposing the usual transversality constraint, the above law of motion for the current account can be solved forward, to yield the non-linear intertemporal budget constraint.

$$B_{t-1}^{k} = \sum_{l=0}^{\infty} E_t \left\{ R_{t+k}^{k,T} \left[C_{t+l}^{k} - NO_{t+l}^{k} \right] \right\}$$

where $R_{t+l}^{T,k} = \left[\prod_{i=0}^{l} (1 + r_{t+i}^{T,k}) \right]^{-1}$. We build on Kano (2008) and log-linearize this expression to obtain a formula for the net exports / net output ratio[2]

$$\frac{\widetilde{NX}}{NO_t}^{k} = c \sum_{l=1}^{\infty} \kappa^l E_t \left\{ \Delta\widetilde{c}_{t+l}^{k} - \widetilde{r}_{t+l}^{T,k} \right\} + \sum_{l=1}^{\infty} \kappa^l E_t \left\{ \widetilde{r}_{t+l}^{T,k} - \Delta\widetilde{no}_{t+l}^{k} \right\} \qquad (2)$$

Here, Δno and Δc are the growth rates of net output and consumption expenditure respectively and the tilde denotes deviations from the unconditional mean. The parameters b and c are the long-term means of B/NO and C/NO. The discount parameter takes the form $\kappa = exp\left[E(\Delta no_t) - E(r_t)\right]$. In the derivation, we have assumed that $E(\Delta no_t^k) = E(\Delta c_t^k)$. Note that the approximation above follows directly from the intertemporal budget constraint and that we have, so far, not imposed any restrictions on technology or preferences.

In what follows, we restrict this setup using some theory. Specifically, we posit that each province's representative agent has lifetime CRRA utility over a consumption bundle composed of a tradeable and non-tradeabble

[2] Kano (2008) obtained an expression for the CA/NO ratio. As no income flows data among regions are availaible, we use the approximation $\frac{\widetilde{NX}}{NO_t}^{k} = \frac{\widetilde{CA}}{NO_t}^{k} - b\widetilde{r}_t^{T,k}$.

goods:

$$\sum_{t=0}^{\infty} \beta^t E_0 \left[\frac{X\left(C^k_{Nt}, C^k_{Tt}\right)^{1-\gamma}}{1-\gamma} \right]$$

where

$$X^k_t = X\left(C^k_{Nt}, C^k_{Tt}\right) = C^{k\alpha}_{Tt} \times C^{k1-\alpha}_{Nt}$$

In this setting, it is well known that the intertemporal consumption allocation can be solved for independently from the intratemporal allocation between tradeable and non-tradeable goods. Specifically, we can define the price index of aggregate consumption by recognizing that for any such index P^{k*}_t it must be true that $P^{k*}_t X^k_t = C^k_{Tt} + P^k C^k_{Nt} = C^k_t$ for all P^k_t. Then replacing C^k_t with $P^{k*}_t X^k_t$ in the budget constraint, one obtains the Euler equation

$$E_t \left(\beta \frac{P^{k*}_t}{P^{k*}_{t+1}} \left(\frac{X^k_t}{X^k_{t+1}} \right)^{\gamma} \left(1 + r^{T,k}_{t+1}\right) \right) = 1$$

which can be rewritten in terms of aggregate consumption expenditure as

$$E_t \left(\beta \left(\frac{C^k_t}{C^k_{t+1}} \right)^{\gamma} \left(\frac{P^{k*}_t}{P^{k*}_{t+1}} \right)^{1-\gamma} \left(1 + r^{T,k}_{t+1}\right) \right) = 1 \qquad (3)$$

The aggregate price index for consumption is given by $P^*_{t+1}/P^*_t = \left(P_{t+1}/P_t\right)^{1-\alpha}$. Hence, (3) links aggregate consumption expenditure growth to the consumption-based real interest rate, which is the world-real interest rate corrected for the savings wedge and real exchange rate changes (defined as the change in the relative price of non-traded goods). Assuming that consumption growth, the real exchange rate, and the real interest rate are jointly log-normal, Bergin and Sheffrin (2000) show that this condition can be log-linearized to obtain

$$E_t(\Delta c^k_{t+1}) = \frac{1}{\gamma} E_t\left(r^k_{t+1}\right) + constant \tag{4}$$

where r^k_t is the consumption-based real interest rate

$$r^k_{t+1} = r^{T,k}_{t+1} + (1-\alpha)(\gamma - 1)\Delta p^k_{t+1}$$

and where Δp^k_{t+1} reflects the change in the non-tradeable-price.

We now substitute for consumption growth and the real interest rate term on the right hand side of the log-linearized budget constraint.[3] Plugging in for $r^k_{t+1}/\gamma = E(\Delta c^k_{t+1})$, and using the approximation $r^{T,k}_t = r^W_t - \tau^{ks}_t$, we obtain the following expression for the net exports

$$\frac{\widetilde{NX_t}}{NO_t}^k = [1-\phi]\sum_{l=1}^{\infty}\kappa^l E_t \widetilde{r^W}_{t+l} + \phi \sum_{l=1}^{\infty}\kappa^l E_t \widetilde{\Delta q}^k_{t+l} - \sum_{l=1}^{\infty}\kappa^l E_t \Delta\widetilde{no}^k_{t+l} - \left[b\widetilde{\tau}^{ks}_t + [1-\phi]\sum_{l=1}^{\infty}\kappa^l E_t \widetilde{\tau}^{ks}_{t+l}\right] \tag{5}$$

where we have introduced additional notation so that $\phi = c\left(1 - \frac{1}{\gamma}\right)$ and $\Delta q_{t+1} = (1-\alpha)\Delta p_{t+1}$ is the change in the real exchange rate (or rather: the inflation differential in relative price of nontradables and tradables).

This equation suggests four channels of current account adjustment. The first term is consumption-tilting due to expected variation in the world (or China-wide) real rate of interest: if interest rates are temporarily high, so that the sum of future interest-rate deviations from the long-term mean interest rate is positive, consumers will want to defer consumption and save more. We call this the global tilting term since it is determined by global (or at least: country-wide) variation in interest rates. Clearly, this global tilt-

[3] This follows Bergin and Sheffrin (2000) and Bouakez and Kano (2009). However, these models do not feature a savings wedge.

ing effect becomes stronger as the intertemporal elasticity of substitution, $1/\gamma$, increases. The second term is the effect on intertemporal substitution of expected real exchange rate changes. If the price of the domestic consumption bundle relative to tradeable goods is expected to rise in the future, there is an incentive to save more. In analogy to Hoffmann (2012), we refer to this channel as 'domestic tilting' since it is driven by relative variation in expected prices of only domestically consumed (non-tradeable) to both internationally and domestically consumed (tradeable) goods. The third term reflects the classical consumption smoothing channel: if output is below (above) trend, so that the sum of its expected changes is positive (negative), the country should run a deficit (surplus) *ceteris paribus*.

Finally, the fourth term reflects the impact of expected variation in financial frictions – the savings wedge – on the current account. The impact is completely symmetric to variation in the world interest rate. If $0 < \phi < 1$, a temporary drop of τ_t^s below its long-run mean will turn the sum of expected future mean deviations $\widetilde{\tau}_{t+k}^s$ negative, thus increasing the current account ceteris paribus: it will be optimal to take advantage of the temporary subsidy to savings and to defer consumption for a while. Conversely, a temporary increase in τ_t^s will tend to lower the current account.

If the savings wedge $\tau_t^{ks} = \tau^{ks}$ is constant, then $\widetilde{\frac{NX}{NO_t}}^k$ becomes

$$\widetilde{\frac{NX_t}{NO_t}}^k = \left[1 - c\left(1 - \frac{1}{\gamma}\right)\right] \sum_{l=1}^{\infty} \kappa^l E_t \widetilde{r^W}_{t+l} + c\left[1 - \frac{1}{\gamma}\right] \sum_{l=1}^{\infty} \kappa^l E_t \widetilde{\Delta q}_{t+l}^k - \sum_{l=1}^{\infty} \kappa^l E_t \Delta \widetilde{no}_{t+l}^k \tag{6}$$

Formally, this equation would also hold in a frictionless model, i.e. if $\tau^{ks} = 0$.[4] Note however, that $\kappa = exp\left[E(\Delta no_t) - E(r_t^w) + E(\tau_t^s)\right]$ so that future

[4] In fact, equation 6 is a special case of equation (18) studied in Bouakez and Kano (2009). Their model also allows for changes in the terms of trade and nests the model here if $\tau_t^s = 0$.

expected values of prices and quantities affect the current account very differently if $\tau^s \neq 0$. For example, with a savings subsidy ($\tau_s = E(\tau_t^s) < 0$) we will have a lower value of κ than in a frictionless model ceteris paribus and the current account therefore reacts relatively more strongly to current or immediately imminent changes in the expected values of Δq, Δno and r_t^W than in a frictionless model. It can also be shown that $\tau^s \neq 0$ also affects the mean of the the current account itself around which equation (6) is log-linearized. We return to these points in our calibration of the model parameters below. Clearly, whether or not τ_t^s varies over time and whether it has a constant mean is an empirical question.

Equation (6) is the focus of our empirical anylsis of province-level net exports. For each region in our sample, we can now proxy the expectations on the right hand side of (6) using a vector autoregressive model (VAR):

$$X_t^k = \sum_{\boldsymbol{l=1}}^{\boldsymbol{p}} \boldsymbol{A_l(k)} X_{t-l}^k + \boldsymbol{\varepsilon}_t^k$$

where $X_t^k = \begin{bmatrix} \Delta no_t^k & \Delta q_t^k & r_t^W & NX/NO_t^k \end{bmatrix}'$ is the vector of endogenous variables, the $\boldsymbol{A}_l(k)$ are 4×4 coefficient matrices of the p-th order VAR and $\boldsymbol{\varepsilon_t^k}$ is the vector of reduced-form residuals. Stacking $Z_t^k = \begin{bmatrix} X_t^k, & X_{t-1}^k, & \dots & , X_{t-p+1}^k \end{bmatrix}'$, write the VAR companion form as VAR(1) so that

$$Z_t^k = \boldsymbol{A_{\{k\}}} Z_{t-1}^k + U_t^k \tag{7}$$

where $\boldsymbol{A}_{\{k\}}$ is the companion matrix of the VAR estimated on province k data and $U_t^k = \begin{bmatrix} \boldsymbol{\varepsilon}_t^k, & 0, & \dots & , 0 \end{bmatrix}$ the associated vector of residuals. Then, once the VAR-parameters has been estimated, the expectation terms are easily backed out as

$$\sum_{l=1}^{\infty} \kappa^l \boldsymbol{E}_t X_{t+l}^k = \boldsymbol{e}_x' \kappa \boldsymbol{A}_{\{k\}} \left[\boldsymbol{I} - \kappa \boldsymbol{A}_{\{k\}} \right]^{-1} Z_t^k$$

where X_t stands, in turn, for Δno_t, Δq_t, r_t^W, $\frac{NX_t}{NO_t}$ and $\boldsymbol{e}_x$ is the unit vector associated with the position of x in the vector Z_t^k (i.e. the first unit vector for Δno, the second for Δq_t etc.). Plugging this representation of the expectation terms into (5) above, one gets the NX/NO ratio predicted by the model for each province:

$$\widehat{\frac{NX_t}{NO_t}}^k = \left[(1-\phi) e_r' + \phi e_{\Delta q}' - e_{\Delta no}' \right] \kappa \boldsymbol{A}_{\{k\}} \left[\boldsymbol{I} - \kappa \boldsymbol{A}_{\{\boldsymbol{k}\}} \right]^{-1} Z_t^k \qquad (8)$$

where again $\phi = \left(1 - \frac{1}{\gamma}\right) c$ and where we denote the predicted value from the model with a hat.

For each province and for any known set of parameter values $1/\gamma$, κ and c the predicted net exports can now be compared to the actual net exports. This can be done either through an informal comparison of the predicted net exports with the data (in terms of correlation and variance) or formally, based on a Wald test.[5]

Note that in the above setup, we let the VAR-parameters vary across provinces, allowing for potentially very different dynamics in outputs, prices and interest rates across regions. One decision we have to take at this junction is to what extent we want to allow the parameters of the theoretical model like c (the long-term consumption ratio) and in particular $1/\gamma$ (the

[5] Rewriting equation (8) for a given companion matrix $\boldsymbol{A}$ as $\boldsymbol{e}_{ca}' = b\boldsymbol{e}_r' + \left[(1-\phi)\boldsymbol{e}_r' + \phi \boldsymbol{e}_{\Delta q}' - \boldsymbol{e}_{\Delta no}' \right] \kappa \boldsymbol{A} \left[I - \kappa \boldsymbol{A} \right]^{-1}$ and denoting the right hand side of this restriction with $\boldsymbol{\Psi}(\boldsymbol{A})$, the Wald-statistics $[\boldsymbol{e}_{ca}' - \boldsymbol{\Psi}(\boldsymbol{A})] \frac{\partial \boldsymbol{\Psi}(A)}{\partial A} var(\boldsymbol{A})^{-1} \frac{\partial \boldsymbol{\Psi}(A)}{\partial A}' [\boldsymbol{e}_{ca}' - \boldsymbol{\Psi}(\boldsymbol{A})]'$ is asymptotically distributed as a χ^2 with m degrees of freedom where m is the dimension of the companion matrix $\boldsymbol{A}$.

intertemporal elasticity of substitution) to differ across regions. In principle, c can be fixed from the data. Also, one may want to restrict the preference parameters γ and possibly fix it to be the same across regions. For now, we estimate $1/\gamma$ and κ using a GMM-procedure for each province separately. We discuss the details of this below.

Channels of province-level external adjustment

Once the parameters κ, c and γ have been fixed, we can use (8) to decompose the variance of each province's net exports as follows. Write the component that is unexplained by the model as $res^k = NX^k/NO^k - \widehat{NX/NO}^k$, take the variance on both sides and plug in for $\widehat{NX/NO}^k$ from (8). Then, dividing by $var(NX^k/NO^k)$, one gets

$$1 = \beta_r^k + \beta_{\Delta q}^k + \beta_{\Delta no}^k + \beta_{res}^k \tag{9}$$

where

$$\begin{aligned}
\beta_r^k &= \frac{cov\left((1-\phi)\boldsymbol{e}_r'\kappa \boldsymbol{A}_{\{k\}}\left[\boldsymbol{I}-\kappa \boldsymbol{A}_{\{k\}}\right]^{-1} Z_t^k, NX^k/NO^k\right)}{var(NX^k/NO^k)} \\
\beta_{\Delta q}^k &= \frac{cov\left(\phi \boldsymbol{e}_{\Delta q}'\kappa \boldsymbol{A}_{\{k\}}\left[\boldsymbol{I}-\kappa \boldsymbol{A}_{\{k\}}\right]^{-1} Z_t^k, NX^k/NO^k\right)}{var(NX^k/NO^k)} \\
\beta_{\Delta no}^k &= \frac{cov\left(-\boldsymbol{e}_{\Delta no}'\kappa \boldsymbol{A}_{\{k\}}\left[\boldsymbol{I}-\kappa \boldsymbol{A}_{\{k\}}\right]^{-1} Z_t^k, NX^k/NO^k\right)}{var(NX^k/NO^k)} \\
\beta_{res}^k &= \frac{cov(res^k, NX^k/NO^k)}{var(NX^k/NO^k)}
\end{aligned}$$

where again $\phi = \left(1-\frac{1}{\gamma}\right)c$. Here, β_r^k is the contribution of (expected) variation in the world real rate of interest (the global tilting factor), $\beta^k_{\Delta q}$ the contribution of expected changes in the real exchange rate (the domestic tilting factor), and $\beta^k_{\Delta no}$ the contribution of output variation (consumption smoothing). The coefficient β^k_{res} is the fraction of the variance of province k's current account that remains unexplained by the model.

For notational compactness, we collect the various β^k_xs into the vector

$$\boldsymbol{\beta}^k = \left[\begin{array}{ccc} \beta^k_r & \beta^k_{\Delta q} & \beta^k_{\Delta no} \end{array} \right]'$$

and we call $\boldsymbol{\beta}^k$ the pattern of external adjustment of province k. In what follows, we also allow for the possibility that the elements of β^k vary over time

At the level of each province, the elements of $\boldsymbol{\beta}(k)$ could easily be estimated from time-series OLS regressions of the expected present values of $\widetilde{r^{W,k}}$, $\widetilde{\Delta q^k}$ and $\widetilde{\Delta no^k}$ on NX^k/NO^k respectively. However, our main interest in this paper is also to analyze to what extent province-level characteristics (such as financial and economic development, industrial structure, demography, etc...) affect the patterns of external adjustment and, potentially, also to allow for time-variation in these patterns. We therefore posit that the external adjustment in province k through a given channel is an affine-linear function of a (potentially time-varying) vector $\boldsymbol{z}^k_t$ of province-level characteristics so that

$$\beta^k_x(t) = \beta_x + \gamma'_x \boldsymbol{z}^k_t$$

where x denotes the channel: Δq, Δno and r respectively. The coefficient β_x measures the average (across-provinces) importance of channel x and the vector γ_x describes the sensitivity of the respective external adjustment channel to variation in characteristics across provinces. This assumption on $\beta_x^k(t)$ allows us to analyze the cross-provincial variation in external adjustment patterns using a panel set-up. Specifically, we estimate the $\beta_x^k(t)$ from a the following relation

$$x_t^k = \alpha + \tau_t + \mu_k + \beta_x^k(t) \times \left[\frac{NX}{NO}\right]_t^k + z_t^{k\prime}\,\delta + \nu_t^k \tag{10}$$

where x_t^k stands in turn for the VAR-implied expectations of the corresponding channel. On the right hand side of (10), α is a constant and τ_t and μ_k reflect time- and country effects and and the vector z_t^k stacks additional controls. For each channel, equation (x) can be estimated as a panel regression once we plug in from (x) above:

$$x_t^k = \alpha + \tau_t + \mu_k + \beta_{x0} \times \left[\frac{NX}{NO}\right]_t^k + \gamma_{x0}' z_t^k \times \left[\frac{NX}{NO}\right]_t^k + z_t^{k\prime}\,\delta + \nu_t^k \tag{11}$$

The coefficient on $\left[\frac{NX}{NO}\right]_t^k$ then measures the average importance of the channel x across provinces, β_x, whereas the coefffients on the interaction terms of the province-current accounts with the province-level characteristics capture the sensitivity of the respective channel to variation in characteristics over provinces and time.

Data

All data used in this paper are from the *National Statistical Yearbooks* of the People's Republic of China and of the *Provincial Statistical Yearbooks* of the 22 provinces, 5 autonomous regions and 4 municipalities of Mainland China[6]. The data are available online through the *China Data Center* (CDC)

[6] 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.

of the University of Michigan.[7] The CDC reports data values as soon as they are published in the corresponding yearbook. Although the data have been sometimes subject to official revisions in later years, the CDC did not systematically adapt past values. For most provinces, our online access only covers regional statistical Yearbooks over the 1990s and 2000s. Thus, it happens that the data are sometimes incomplete. We will primarily rely on recent data directly retrieved from the recent online yearbooks and complete possible gaps with CDC prepared sheets. This allows us to take account of revisions as much as possible. The most recent data stem from the 2011 yearbooks.

The quality of regional (province-level) and aggregate Chinese national accounts data si an important issue that we explore in detail in a descriptive companion paper (Cudré (2012*b*)), where we extensively focused on some stylized facts and discussed the quality and aggregation properties of the data. This analysis reveals 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 discrepancies between regional and national reported investment that have been widening since the 1970s. Conversely, the discrepancy between the sum of provincial savings and national aggregate savings shows no clear trend over time but the sum of province-level savings overestimates national values by round 7 percent of China's GDP in 2010. This suggests that the sum of province-level net exports will generally be lower than the corresponding official aggregate statistics. Other authors have argued that China's current account surplus is overstates for a variety of reasons (see Zhang (2008)). In fact, the

[7] ChinaDataCenter

2004 national economic census suggested that provincial data were in some cases even better than national ones as discussed in Holz (2008).

But while there is considerable uncertainty concerning the levels of aggregate and regional statistics, our previous analysis also shows that that the sum of province-level GDP, investment and savings data is generally highly correlated with movements in aggregate statistics. Since our empirical analysis focuses on a log-linearized model which emphasizes the movements in these variables over time rather than their levels, we are therefore reasonably confident that our province-level data capture important aspects of external adjustment among China's provinces.

We drop some provinces from the analysis for which data are available only for a very short time period or do not pass some a priori plausibility checks.[8] Tibet is excluded for lack of data availability. In economic terms, Ningxia and Qinghai are small provinces and have very low or even negative net output values towards the end of the sample due to extremely large inward investment. Obviously, this puzzling empirical facts originates in a recent increase in investment rate and the corresponding aggregation errors discussed in Cudré (2012*b*). We encountered some difficulties towards the end of the sample as some provinces like Tianjin, Jilin or Guangxi experienced a fast deterioration of their relative net exports, making the system non-stationary. For this reason, some regions have a shorter sample. No stable VAR specification has been found for Sichuan and Gansu. For Shandong and Hunan, the fit is less convincing. For the four mentioned provinces, we provide the specification and basic fit measures but exclude them from the channels and econometrics part for the moment. All in all,

[8]The provinces and autonomous regions excluded for reasons of data availablity are Ningxia, Qinghai and Tibet. These are quite small for Chinese standards, however, jointly accounting for a population of round 15 million in 2010.

we end up estimating the model for 28 out of 31 regions and will provide estimates for the channels of 24 regions. Table 1 summarizes the specification and the general fit. The maximal sample length stretches from 1985 to 2010.

Results

Fitting the model to province-level net exports

We estimate the province-level VAR with one or two lags. This allows us to back out the VAR-implied expectations on the right hand side of the present-value relation (6). For each province, we then estimate the parameters of the model – $1/\gamma$ and κ containing the savings wedge τ^k – based on a grid-search procedure that minimizes the squared deviation between the right hand side of (6) and the respective province's observed net export / net output ratio. In the grid search procedure we let $1/\gamma$ vary between 5 and 0.25. The savings wedge τ^{ks} enters the present-value relation through the discount factor $\kappa_k = \exp(E_t(\Delta no_t^k) - E_t(r_t^w) + \tau^{ks})$. We indirectly estimate τ by letting κ vary in the range $0.900 - 0.995$. Given the long-term net output growth rate and the real interest rate, this allows us to back out the implied value of τ.

Table 1 summarizes the specifications for the individual provinces, the estimated parameter values and the general fit of the model in terms of correlation and relative variance of actual to predicted net exports. Figures 1 and 2 provide a graphical representation of the predicted and real net exports for the entire sample (28 regions). For most provinces, our simple model provides a very considerable fit: the mean correlation between actual and predicted net exports is 0.90 with the lowest value of 0.49. The model also matches the standard deviation of actual province-level net exports quite closely. The average relative standard deviation is 1.00 with a minimum of 0.59 and a maximum of 1.42. On average, we find a value of γ of 2, corresponding to an average elasticity of substitution of 0.5. This value is close to the values conventionally used in the literature and also close to the estimate of Hoffmann (2012) for China as a whole. For the discount factor we find a value of 0.950 on average but in many cases we also hit the upper or lower bounds of the grid search.

Channels of adjustment

Using the methodology we outlined above, we are able to decompose the variability of our proxy for regional net exports into four channels (see table 2). All in all, the model is able to explain the bulk of variations in net exports with an unexplained part varying between -0.28 and 0.55. Expected variation in the China-wide interest rate (the global tilting factor) is also generally not very important for net export dynamics in most provinces, except Beijing and Hubei. This pattern is actually quite consistent with the view that fluctuations in the country-wide real interest rate largely reflect common shocks that, therefore, can only be smoothed by the individual provinces to a very limited extent. The most important channels, therefore, are the domestic tilting channel (real exchange rate movements) and the consumption smoothing channel (expected variation in regional cash flow). In some regions, the variation in external balance is primarily dominated by the exchange rate channel (domestic tilting). As an example, see figure 3. Expected net output fluctuations are mostly positively correlated with net exports variations. It is the most important factor in many provinces – see for example figure 4. For some regions, the relative contribution of the domestic tilting and net output factor is roughly similar, as illustrated on figure 5.

Some regions have particular patterns. Inner Mongolia's current account is nearly exclusively driven by variations in expectations in net output. Another exception is that the global tilting channel is the dominant source of variations in net exports in Henan. While the adopted methodology attributes sensible values to most regions, a graphical check reveals that six provinces (Liaoning, Zhejiang, Anhui, Jiangxi, Yunnan and Shaanxi) experience large asymmetric moves in the domestic tilting and net output components. Hubei has a comparable pattern but with global tilting instead of domestic tilting mirroring the evolution of net output. This phenomenon is easily observable in the results table and manifests itself in the respective channels being far higher than unity (in absolute value). Still, the general fit of the net exports is reasonable even for these provinces. We note that there is *a priori* no reason – theoretical or empirical – why the β_x coefficients should not be bigger than one in absolute value and also negative. But we take such values as an indication that the allocation of variance in net output to the various channels is not quite as meaningful for some of the provinces. For example, terms of trade movements, if not properly accounted for, could make it difficult to disentangle the role of price and quantity movements in net export dynamics. We will work to incorporate this channel into our analysis in a future version of the paper. This channel could be particularly relevant for resource-rich provinces of regions. At such an early stage, we do not want patterns of these provinces to unduly affect our econometric results and refrain from using provinces for which the problem seems more acute in the panel analysis that follows. Thus, the panel analysis in the next subsection is, for now, based on 21 regions accounting for more than 70% of Chinese GDP.[9]

Regional external adjustment: panel analysis.

In the preceding section, the contribution of the different factors has been estimated for each region separately. In order to better appreciate the general patterns of regional external balance, we now turn to estimating the patterns of external adjustment in a panel framework, as was discussed in the section of the channels of external adjustment. We start with a general characterization of external adjustment in the average province. To this extent, we estimate equation (11) without any interaction terms (i.e. without the z_t^k), which gives us the specification

$$x_t^k = \beta_0 + \tau_t + \mu_k + \beta_1 \times \left(\frac{NX}{NO}\right)_t^k + \nu_t^k$$

where the x stands for one of the VAR-implied expectations of the five channels.

Note that our panel of province-time observations is somewhat unbalanced due to missing observations for some provinces at the beginning (differences in number of lags) and at the end (stability and fit issues). Across these 21 regions, intertemporal smoothing is the main channel of adjustment and accounts for round two third of the variations in our proxy for provincial current account (table 3) . Expected changes in the price of non tradables seem to explain one fifth while a similar chunk remains unexplained. All three channels are significant at the 1% level. The global (country-wide) tilting channel does not play a central role. Interestingly, the 21 regions used in the panel seem to be quite representative of China in

[9]As mentioned before, Tibet, Ningxia and Qinghai are excluded because of data issues. Sichuan and Gansu have inverse roots outside the unit circle. Shandong has a poor fit. Liaoning, Hubei, Jiangxi and Yunnan have very asymmetric channels.

the sense that our results are very close to the ones obtained in Hoffmann (2012) for aggregate Chinese data[10].

In the remainder of this section, we now relate the patterns of external adjustment to province-level characteristics, using the the general setup with interaction terms (11) in which the β_x can vary across provinces and, potentially, also over time[11]. We estimate:

$$x_t^k = \beta_0 + \tau_t + \mu_k + \beta_1 \times \left(\frac{NX}{NO}\right)_t^k + \beta_2 \times \left(\frac{NX}{NO}\right)_t^k \times z_t^k + \beta_3 \times z_t^k + \varepsilon_t^k$$

where z_t^k is our vector of region-characteristics interest. To gain an impression of the link between external adjustment and particular regional characteristics, we start by considering z_t^k one by one (one individual variable at a time). The characteristics we consider are the following: an indicator for the dependence of the regional economy on mineral resources ($MinRes$) is computed using regional resources production data (coal, oil, steel). They are valued using world prices and their sum related to regional GDP. Results are reported in Table 4. Provinces with large mineral resource wealth ($MinRes$) display a significantly more important role of the domestic tilting channel and, correspondingly, a lower role of net output for net export variability. We suspect variations in the terms of trade to be partly responsible for this pattern. A second indicator is the share of foreign owned investment in fixed assets ($FOInvFA$) that is supposed to measure a region's openess to foreign capital. We see that a larger involvement of foreigners in the capital stock tends to increase the importance of expectations in changes in

[10] The real exchange rate and net output channels were 0.61 and 0.19 over the 1987-2007 period using valuation adjusted data. The unexplained part was 0.23.

[11] For a similar specification applied to international shock transmission during the interwar gold standard, see Hoffmann and Woitek (2011).

prices of non-tradables. Note that the size of the global tilting component is negatively correlated with the province-level incidence of foreign investment. As a third indicator, meant to measure financial development and financial depth, we use deposits in banks and financial institutions over GDP (*Deposits*). This indicator is positively related to the domestic tilting component. Thus, dynamics in expected real exchange rate changes are more relevant for regions experiencing a high level of financial development (or a saving glut, finding its reflection in high bank deposits). Finally, we use the importance of the secondary sector in economic output (*SecSect*) to see whether differences in economic structure matter. The estimates suggest that domestic titling – an expected appreciation of the real exchange rate vis-a-vis other provinces and the rest of the world – is more important as a channel of external adjustment for more industrialized provinces. Conversely, variation in expected net output plays a somewhat more subdued role for these provinces.

The lower part of table 4 reports the same type of regressions for a number of further plausible drivers of external adjustment, that, however, we find largely to be insignificant: The first is a measure of the importance of state-owned enterprises for a province's economy. State-owned enterprises continue to play a pivotal role in the Chinese economic system. However, our results suggest that the share of state-owned firms in gross industrial output value ($SOGIOV$) *per se* does not seem to impact on a province's external adjustment patterns. We also compute a measure of international trade openness at the province level ($Open$). This turns out to be related to the importance of the global tilting channel but not to any other channel. A dummy is generated to distinguish between typical surplus and deficit provinces[12]. In our regression above, we then interact this dummy (*EastCoast*) with NX/NO in the same spirit as before. These provinces don't seem to differ from the rest. Finally, we do not find that the mechanisms of adjustment in regional net exports is sensitive to China's WTO membership (we include a *PostWTO* dummy since 2002).

Summary and Outlook

We have proposed a simple, theory-based framework to analze capital flows between Chines provinces. Our model allows us to distingusih between variation in intertemproal prices – real exchange rates, real interest rates and the terms of trade – and quantity variation in province-level output, investment and government spending as channels of regional external adjustment. Our results shed light on the province-level sources of global imbalances, i.e. on the regional composition of China's persistent surpluses over the last decade. We find that expected variation in real exchange rates is a main driver of capital flows, in particular in provinces that are more financially developed, more open to foreign capital and more mineral rich.

In the baseline version of the model, a unit intratemporal elasticity of substitution is assumed. A natural extension is to allow for more flexibility in this respect. This supplementary degree of freedom should eventually help us to impose more structure on the choice of the deep parameters. As soon as a good proxy will be available, we plan to account for a time-varying saving wedge in the empirical part. Another future extension is to explicitly incorporate a channel for terms of trade fluctuations.

[12]Examples of provinces that have typically experienced high saving - investment surpluses and high international exports over the last decades are Jiangsu,Zhejiang, Fujian and Guangdong.

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Data appendix

Population

Chinese population data are an topic of their own. Two main problems are plaguing them: the underreported birth numbers as a consequence of the one child policy (Scharping, 2001) and the *"largest migration in human history"* (Chan, 2010*a*). We tried to address the second issue.

Basically, three sources for population estimates exist. The Hukou Household Registration System population data is reported by the Public Security Authorities. The Hukou aims at limiting rural migration by restricting access to welfare goods and services for non-urban residents such as health care, insurances or education (Chan, 2010*b*). It can be considered as a *de jure* statistics because it doesn't capture migration flows adequately. Typically, richer coastal provinces have an underestimated population and hinterland provinces a too high population which biases most studies on inequality (Chan and Wang, 2008). An alternative is the use of regular sample surveys of round 1% of the population and population censuses (1982, 1990, 2000 and 2010). They should better approximate resident population but unfortunately, the time of the survey as well as the definition of permanent residents and migrants isn't always stable over time and over regions. They are usually referred to as *de facto* data.

The official population data often are a combination of the three sources we have already mentioned (Hukou, sample surveys and censuses). We carefully compared CDC data, recent yearbooks data, sample surveys, censuses and existing studies to avoid sudden jumps due to changes in definition and assembled our own population time series by mixing them. We tried to consider de facto data as much as possible, particularly for provinces traditionally heavily influenced by migration[13].

Long-run consumption ratio

Although the mean of the consumption over net output ratio c over 1984-2010 is slightly below 1 for China (0.95), there is a large cross-regional variation with values ranging from 0.82 (Hebei) to 1.65 (Xinjiang) with a mean of 1.13. The near 0 net output for Qinghai and Ningxia lead to unrealistic values but they were excluded from the analysis anyway.

Net exports

The net exports are proxied with the regional difference between saving and investment. Note that this indicator includes international and inter-provincial flows in goods and services. In Cudré (2012*b*), we showed that large discrepancies in regional external balances exist in China. As most provinces have near neutral or positive international trade balance, most of theses cross-sectional differences stem from intranational capital flows. Unfortunately, we were unable to include income and current transfers to extend the analysis to the current account level. For China as a whole, trade and services capture most of the dynamics of the CA . Over the last decades, income flows have been slightly negative with the exception of 2007 and 2008. Current transfers have been more sizeable and stabilized on a positive level since the mid-2000s. Still, it was only roughly one tenth of the trade balance in 2011.

For regions having a considerable share of migrant workers in their labor force, we would expect a high share of household remittances to lower

[13]Center China as well as Chongqing and Sichuan have been the main outflow regions. Shanghai, Guangdong and to a lesser extent other East Coast provinces have been net migration recipients.

the CA and increase it in hinterland provinces. Another important pattern is certainly linked to the capital outflows generated by the returns on FDI of foreign firms. Here again, well-integrated coastal provinces certainly have a lower true CA than we may think. A last issue is the potential large transfers between government and/or state-owned enterprises among provinces. One would expect them to boost the CA of less developped provinces, particularly in the West.

Net output per capita

Net output is computed using GDP, government expenditures and investment. Sadly, the provinces of Qinghai and Ningxia have very low or negative net output towards the end of the sample and had to be excluded from the sample. This conundrum certainly originates in the problem of the overestimation of regional investment discussed in Cudré (2012*b*). Net output is deflated using Brandt and Holz (2006) for the initial price level and regional CPI for its development over time. As explained before, we construct a population time series from different sources and try to take migration flows into account as much as possible.

Reference interest rate

As in the baseline paper, the real world interest rate is proxied with the averaged monthly Federal Reserve Board 3 month Treasury Bill. The US Department of Labor city average CPI is used to correct for ex ante inflation. The extent to which regions are sensitive to the world interest rate is certainly varying depending on how far they integrate with the world economy. To account for national interest rate as well, we compute the ex-ante provincial real interest rate by taking the official lending rate of the bank of China and substracting ex-ante local CPI inflation. We mix both real interest rate using a weight factor between 0.7 an 0.9 on world interest rate. The weight level is determined by the mean of absolute international trade balance over GDP over the 1984-2010 period. The official IFS exchange rate is used to convert dollar trade data into Renminbi. Thus, for East Coast regions like Guangdong (weight of 0.84) or city-provinces like Shanghai (0.81), world interest rate matters more than for hinterland regions like Guangxi (0.72). Figure 6 provides an overview of the regional variations in interest rate compared to both baseline rates. A national lending rate using Chinese CPI is computed for comparison's sake.

Real exchange rate

Numerous possibilities arise for computing a regional real exchange rate. In the empirical section, two indicators will be used. In Hoffmann (2012), the IFS real effective exchange rate based on consumer prices is used. Remember that an increase of the index corresponds to an appreciation of the home currency. A straigthforward regional alternative would be to correct for the differences in development between local prices using CPI data on tradables and nontradables. To get a complete time series over the period, we have no choice but to combine different sources according to data availability. A possibility lies in considering the evolution of the price of nontradables relative to tradables multiplied by the share of nontradables in consumption expenditure.

Data on regional CPI categories are available from 1994 to 2010. We define tradables as expenditures on food (X_{food}) and clothes ($X_{clothes}$) while nontradables are composed of healthcare (X_{health}), transport and communication ($X_{transcom}$), education and culture (X_{edcult}) as well as residence and housing ($X_{reshous}$). As household surveys expenditure data are separated between urban and rural population, we have to merge them using regional urbanization rate[14]. The relative weight W of each category of expenditure X (here food and health) in the composed CPI is:

$$W_{food} = \frac{X^{urb}_{food}}{X^{urb}_{food} + X^{urb}_{clothes}} \times urbrate + \frac{X^{rur}_{food}}{X^{rur}_{food} + X^{rur}_{clothes}} \times (1 - urbrate)$$

$$\begin{aligned} W_{health} &= \frac{X^{urb}_{health}}{X^{urb}_{health} + X^{urb}_{transcom} + X^{urb}_{edcult} + X^{urb}_{reshous}} \times urbrate \\ &+ \frac{X^{rur}_{health}}{X^{rur}_{health} + X^{rur}_{transcom} + X^{rur}_{edcult} + X^{rur}_{reshous}} \times (1 - urbrate) \end{aligned}$$

For China, health expenditures would enter with a weight of 16%, transport and communication with 28%, education and culture 23% and residence or housing 33%. In the tradables, food (82%) logically has a higher weight than clothing (18%).

The CPI of tradables and nontradables can then be computed as:

$$\begin{aligned} CPI^{reg}_{NT} &= W_{health} CPI^{reg}_{health} + W_{transcom} CPI^{reg}_{transcom} + W_{edcult} CPI^{reg}_{edcult} + W_{reshous} CPI^{reg}_{reshous} \\ CPI^{reg}_{T} &= W_{food} CPI^{reg}_{food} + W_{clothes} CPI^{reg}_{clothes} \end{aligned}$$

The regional share of tradables in consumption expenditure (α) is proxied with the weighted mean over 1993-2010 of the corresponding consumption

[14]We used Shen (2006), data from the Statistical Yearbooks and interpolated assuming constant growth rates. From 1985 to 1999, Chongqing was computed using the same growth rates as Sichuan. From 1985 to 1989, growth rates of Guangdong were used for Hainan.

expenditure in urban and rural area[15]. In the end, our first indicator is:

$$\lambda_1^{84-93} = REER$$
$$\lambda_1^{94-10} = REER \times (1-\alpha)\frac{CPI_{NT}^{reg}}{CPI_T^{reg}}$$

Against a backdrop of financial repression, the progressive liberalization of the housing market in the 2000s led to a fast growth in real estate prices. Household quickly redirected their savings towards housing and the ownership rate increased substantially. Unfortunately, the price of housing is not included directly in Chinese CPI but in fixed capital formation. Rents, interest rates of housing loans and maintenance costs are considered but they certainly miss the bulk of the dynamics. To correct for that, we integrate the average selling price of housing per square meter in the CPI of nontradables. Besides being available for a relative long period (1999-2010), this indicator entails residential and business uses and should thus be representative of the conditions prevailing on the housing market. Another consequence is that the weight attributed to residence and housing in the CPI of nontradables seems to be too low. For example, in Shanghai, it enters with a weight of round 23%, far lower than in rural regions like Guizhou (42%). We inflate it by considering only half the weight of the other three categories and attributing the rest to housing. All in all, we thus use this indicator for the 1999-2010 period due to the late recording start of the housing prices and dub it $HCPI_{NT}$.

Before 1999, the index is computed by in the following way: for 1984, we directly use provincial CPI. Then, a service price index SPI (urban from

[15]For Chongqing, we had to take a shorter average due to data availability issues

1985 to 1988 and regional from 1989 to 1998[16]) is used as a proxy for the price of non tradables and is divided by general CPI (1984-1993) and later by tradables CPI computed earlier (1994-1998).

Thus, our second indicator is:

$$
\begin{aligned}
\lambda_2^{84} &= REER \\
\lambda_2^{85-93} &= REER \times (1-\alpha)\frac{SPI^{reg}}{CPI^{reg}} \\
\lambda_2^{94-98} &= REER \times (1-\alpha)\frac{SPI^{reg}}{CPI_T^{reg}} \\
\lambda_2^{99-10} &= REER \times (1-\alpha)\frac{HCPI_{NT}^{reg}}{CPI_T^{reg}}
\end{aligned}
$$

A graphical representation of the variations over time of the second indicator is available on figure 7. We use λ_2 for all provinces except for Beijing where the fit was substantially better with λ_1 .

[16]The services price index stopped to be computed in most provinces in 2001.

Table 1: Specification, grid search results and basic fit measures

	Lag	*Sample*	γ	κ	$\rho(\hat{x}, x)$	$\sigma(\hat{x})/\sigma(x)$
Beijing	1	85-10	0.3	0.995	0.93	0.98
Tianjin	1	85-09	1.0	0.833	0.99	0.83
Hebei	2	85-10	4.0	0.995	0.72	1.00
Shanxi	1	85-10	4.0	0.900	0.97	0.98
Inner Mongolia	1	85-08	1.0	0.995	0.98	0.84
Liaoning	1	85-10	2.7	0.900	0.97	1.06
Jilin	1	85-07	2.4	0.905	0.98	0.94
Heilongjiang	2	85-10	4.0	0.995	0.94	0.59
Shanghai	1	85-10	0.9	0.925	0.95	0.96
Jiangsu	1	85-10	2.6	0.900	0.96	1.33
Zhejiang	2	85-10	4.0	0.900	0.92	1.12
Anhui	1	85-08	1.5	0.900	0.80	0.99
Fujian	1	85-10	3.2	0.995	0.92	1.05
Jiangxi	1	85-10	1.5	0.900	0.91	1.38
Shandong	2	85-10	2.3	0.995	0.54	1.22
Henan	1	85-08	1.0	0.900	0.88	1.39
Hubei	1	85-08	1.1	0.995	0.95	0.80
Hunan	1	85-10	1.6	0.900	0.49	0.92
Guangdong	1	85-10	4.0	0.995	0.89	0.94
Guanxi	1	85-08	0.8	0.995	0.93	1.04
Hainan	2	85-10	3.0	0.995	0.95	0.81
Chongquing	1	85-10	1.8	0.995	1.00	1.00
Sichuan	1	85-10	1.8	0.900	0.87	1.42
Guizhou	1	85-10	0.8	0.995	1.00	0.91
Yunnan	1	85-09	1.0	0.926	0.97	0.93
Tibet	data					
Shaanxi	1	85-10	1.5	0.995	0.98	0.91
Gansu	2	85-09	1.8	0.995	0.90	0.98
Qinghai	data					
Ningxia	data					
Xinjiang	2	85-10	0.7	0.995	0.96	0.62
Median			1.7	0.995	0.95	0.98
Mean			2.0	0.950	0.90	1.00

Results obtained from a three dimensional grid search by minimizing the square distance between the real and estimated CA/NO. Tibet, Qinghai and Ningxia are excluded because of data issues.

Table 2: Channels of external adjustment

	glob tilting	*dom tilting*	*net output*	*unexpl*
Beijing	-0.33	0.85	0.39	0.09
Tianjin	-0.01	-0.10	0.94	0.17
Hebei	-0.02	1.23	-0.48	0.27
Shanxi	0.00	0.79	0.16	0.05
Inner Mongolia	0.02	0.00	0.80	0.18
Liaoning	0.06	-0.74	1.71	-0.03
Jilin	0.00	0.35	0.57	0.08
Heilongjiang	-0.02	0.42	0.16	0.44
Shanghai	-0.05	0.11	0.85	0.09
Jiangsu	-0.03	0.73	0.58	-0.28
Zhejiang	-0.04	1.20	-0.13	-0.03
Anhui	-0.26	-0.50	1.56	0.20
Fujian	-0.19	1.61	-0.45	0.03
Jiangxi	0.20	1.23	-0.17	-0.26
Shandong	-0.02	-0.11	0.79	0.34
Henan	1.43	0.00	-0.21	-0.22
Hubei	-0.57	-0.02	1.34	0.25
Hunan	-0.14	-0.85	1.45	0.55
Guangdong	-0.10	0.52	0.42	0.16
Guanxi	0.10	0.28	0.59	0.03
Hainan	0.01	-0.03	0.79	0.23
Chongquing	0.04	-0.24	1.19	0.00
Guizhou	-0.03	0.09	0.84	0.10
Yunnan	0.06	-2.56	3.40	0.10
Shaanxi	-0.01	1.07	-0.16	0.11
Xinjiang	0.01	0.07	0.52	0.40
Median	-0.02	0.10	0.58	0.10
Mean	0.00	0.21	0.67	0.12

The table presents estimates of the variance decomposition coefficients β_r, $\beta_{\Delta q}$, $\beta_{\Delta no}$ and β_{res}.

Table 3: Panel regression of channels

	coeff	*t-stat*	*p-val*
glob tilting	-0.044	-1.308	0.192
dom tilting	0.225	2.458	0.014
net output	0.641	9.220	0.000
unexpl	0.178	3.625	0.000

Panel estimates of the respective channels from the regression $x_t^k = \alpha + \tau_t + \mu_k + \beta \times \left(\frac{NX}{NO}\right)_t^k + \varepsilon_t^k$, where x_t^k stands for the VAR-implied expectations of the global tilting, domestic tilting and consumption smoothing channel. T-statistics based on Arellano's heteroskedasticity's and autocorrelation-consistent standard errors are in parentheses.

Table 4: Channels of external adjustment and province-level characteristics

	glob	*dom*	*cons*	*un*	*glob*	*dom*	*cons*	*un*	*glob*	*dom*	*cons*	*un*	*glob*	*dom*	*cons*	*un*
NX/NO	−0.053	0.120	0.779	0.153	0.020	0.103	0.658	0.219	0.064	−0.047	0.692	0.290	0.072	−0.195	0.890	0.234
	(−1.55)	(1.18)	(8.55)	(3.15)	(1.29)	(1.79)	(7.83)	(3.32)	(2.60)	(−0.54)	(7.46)	(4.15)	(1.91)	(−1.06)	(4.84)	(1.76)
Interaction of NX/NO with:																
MinRes	0.037	0.475	−0.623	0.111												
	(0.65)	(1.81)	(−2.64)	(0.71)												
FOInvFA					−0.887	1.634	−0.177	−0.570								
					(−3.20)	(2.47)	(−0.31)	(−1.64)								
Deposits									−0.080	0.203	−0.034	−0.088				
									(−3.11)	(2.54)	(−0.53)	(−3.03)				
SecSect													−0.256	0.942	−0.564	−0.122
													(−2.64)	(2.34)	(−1.36)	(−0.51)

	glob	*dom*	*cons*	*un*	*glob*	*dom*	*cons*	*un*	*glob*	*dom*	*cons*	*un*	*glob*	*dom*	*cons*	*un*
NX/NO	−0.038	0.259	0.665	0.113	−0.009	0.158	0.652	0.200	−0.046	0.226	0.638	0.182	−0.059	0.230	0.626	0.203
	(−1.19)	(2.21)	(7.47)	(2.74)	(−0.43)	(2.20)	(7.90)	(3.44)	(−1.24)	(2.30)	(8.86)	(3.49)	(−1.16)	(1.99)	(8.95)	(3.70)
Interaction of NX/NO with:																
SOGIOV	−0.014	−0.073	−0.053	0.140												
	(−0.30)	(−0.64)	(−0.52)	(2.64)												
Open					−0.148	0.286	−0.050	−0.088								
					(−2.61)	(1.22)	(−0.31)	(−1.42)								
EastCoast									0.023	−0.008	0.043	−0.057				
									(0.45)	(−0.03)	(0.22)	(−0.77)				
PostWTO													0.029	−0.009	0.029	−0.049
													(0.78)	(−0.12)	(0.60)	(−1.89)

The table reports the results of panel regressions of the form $x_t^k = \alpha + \tau_t + \mu_k + \beta_1 \times \left(\frac{NX}{NO}\right)_t^k + \beta_2 \times \left(\frac{NX}{NO}\right)_t^k \times Z_t^k + \beta_3 \times Z_t^k + \varepsilon_t^k$, where x_t^k stands in turn for the VAR-implied expectations of the global tilting, domestic tilting and consumption smoothing channel. The variable Z_t^k stands for the different potential explaining variables. For each regression, we report β_1 and β_2. T-statistics based on Arellano's heteroskedasticity and autocorrelation-consistent standard errors are in parentheses.

Figure 1: NX/NO: data (solid) versus predicted (dashed)

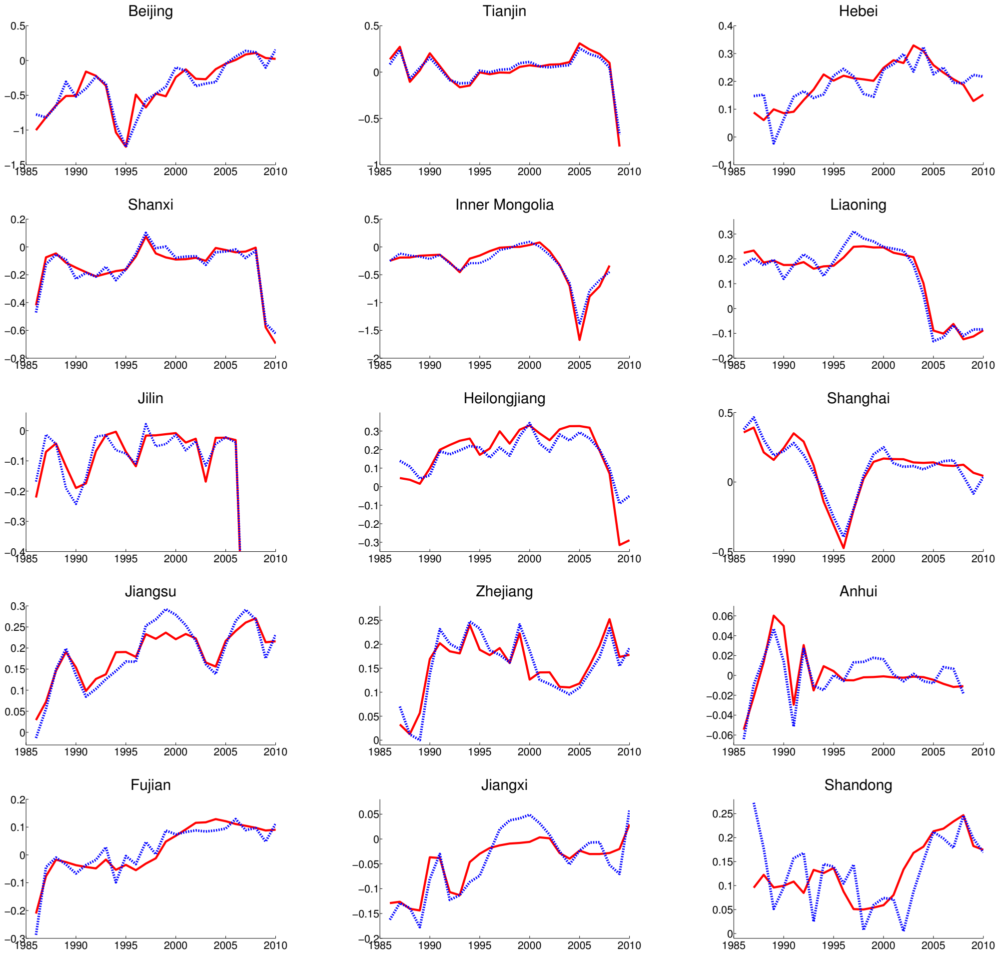

Figure 2: NX/NO: data (solid) versus predicted (dashed)

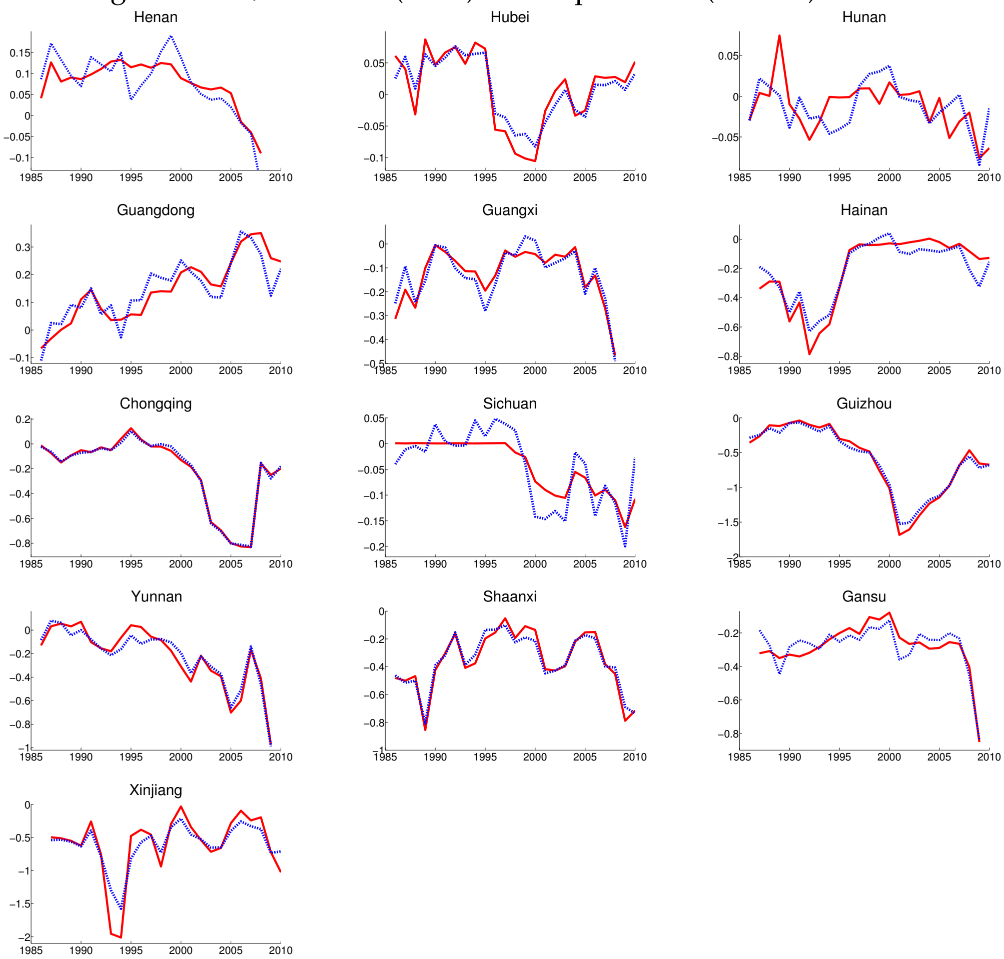

Figure 3: Two provinces with substantial domestic tilting channel

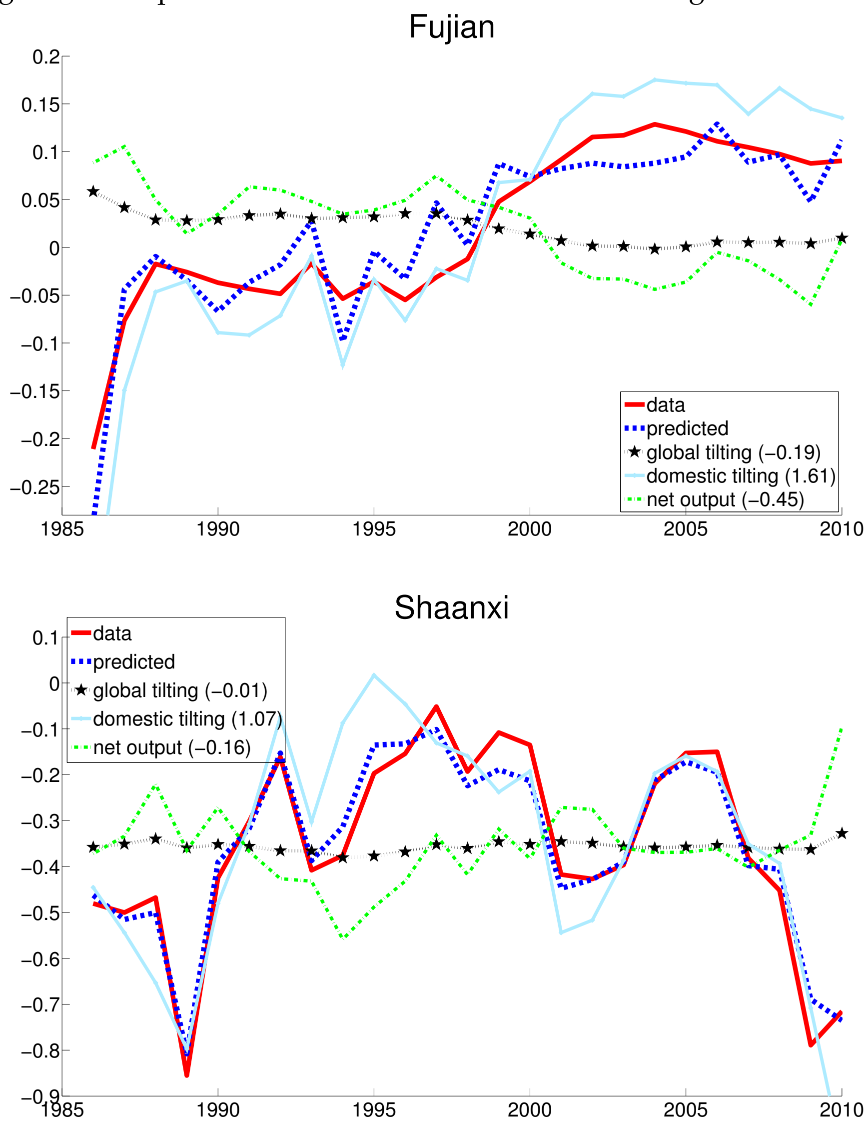

Figure 4: Two provinces with substantial net output tilting

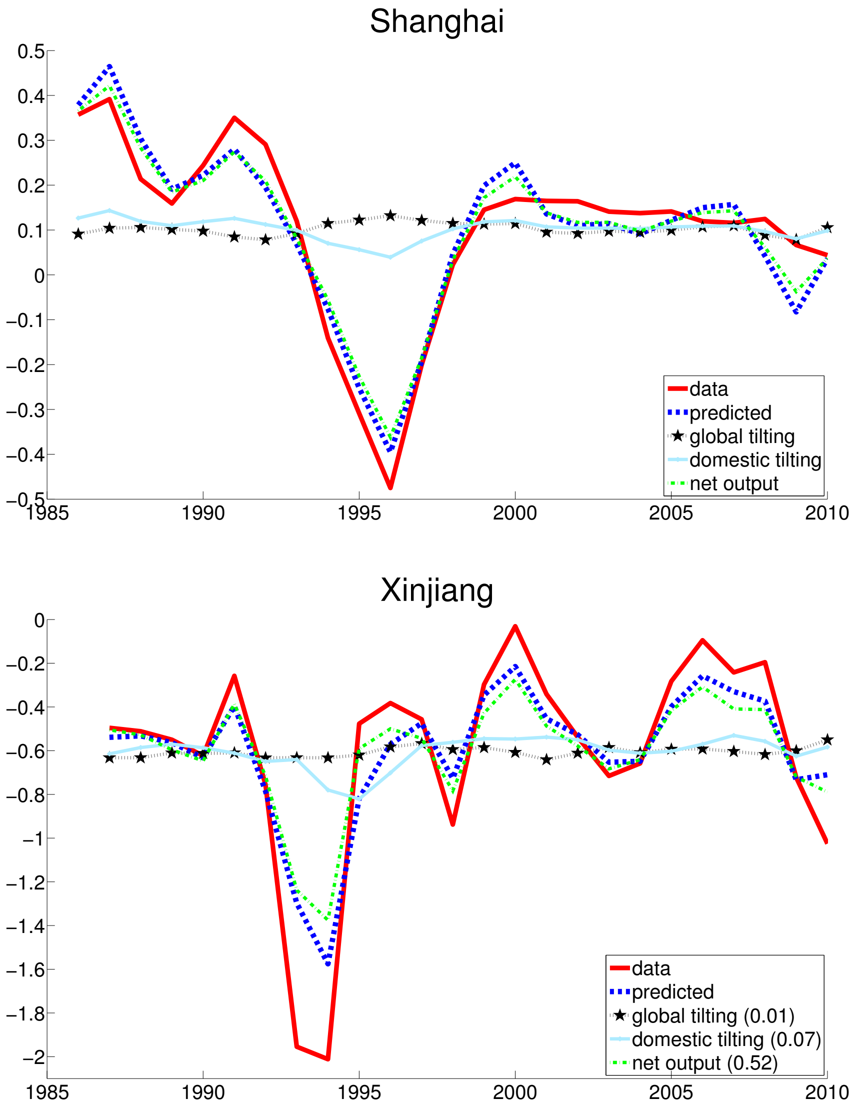

Figure 5: Two provinces with relative mixed channels

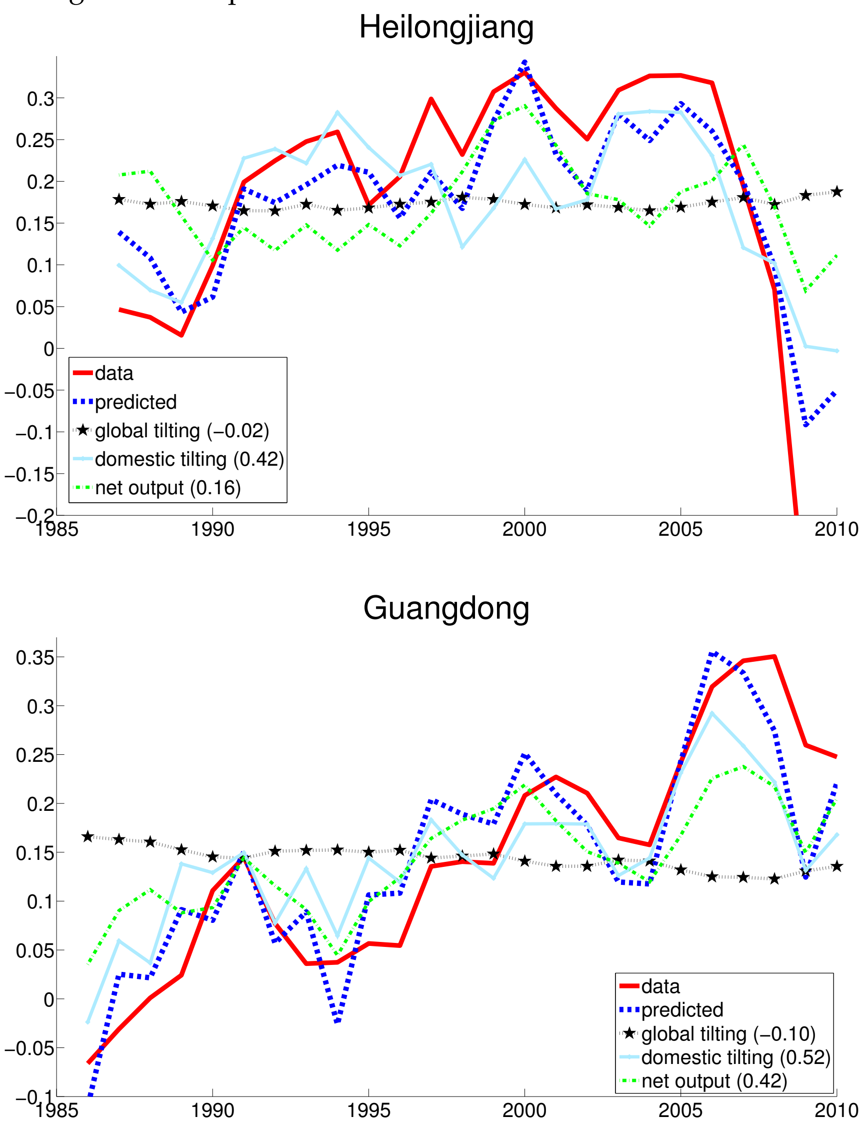

Figure 6: Reference interest rate

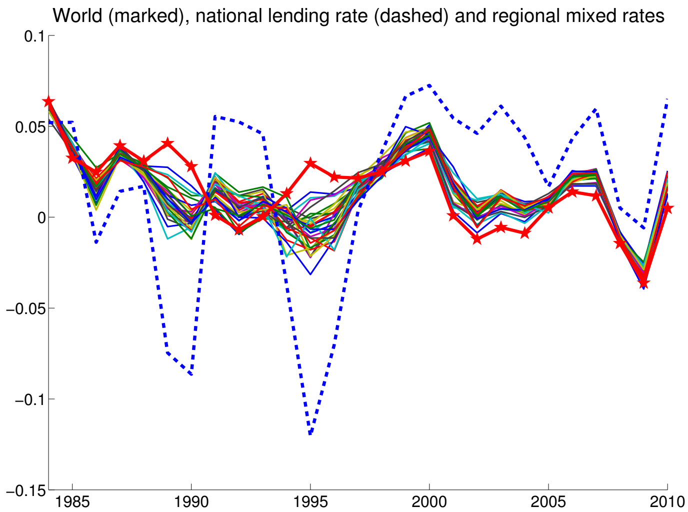

Figure 7: Regional REER