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Regional Capital Mobility in China: An Endogenous Parameter Approach

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Abstract

In this paper we empirically evaluate inter-regional capital mobility in China from 1978 to 2012. We measure the degree of capital mobility as the ability of regions, each as a representative consumer, to engage in intertemporal consumption smoothing through running external imbalances. We estimate a correlated random coefficient model which takes into account the potential correlation of capital mobility with output. Our results show that barriers to capital mobility across regions are still high in China. However, there is a slight increase in capital mobility over time. After 2000, the improvement of the degree of capital mobility becomes stagnant. This may reflect the prevalence of capital market distortion in China.

JEL classification: F15; O18; O53; C11; C23

Keywords: Regional capital mobility, China capital market integration, Permanent income model, Endogenous parameter random coefficient model

1. Introduction

This paper aims at empirically evaluating the degree of provincial and regional capital mobility in China from 1978 to 2012. After China started its economic reform in 1978, evaluating its internal market integration has been a hot topic in economic research. The pre-reform China is characterized by provincial autonomy (World Bank, 1992) and separated by many barriers to free resource allocation (Xu, 2002). Reform is expected to dismantle these barriers, promote resource mobility across provinces and regions, and move the economy closer to the efficient frontier. From the production side, Young (2000) shows that during the reform period the structure of output across provinces converges and the markets in China are segmented by local protectionism. From the trade approach, Poncet (2003) and Poncet (2005) show that trade barriers across provinces in China becomes more severe when reform proceeds in the 1990s. From the price approach, Fan and Wei (2006) find that the law of one price holds in China for a majority of goods and services, which provides evidence for domestic market integration.

In this paper we focus our attention on capital market integration in China, which is of crucial importance as free flow of funds provides opportunities to capital owners to search for the highest return nationwide. It also contributes to interprovincial risk sharing and welfare improvement in general[1].

Many previous papers have done similar works. By utilizing the celebrated Feldstein and Horioka (1980) framework in which saving and investment correlation is used as a measure of capital mobility, Boyreau-Debray and Wei (2005) show that capital mobility across provinces in China is low and decreased in more recent period. Li (2010) confirms this result by using panel cointegration technique on savings and investment correlation. However, Chan et al. (2011b) find that interprovincial capital mobility increased from the late 1990s to the mid-2000s. Chan et al. (2011a) also find that when one controls for cross-sectional dependence, the degree of capital mobility measured by savings and investment correlation in China improves after 1997. Lai et al. (2013) show that interprovincial capital mobility increased slightly after 1997 by employing panel time-varying estimation technique on provincial consumption and net output. Jiang

[1]For detailed discussion on interprovincial risk sharing across China, see Xu (2008), Curtis and Mark (2010), Du et al. (2011), Lai et al. (2014), Chan et al. (2014), and Ho et al. (2015).

(2014) finds that capital mobility across provinces in China improved after mid-1990s by using nonparametric estimation technique[2].

This paper differs from previous studies in that we assume the degree of capital mobility across China is endogenously correlated with output growth of the economy. In previous studies, the degree of capital mobility is measured either by savings investment correlation, or by consumption and net output correlation (Shibata and Shintani, 1998). This correlation parameter is assumed to be uncorrelated, or independent of the level of investment or output. However, the degree of capital mobility across regions within or across national borders is perceived as an important aspect of financial market development of an economy. Many studies that focus on measuring the effect of financial market development on economic growth find that it has a significantly positive effect on growth. For example, Bekaert et al. (2005) show that financial liberalizations, particularly equity market liberalizations, on average, lead to a 1% increase in annual real economic growth. Hao (2006) finds that the development of financial intermediation significantly contributes to rapid economic growth of China. Hasan et al. (2009) also find that the development of financial markets is associated with stronger growth of the economy in China. Liang and Teng (2006) show that economic growth in China leads to financial development. In a more recent paper, Zhang et al. (2012) also show that there is a positive association between financial development and economic growth in China. In addition, Mendoza (1992) shows that persistent shocks to output would cause output and the macroeconomic indicators, such as saving and investment correlation and consumption and output correlation, to change simultaneously even if the underlying regime that governs the degree of capital mobility remains unchanged.

Based on the findings of the above-mentioned papers, we argue that the degree of capital mobility, as one of the component that reflects the development of financial market, could be potentially correlated with output. Neglecting this correlation leads to potential bias of the estimated degree of capital mobility. Thus, by taking into account the parameter endogeneity problem, we are able to estimate the degree of capital mobility within China in a more precise way.

Our main finding is that the degree of capital mobility across regions in China is generally low. In addition, we only detect a slight increase of regional capital mobility over time, which means reform does not seem to bring about substantial improvement in capital market integration. This result is consistent with Boyreau-Debray and Wei (2005), and may reflect the fact that capital market distortion is still prevalent in China after 2000 (Zhu, 2012).

The remaining of the paper is organized as follows. Section 2 lays out the theoretical model. Section 3 presents the endogenous parameter model we utilize in the estimation part. Section 4 presents the data and the estimation results. Section 5 concludes.

2. Theoretical Model

We apply Shibata and Shintani (1998)'s framework to assess the provincial and regional capital mobility in China. This framework was an extension of Campbell and Mankiw (1990)[3].

We assume that each province in China, as a representative consumer, maximizes its expected utility subject to the intertemporal budget constraint:

$$\max_{c} E_t \sum_{t=0}^{\infty} \beta^t U(C_t) \tag{1}$$

$$s.t. \quad W_{t+1} = (1+r)W_t + Y_t - C_t - I_t - G_t \tag{2}$$

where r represents national interest rate, which is assumed to be constant. Y, I, C and G denote provincial GDP, investment, private consumption and government expenditure respectively. W is the foreign asset holdings of a province[4]. Define net output $X_t = Y_t - I_t - G_t$, and use national income accounting identity, we arrive at:

$$CA_t \equiv r \cdot W_t + X_t - C_t \tag{3}$$

[2]Apart from works that are focused on measuring capital mobility across provinces and regions in China, others have also done similar works for other countries. They include, but not limited to, Bayoumi and Rose (1993), Dekle (1996), Helliwell and McKitrick (1999), Iwamoto and van Wincoop (2000) and Yamori (1995).

[3]Shibata and Shintani (1998) extends Campbell and Mankiw (1990) into examining the dynamics of current account as a mean for consumption smoothing at country level, thus incorporates the two extreme cases of free capital mobility and financial autarky. Decressin and Disyatat (2008) and Huang (2010) performed some further extension.

[4]Here foreign means other provinces as well as foreign countries.

where CA is the current account of the province[5].

We assume that preferences are quadratic, and that the discount rate equals the national interest rate. Optimal consumption under perfect capital mobility has the following representation:

$$C_t^p = r\left\{W_t + \left(\frac{1}{1+r}\right)\sum_{i=0}^{\infty}\left(\frac{1}{1+r}\right)^i E_t X_{t+i}\right\} \tag{4}$$

Taking the first difference of eq. 4, we have eq. 5:

$$\Delta C_t^p = \frac{r}{1+r}\sum_{i=0}^{\infty}\left(\frac{1}{1+r}\right)^i \left(E_t - E_{t-1}\right) X_{t+i} \tag{5}$$

In eq. 5, $\left(E_t - E_{t-1}\right) X_{t+i}$ is the update of expectation from time t-1 to time t when new information comes in at time t. This is unpredictable at time t-1. It thus implies that current consumption is the best predictor of tomorrow's consumption (Hall, 1978):

$$\Delta C_t^p = \varepsilon_t \tag{6}$$

Under financial autarky where there is zero degree of capital mobility, provincial consumption is restricted by its own net output:

$$C_t^a \le X_t \tag{7}$$

If we assume the equality holds in eq. 7 and substitute it to eq. 3, we have the following equation for the trade balance, given by TB_t:

$$TB_t \equiv CA_t - r \cdot W_t \tag{8}$$

Under financial autarky, trade balance is zero and provincial savings equal provincial investment. In a real world, free capital mobility and financial autarky are both extreme cases. As such, consumption could be expressed as somewhere between the two:

$$C_t = (1-\lambda)\left(C_t^p\right) + \lambda\left(C_t^a\right) = (1-\lambda)\left(C_t^p\right) + \lambda\left(X_t\right) \tag{9}$$

In eq. 9, λ can be taken as a measure of the degree of capital mobility. If $\lambda = 0,\ C_t = C_t^p$ and capital is fully mobile. If $\lambda = 1,\ C_t = C_t^a$ and capital is extremely immobile.

The smaller the λ, the higher the degree of capital mobility. Thus, estimating λ provides a way to measure the degree of capital mobility in China. However, from eq. 4 it can be seen that C_t^p is determined by the expected future net output, which is unobservable. To render this model estimable, we take the first difference of eq. 9 and use eq. 6 to obtain the following eq. 10:

$$\Delta C_t = (1-\lambda)\left(\Delta C_t^p\right) + \lambda\left(\Delta X_t\right) = (1-\lambda)\varepsilon_t + \lambda\left(\Delta X_t\right) \tag{10}$$

Noticing that we are using panel data, and assuming that there is heterogeneity in degree of capital mobility across provinces and regions, we rewrite eq. 10 as:

$$\Delta C_{it} = \left(1-\lambda_i\right)\varepsilon_{it} + \lambda_i \Delta X_{it} \tag{11}$$

This yields the following equation for panel data estimation:

[5]Here the current account is the pseudo-current account for a province, as it includes exports and imports of this province with other provinces as well as foreign countries.

$$\Delta C_{it} = \lambda_i \cdot \Delta X_{it} + \zeta_{it} \tag{12}$$

where $\zeta_{it} = (1-\lambda_i)\varepsilon_{it}$. We estimate eq. 12 and test whether λ_i equals zero or not for each region in China[6].

3. The Endogenous Parameter Model

When estimating λ_i, previous literature, such as Chan et al. (2011b), made two assumptions. First, λ_i is homogeneous across different provinces in China. Second, λ_i is uncorrelated with ΔX_{it}. Lai et al. (2013) show empirically that λ_i is heterogeneous across different regions in China while maintaining the assumption that the degree of capital mobility is uncorrelated with net output. However, previous studies have shown that financial development and output growth are positively correlated (Zhang et al., 2012). The degree of capital mobility, as a measure of financial development, could also potentially be correlated with output growth. In addition, Mendoza (1992) shows that output and the macroeconomic indicators[7] of capital mobility tend to change at the same time due to persistent output shocks, even if there is no fundamental change of the regime that governs the degree of capital mobility. If this correlation between output and the measure of capital mobility is ignored, λ_i would be estimated with bias. This could be shown as follows.

Rewrite eq. 12, we obtain:

$$\Delta C_{it} = \lambda_{0,it} + \lambda_{1,it} \cdot \Delta X_{it} \tag{13}$$

where $\lambda_{0,it} = \overline{\lambda}_{0,i} + \zeta_{it}$, $\lambda_{1,it} = \overline{\lambda}_{1,i} + \xi_{it}$, $\overline{\lambda}_{1,i} = \lambda_i$ in eq. 12.

Eq. 13 can be reformulated as follows:

$$\Delta C_{it} = \begin{pmatrix} 1 & \Delta X_{it} \end{pmatrix} \begin{pmatrix} \lambda_{0,it} \\ \lambda_{1,it} \end{pmatrix} = \begin{pmatrix} 1 & \Delta X_{it} \end{pmatrix} \begin{pmatrix} \overline{\lambda}_{0,i} \\ \overline{\lambda}_{1,i} \end{pmatrix} + \begin{pmatrix} 1 & \Delta X_{it} \end{pmatrix} \begin{pmatrix} \zeta_{it} \\ \xi_{it} \end{pmatrix} \tag{14}$$

Let $\beta_{it} = \begin{pmatrix} \lambda_{0,it} \\ \lambda_{1,it} \end{pmatrix}$, $\overline{\beta}_i = \begin{pmatrix} \overline{\lambda}_{0,i} \\ \overline{\lambda}_{1,i} \end{pmatrix}$, $Y_{it} = \begin{pmatrix} 1 & \Delta X_{it} \end{pmatrix}$, eq. 14 can be written as:

$$\Delta C_{it} = Y_{it}\beta_{it} = Y_{it}\overline{\beta}_i + Y_{it}\left(\beta_{it} - \overline{\beta}_i\right) = Y_{it}\overline{\beta}_i + W_{it} \tag{15}$$

where $W_{it} = \left(\beta_{it} - \overline{\beta}_i\right) = \begin{pmatrix} \zeta_{it} \\ \xi_{it} \end{pmatrix}$.

If W_{it} satisfies the standard assumption that:

$$E\left(W_{it} \mid Y_{it}\right) = 0 \tag{16}$$

Then $\overline{\beta}_i$ could be estimated consistently using ordinary least squares under standard conditions. However, because the degree of capital mobility could be potentially correlated with output, $E\left(W_{it} \mid Y_{it}\right) \neq 0$, ordinary least square estimator of β_i becomes inconsistent.

When the parameter endogeneity is present, Heckman and Vytlacil (1998) provide an instrumental variable estimator that could consistently estimate β_i except for the intercept component[8]. Suppose that Y_{it} can be expressed as a linear function of exogenous variables $Z_{1,it}$ and error V_{it}, and β_{it} as a linear function of exogenous variables $Z_{2,it}$ and error U_{it}:

[6]This model has also been used by Chan et al. (2011b) and Lai et al. (2013) to measure the degree of capital mobility across regions and provinces in China. However, our framework differs from them by assume correlation between λ_i and ΔX_{it}.

[7]Mendoza (1992) examined several such indicators, such as the saving-investment correlation and so on.

[8]The overall intercept term is not identified unless $E\left(V_{it}U_{it}\right) = 0$, see Heckman and vytlacil (1998).

$$Y_{it} = Z_{1,it}\pi_i + V_{it} \tag{17}$$

$$\beta_{it} = \Phi' Z_{2,it} + U_{it} \tag{18}$$

where $Z_{1,it}$ is a $1\times K_1$ vector of variables and π_i is a $K_1\times 1$ vector of coefficients. $Z_{2,it}$ is a $1\times K_2$ vector of variables, and Φ' is a $K_2\times 1$ vector of coefficients. Assuming that $E(U_{it} \mid Z_{1,it}, Z_{2,it}) = 0,\ E(V_{it} \mid Z_{1,it}, Z_{2,it}) = 0,$ and $E(V_{it}U_{it} \mid Z_{1,it}, Z_{2,it}) = \Sigma_{V,U}$ is not a function of $Z_{1,it}$ and $Z_{2,it}$, the model can be estimated consistently by using Two Stage Least Square proposed by Heckman and Vytlacil (1998)[9]. In addition, we use first differenced log consumption and log output instead of levels, which we denote in lower case letters[10].

4. Data and Estimation Results

4.1 Data

We use private consumption, output, investment and government consumption data of 30 provinces[11] in China over 1978 to 2012 from China Statistical Yearbooks and complement it by provincial statistical yearbooks when necessary. Four provinces are deleted due to missing data problem[12].

The data for net output is constructed from subtracting investment and government consumption from GDP. Both private consumption and net output are deflated by provincial GDP deflator and by population.

In order to estimate the time-varying degree of capital mobility across different regions, we further group the 26 provinces into nine regions according to their level of economic development and geographical vicinity[13]. Table 1presents the nine regions and their member provinces. Thus, our samples consist of 9 regions in China from 1978 to 2012.

Table 1. Grouping of 26 Provinces into 9 Regions

Region number	Provinces included
1	Beijing, Tianjin, Hebei
2	Shanxi, Shandong
3	Liaoning, Jilin, Heilongjiang
4	Shanghai, Jiangsu, Zhejiang
5	Henan, Anhui
6	Hubei, Hunan
7	Guangdong, Fujian, Hainan
8	Guangxi, Yunnan, Guizhou
9	Shaanxi, Xinjiang, Inner Mongolia, Gansu

For the instrumental variable $Z_{1,it}$ for net output in eq. 17, we use the growth rate of the number of college students enrolled per 10,000 people in each region. For the instrumental variable $Z_{2,it}$ to the degree of capital mobility in eq. 18, we use three different variables: distance from financial centers (DF), which is defined as the average distance from the provincial capital to Shanghai and Shenzhen, the longitude (LG) and latitude (LA) of provincial capitals. They are all exogenously given and can be reasonably assumed as being uncorrelated with the error terms[14].

Before we estimate the equations laid out in Section 3, we need to first test if the growth rates of consumption and net output across regions are stationary. We employ Chang (2004)'s panel unit root test which takes the cross-sectional dependence into consideration. The results are presented in Table 2. Almost all the test statistics have p-values that are less than or equal to 0.001, except K_{GLS} of Δx_{it}. Thus we can reject the null hypothesis of unit root and proceed to the estimation part.

[9]Detailed procedure can be found in Heckman and Vytlacil (1998).

[10]Campbell and Mankiw (1990) provide justification of using log consumption and output instead of levels.

[11]This consists of three municipalities, and 27 provinces. Hong Kong and Macau SARS are not included. Tibet is not included because of lack of data.

[12]The four provinces are Jiangxi, Sichuan, Chongqing and Ningxia.

[13]This group of provinces is similar to that in Chan et al. (2011a).

[14]These three variables have been widely used in empirical economic growth literature, for example, Frankel and Romer (1999), Rose and Spiegel (2009). See Durlauf (2000) for a review of these instrumental variables.

Table 2. Panel Bootstrap Unit Root Test Results on Δx_{it} and Δc_{it}

Series name	F_{OLS}^{1}	F_{GLS}	K_{OLS}	K_{GLS}
Δx_{it}	81.1334	117.6401	81.1334	117.6401
	(0.000)	(0.000)	(0.001)	(0.054)
Δc_{it}	68.4766	117.2034	68.4766	117.2034
	(0.000)	(0.000)	(0.001)	(0.000)

1. F_{OLS}, F_{GLS}, K_{OLS}, K_{GLS} are bootstrap statistics in Chang (2004). They test the null hypothesis that the data series is integrated of order 1. P values are in parentheses.

4.2 Estimation Results

Table 3 shows the estimation results. Panel A presents the results for the whole sample period from 1978 to 2012, while Panel B and C present those of the subperiods respectively. We split the sample in 1993 because several reforms took place around that time. For example, the tax redistribution reform was implemented in 1994, which consolidated the fiscal power of the central government but also gave more fiscal expenditure discretion to local governments (Lai et al., 2014). This reform provided the central government with more resource to inject funds to the state sector when needed. In addition, the RMB exchange rate reform was implemented in 1994, which may have some potential impact on regional capital mobility as well.

Table 3. Estimation Results for 9 Regions: LG[1] as the Second Stage Instrument

Region	Estimated π_i	Estimated Φ	Estimated λ_i
Panel A: Whole sample period 1978-2012			
1	0.1317 (0.0632)*[2]	0.0103	1.1918 (0.3531)**
2	0.1517 (0.0381)**	(0.0030)**	1.1786 (0.3492)**
3	0.1155 (0.0875)		1.2850 (0.3807)**
4	0.1249 (0.0533)*		1.2339 (0.3656)**
5	0.1405 (0.0791)		1.1858 (0.3513)**
6	0.2014 (0.0304)**		1.1672 (0.3458)**
7	0.1649 (0.0384)**		1.1738 (0.3477)**
8	0.0192 (0.0780)		1.0878 (0.3223)**
9	0.0596 (0.0870)		1.0520 (0.3117)**
Panel B: 1st subperiod: 1978-1993			
1	0.0093 (0.0099)	0.0104	1.2063 (0.9666)
2	0.1125 (0.0784)	(0.0083)	1.1930 (0.9559)
3	0.1405 (0.0693)*		1.3007 (1.0422)
4	0.0141 (0.0656)		1.2490 (1.0008)
5	0.0489 (0.2845)		1.2002 (0.9617)
6	0.1989 (0.0652)**		1.1815 (0.9467)
7	0.0932 (0.0647)		1.1881 (0.9520)
8	0.1039 (0.1069)		1.1011 (0.8823)
9	0.2137 (0.1117)*		1.0649 (0.8533)
Panel C: 2nd subperiod: 1994-2012			
1	0.2267 (0.0778)**	0.0087	1.0076 (0.3045)**
2	0.1642 (0.0442)**	(0.0026)**	0.9964 (0.3012)*
3	0.1043 (0.1333)		1.0863 (0.3284)**
4	0.2348 (0.0752)**		1.0432 (0.3153)**
5	0.1612 (0.0263)**		1.0025 (0.3030)**
6	0.2022 (0.0348)**		0.9868 (0.2983)**
7	0.2140 (0.0451)**		0.9923 (0.2999)**
8	-0.0032(0.1056)		0.9197 (0.2780)**
9	0.0612 (0.1189)		0.8894 (0.2688)**

1. The instrumental variable in the first stage regression is the growth rate of the number of college students enrolled per 10,000 people, while in the second stage it is LG, defined as the longitude of provincial capitals.
2. Estimated parameters are followed by standard errors. * and ** represent 5%and 1% significance level, respectively.

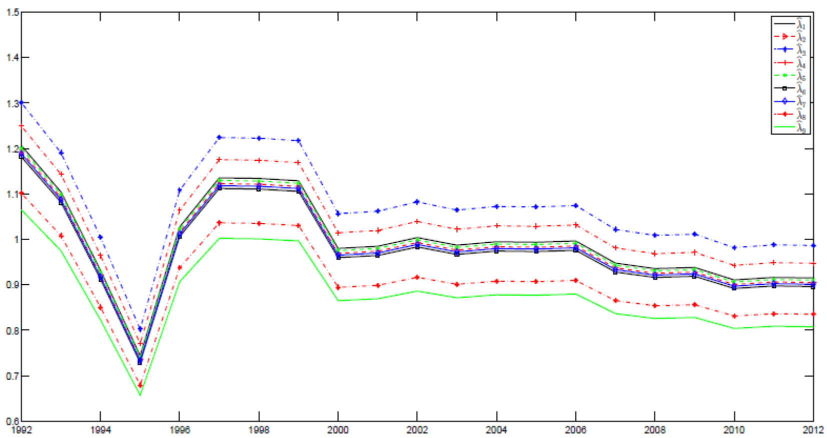
The first column in Table 3 shows the index of regions. Estimated π_i in the second column is obtained from the first stage regression[15], where the growth rate of college students enrolled is used to instrument net output. Except Region 3, 5, 8 and 9, π_i is at least significant at 5 percent level for all other regions. In the second stage regression, we use LG, which is the longitude of provincial capitals[16], as the instrument for the degree of capital mobility. The estimated parameter Φ is also significant at 1 percent level.

Our key focus is on the estimated λ_i, which measures the degree of capital mobility of each region. In the last column it shows that the estimated λ_i for all regions are above 0.5 and statistically significantly different from 0 at 1 percent level. This indicates high barriers to free capital mobility. It also shows that Region 8 (the southwest region) and Region 9 (the northwest region) have relatively higher degree of capital mobility than other regions. Meanwhile, Region 3 (the northeast region) and Region 4 (the Yangzi river delta region) have relatively lower capital mobility compared to the rest of the country. This is to some extent contrary to one's expectation. Yangzi river delta region is among the most developed regions in China. However the result shows that its degree of capital mobility is rather low. In addition, the western part of China is the least developed, but it has the highest degree of capital mobility compared to other regions.

When we split the full sample into two sub period, we observe that from the first sub period (1978-1993) to the second sub period (1994-2012), there is a slight decrease in the estimated λ_i for all regions.

However, estimated λ_i is in general not statistically significant for the first period. This may be due to the fact that subperiod 1 is rather short, which may reduce the statistical power of the test of the estimated coefficients.

To further examine the dynamics of the degree of capital mobility, we employ the rolling window estimation with a length of 14 years. The estimated λ_{it} for nine regions is plotted in Figure 1(a). It shows that from 1992 to 2012, the degree of capital mobility of all nine regions shows a general trend of slight increase over time. However, there is a twist around 1995. From the beginning of the sample period to 1995, the degree of capital mobility across regions was increasing (λ_{it} declined), while it reverted to a sharp decrease from 1995 to around 1997 (λ_{it} increased). Then it started to increase again after around 1999. The increase of the degree of capital mobility till 1995 corresponds to a period of fiscal and monetary expansion in China. The decrease that follows 1995 corresponds to a period of banking reforms and monetary contraction around mid-1990s. This finding is different from that in Chan et al. (2011b) and Chan et al. (2011a). This is because we use consumption and net output data and gauge capital mobility across regions through their ability to smooth consumption by running external imbalances, while these two papers mainly focus on savings and investment correlation. Besides, we take into account the endogeneity of capital mobility with net output. However, our result is consistent with Boyreau-Debray and Wei (2005) which shows that there is hardly any improvement of the degree of capital mobility across China in the 2000s[17].



(a) λ_{it} for nine regions

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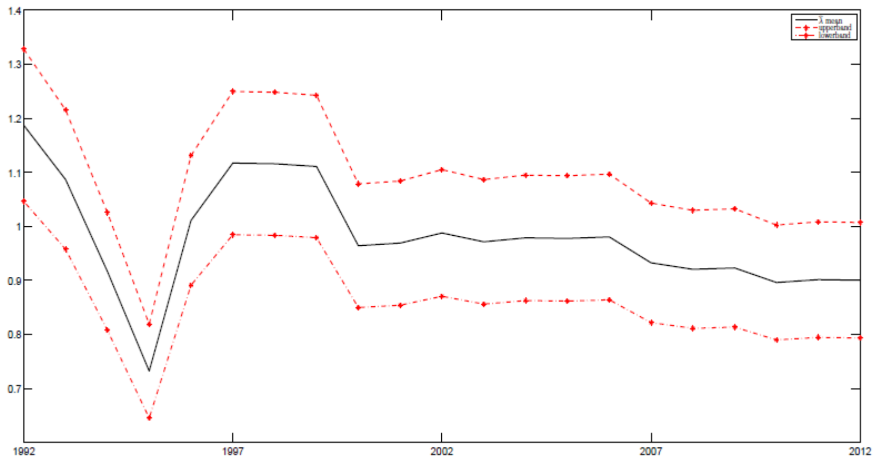
[15]As suggested by Heckman and Vytlacil (1998), we use SUR in the first regression.

[16]Here it is the averaged longitude of provincial capitals in a region.

[17]Du et al. (2011) shows that there is a decrease of risk sharing across provinces in China in the same period as well. When there are nontradable goods in each region, then a decrease of risk sharing is due to a decrease of degree of capital mobility.



(b) Mean of λ_{it} across nine regions and its 5 percent confidence interval

1. The window size of the estimation is 14 years.
2. LG stands for the average longitude of provincial capitals. This is the second stage instrument for capital mobility.

Figure 1. Estimated rolling window[1] λ (LG[2])

One possible explanation for this stagnation of the improvement of the degree of capital mobility, as shown by Zhu (2012), is that, capital market distortions have remained prevalent in recent years. Zhu (2012) shows that the return to capital is decreased in the state sector and increased in the non-state sector from 2000 onwards. At the same time, the capital labor ratio in the state sector increased much more sharply than in the non-state sector. This shows that capitals are not flowing to where the highest return is generated (the non-state sector). This preferential treatment of the state sector in financing may have caused the barriers to capital mobility to remain high across regions in recent years.

Figure 1 (b) plots the mean of λ_{it} across regions and its 5 percent confidence interval. It reflects similar patterns as that of each region shown in Figure 1 (a).

We perform the robustness check by using two different instruments to capital mobility in the second stage regression. Table 4 shows the results when we use the latitude of provincial capitals as the instrument[18]. For abbreviation we only present the estimated results for λ_i .

Table 4. Estimation Results for 9 Regions: LA[1] as the Second Stage Instrument

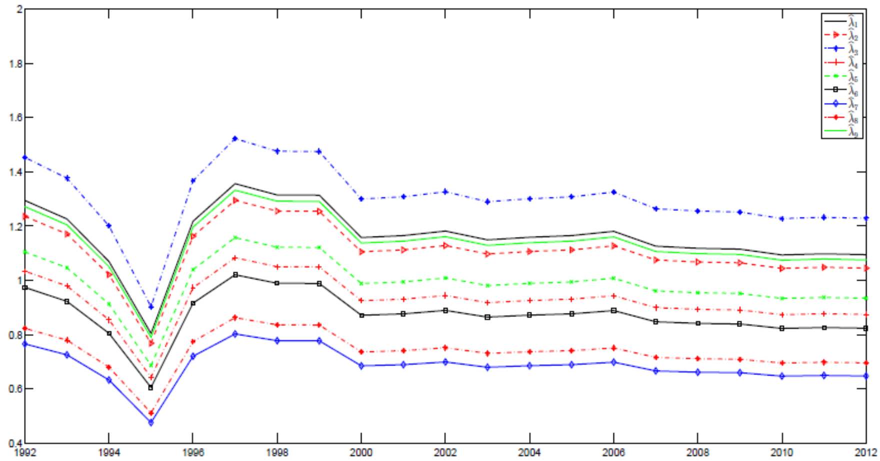
Region	Whole period	1st subperiod	2nd subperiod
1	1.4380 (0.4225)**[2]	1.2942 (1.0566)	1.2165 (0.3683)**
2	1.3729 (0.4034)**	1.2356 (1.0088)	1.1614 (0.3516)**
3	1.6143 (0.4743)**	1.4528 (1.1861)	1.3656 (0.4135)**
4	1.1487 (0.3375)**	1.0337 (0.8440)	0.9717 (0.2942)**
5	1.2274 (0.3606)**	1.1046 (0.9018)	1.0383 (0.3144)**
6	1.0820 (0.3179)**	0.9738 (0.7950)	0.9153 (0.2771)**
7	0.8507 (0.2500)**	0.7656 (0.6251)	0.7196 (0.2179)**
8	0.9144 (0.2687)**	0.8230 (0.6719)	0.7737 (0.2342)**
9	1.4128 (0.4151)**	1.2715 (1.0381)	1.1952 (0.3619)**

1. In the second stage the IV is LA, defined as the latitude of provincial capitals. In the first stage the IV is the growth rate of the number of college students enrolled per 10,000 people.
2. Whole period runs from 1978-2012. The first subperiod spans from 1978 to 1993, while the second spans from 1994 to 2012. Estimated parameters are followed by standard errors. * and ** represent 5% and 1% significance level, respectively.

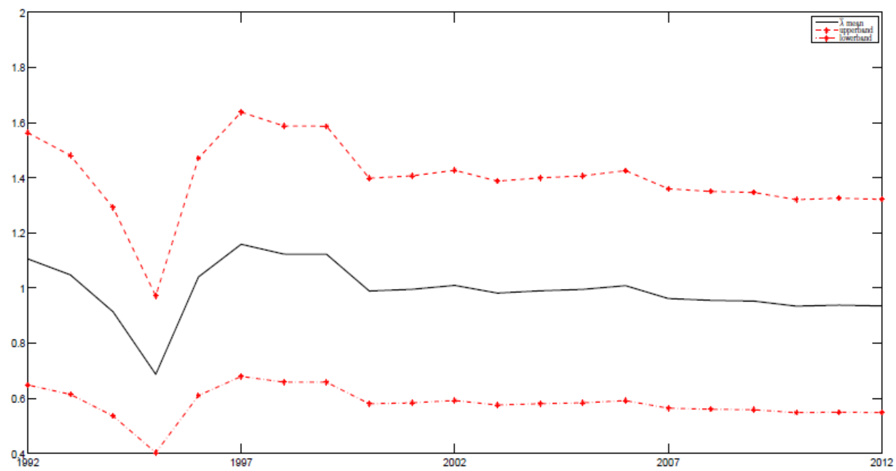
The estimated λ_i is statistically significantly different from 0 and close to 1 for all regions over the whole sample period. From the first to the second subperiod, the estimate λ_i declines slightly, which is consistent with what we obtained in Table 3.

[18]Here it is the averaged latitude of the provincial capitals in a region.

Figure 2(a) plots the rolling-window estimates of λ_{it} for each region. It shows a downward trend in λ_{it} from the beginning of the sample to around 1995. Then there is an upward trend till around 1997. After 1997, λ_{it} exhibits a slightly downward trend similar as that in Figure 1(a). Around 2000, the estimated λ_{it} is almost flat till 2012. Figure 2(b) presents the mean of λ_{it} across regions and the 5 percent confidence interval, which is of similar pattern as that in Figure 1(b). It reflects that since 2000, there is barely any improvement of the degree of capital mobility across regions in China.



(a) λ_{it} for nine regions

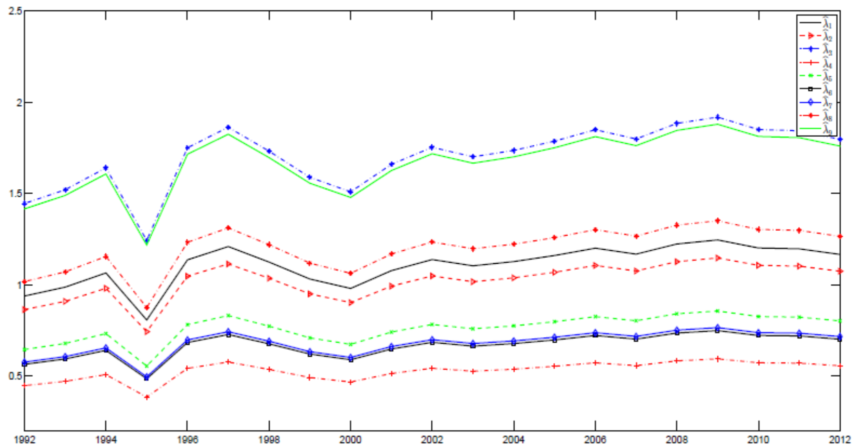


(b) Mean of λ_{it} across nine regions and its 5 percent confidence interval

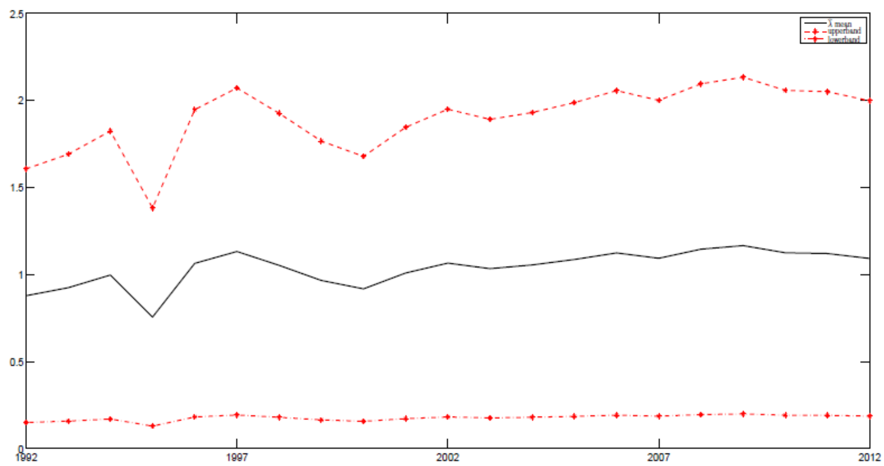
1. The window size of the estimation is 14 years.

2. LA stands for the average latitude of provincial capitals. This is the second stage instrument for capital mobility.

Figure 2. Estimated Rolling Window[1] λ (LA[2])



(a) λ_{it} for 9 regions



(b) Mean of λ_{it} across nine regions and its 5 percent confidence interval

1. The window size of the estimation is 14 years.
2. DF stands for distance to financial centers of provincial capitals. This is the second stage instrument for capital mobility.

Figure 3. Estimated Rolling Window[1] λ (DF[2])

Table 5 presents the results when we use DF, the distance of provincial capitals to the financial centers, as the instrument[19] for capital mobility. The results are in general similar as in Table 3 and 4.

Figure 3 (a) shows the rolling window estimates of λ_{it} in which the second stage IV is DF. Figure 3 (b) plots the mean of λ_{it} and its 5 percent confidence intervals. The results are in general similar to what we obtain in Figure 1 and 2.

In summary, the estimation results show that the degree of capital mobility across regions in China is low, and it does not seem to improve significantly over time since 2000. This indicates that the barrier to free capital mobility remain prevalent across regions in China. One possible explanation is that capital market distortion in China is still quite high (Zhu, 2012).

[19]Here it is the averaged distance to financial centers of the provincial capitals in a region.

Table 5. Estimation results for 9 regions: DF[1] as the Second Stage Instrument

Region	Whole period	1st subperiod	2nd subperiod
1	1.4540 (0.4343)**3	0.9370 (0.8225)	1.2947 (0.4038)**
2	1.3390 (0.4000)*	0.8629 (0.7575)	1.1924 (0.3719)**
3	2.2402 (0.6692)**	1.4437 (1.2673)	1.9949 (0.6222)**
4	0.6927 (0.2069)**	0.4464 (0.3919)	0.6168 (0.1924)**
5	0.9992 (0.2985)**	0.6440 (0.5652)	0.8898 (0.2775)**
6	0.8740 (0.2611)**	0.5632 (0.4944)	0.7782 (0.2427)**
7	0.8925 (0.2666)**	0.5752 (0.5049)	0.7948 (0.2479)**
8	1.5769 (0.4711)**	1.0163 (0.8920)	1.4042 (0.4380)**
9	2.1947 (0.6556)**	1.4144 (1.2415)	1.9543 (0.6095)**

1. In the second stage the IV is DF, defined as the averaged distance to financial centers of provincial capitals. In the first stage the IV is the growth rate of the number of college students enrolled per 10,000 people.

2. Whole period runs from 1978-2012. The first subperiod spans from 1978 to 1993, while the second spans from 1994 to 2012. Estimated parameters are followed by standard errors. * and ** represent 5% and 1% significance level, respectively.

5. Conclusion

This paper examined the degree of capital mobility across different regions in China over the period 1978 to 2012. We employ a model developed by Shibata and Shintani (1998) to measure the capital mobility across regions by the ability of regions to engage in intertemporal consumption smoothing through running external imbalances.

In addition, we take into account the possibility that the degree of capital mobility is endogenous and is correlated with the output level. Thus we employ Heckman and Vytlacil (1998)'s correlated random coefficient model in estimating the degree of capital mobility. This model produces consistent estimates of parameters when they are themselves endogenous.

Our results show that the degree of capital mobility across regions in China is low. There are significant barriers to capital mobility across China. When we split the whole sample into two subperiods, it shows a slight increase in the degree of inter-regional capital mobility. This downward trend is also reflected by the rolling-window estimation. However, after 2000, there is apparently a stagnation of improvement in capital mobility across regions. This may be due to the continuous presence of capital market distortion in recent years in China (Zhu, 2012).

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