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**Saving-Investment Relationship and Capital Mobility:  
Evidence from Chinese Provincial Data, 1980—2007<sup>\*)</sup>**

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Abstract

Panel data for individual Chinese provinces from 1980 to 2007 was used to estimate the saving-investment model used by Feldstein and Horioka (1980), shed light on changes to China's domestic capital mobility since the adoption of the Open Door Policy, and determine whether there has been any increase in mobility since 2000. High capital mobility was observed through the first half of the 1980s followed by low capital mobility during the 1990s. Capital mobility began to gradually increase again around 1996, reaching levels similar to those of other leading industrialized countries in the 2000s.

Keywords: Saving-Investment Relationship; Capital Mobility; Chinese Provincial Data; Feldstein-Horioka puzzle

JEL classification number: F41, O11

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## 1. Introduction

During the China's planned economy era, the central government systematically took in and allocated resources according to an industrialization strategy that gave priority to heavy industry. It siphoned off savings or financial resources generated by the household and business sectors in each region, and invested them in infrastructure and other projects in relatively poor regions of the country.

After the Open Door Policy was adopted in 1978, a system emphasizing local finance<sup>1</sup> began to take hold. Under this system, the role that the central government had played in reallocating resources began to decline. In its place, reforms to the financial system that nurtured the growth of a domestic capital market and financial system were introduced. China's regions began to see the creation of various financial institutions: government-owned banks, privately held banks, joint-stock commercial banks, and stock markets. The Central Bank Law and the Commercial Bank Law, implemented in the mid-1990s, enacted further reform. Additionally, a unified national call market was established in 1996. By the mid-1990s, China's financial system had come to approximate that of a market economy (Imai and Watanabe, 2006).

How has inter-regional capital mobility in China changed, given the conversion of the domestic resource allocation mechanism from a centrally planned government approach to one in which markets mediate between economies? Boyreau-Debray and Wei (2004) and Watanabe (2006) applied the method introduced by Feldstein and Horioka (1980) to quantitatively measure China's domestic capital mobility. They concluded that capital mobility among provinces was high during the era of planned economies, but it declined after the adoption of the Open Door Policy, particularly in the 1990s. This suggests that even though a mechanism for circulating capital among provinces existed during the era of planned economies, it was weakened by the adoption of the Open Door Policy. There are two primary factors that are thought to have brought about the decline in capital mobility. The first is the weakened state of the central government's resource reallocation function following the adoption of the Open Door Policy. The second is the initial immaturity of the market economy's financial system.

What has happened to domestic capital mobility in China since 2000? There are no definitive answers yet. In the latter half of the 1990s, the central government began to actively direct financial resources to those regions where economic development had lagged. A balanced regional development policy was introduced in the mid-1990s, and development of the western region began in 2000. The inflow of foreign capital began to rise with Deng Xiaoping's southern tour of China in 1992. Additionally, China joined the WTO (World Trade Organization) in 2001. Government spending expanded, and the effects of globalization on the Chinese economy may have worked to increase domestic capital mobility.

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<sup>1</sup> To facilitate local economic development, the system gives some autonomy to local governments by allowing them to keep large portions of locally collected revenue.

Panel data for individual Chinese provinces from 1980 to 2007 was used to estimate the saving-investment model used by Feldstein and Horioka (1980), shed light on changes to China's domestic capital mobility since the adoption of the Open Door Policy, and determine whether there has been any increase in mobility since 2000. Section 2 of this paper explains the saving-investment model. Section 3 discusses the estimation method and data, and reports the empirical results.

## 2. Model

In accordance with Feldstein and Horioka (1980) and other previous studies, the following equation was used to investigate the extent of China's domestic capital mobility:

$$\frac{I_{it}}{Y_{it}} = \alpha + \beta \left( \frac{S_{it}}{Y_{it}} \right) + \varepsilon_{it}, \quad i = 1, 2, \dots, N; t = 1, 2, \dots, T \quad (1)$$

where  $i$  and  $t$  denote a region and time,  $I_{it}$  is investment,  $S_{it}$  is savings,  $Y_{it}$  is output,  $\varepsilon_{it}$  is an error term, and  $\alpha$  and  $\beta$  are parameters.

Feldstein and Horioka assert that in a closed economy, savings and investment in one region are equivalent. Consequently  $\beta$  in Equation (1) should be close to one. Conversely, in an open economy with perfect capital mobility among regions, savings in one region must flow to the region with the most attractive investment projects. Under this assumption, investment in one region is not dependant on the local savings within that region. In an extreme case,  $\beta$  would be zero.  $\beta$  can be interpreted as an index of the extent of capital mobility, called the "savings-retention parameter." An estimated  $\beta$  of close to one indicates low capital mobility among regions, while an estimated  $\beta$  of around zero implies a high degree of capital mobility.

Boyreau-Debray and Wei (2004) and Watanabe (2006) computed the magnitude of the saving-investment relationship ( $\beta$ ) using provincial panel data from China. Boyreau-Debray and Wei used the data of 28 provinces from 1978-2001. Their estimated values for  $\beta$  were 0.202 from 1978-1989 and 0.567 from 1990-2001. Watanabe (2006) used the data of 28 provinces from 1952-1984 and data of 31 provinces from 1985-2002. Watanabe's estimated values for  $\beta$  were 0.295 from 1952-1984 and 0.488 from 1985-2002. According to these studies, China's domestic capital mobility declined after the economic reforms of 1978.

In studies of developed countries associated with high domestic capital mobility (i.e., Canada, Japan, the United Kingdom, and the United States), estimates of  $\beta$  have been close to zero, or even negative in value (van Wincoop, 2000). One interpretation of the meaning of a negative value comes from Dekle (1996), who argued that a fiscal policy which reallocates

large financial resources to low-savings regions leads to a negative relationship between savings and investment.

### 3. Estimation

#### 3.1 Estimation Methodology

Provincial panel data from China during 1980-2007 was used to estimate Equation (1); the dataset used will be described in the next subsection. Two approaches to examining the change of the savings-retention parameter  $\beta$  for 1980-2007 were used.

In the first approach, the data was divided into three periods, (a) 1980-1989, (b) 1990-1999, and (c) 2000-2007. The parameters  $\alpha$  and  $\beta$  were estimated separately for each period. For example:

$$\begin{aligned}
 \text{Period (a)} \quad \begin{bmatrix} y_{i,1980} \\ y_{i,1981} \\ \vdots \\ y_{i,1989} \end{bmatrix} &= \begin{bmatrix} 1 & x_{i,1980} \\ 1 & x_{i,1981} \\ \vdots & \vdots \\ 1 & x_{i,1989} \end{bmatrix} \begin{bmatrix} \alpha_a \\ \beta_a \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,1980} \\ \varepsilon_{i,1981} \\ \vdots \\ \varepsilon_{i,1989} \end{bmatrix} \\
 \text{Period (b)} \quad \begin{bmatrix} y_{i,1990} \\ y_{i,1991} \\ \vdots \\ y_{i,1999} \end{bmatrix} &= \begin{bmatrix} 1 & x_{i,1990} \\ 1 & x_{i,1991} \\ \vdots & \vdots \\ 1 & x_{i,1999} \end{bmatrix} \begin{bmatrix} \alpha_b \\ \beta_b \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,1990} \\ \varepsilon_{i,1991} \\ \vdots \\ \varepsilon_{i,1999} \end{bmatrix} \tag{2} \\
 \text{Period (c)} \quad \begin{bmatrix} y_{i,2000} \\ y_{i,2001} \\ \vdots \\ y_{i,2007} \end{bmatrix} &= \begin{bmatrix} 1 & x_{i,2000} \\ 1 & x_{i,2001} \\ \vdots & \vdots \\ 1 & x_{i,2007} \end{bmatrix} \begin{bmatrix} \alpha_c \\ \beta_c \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,2000} \\ \varepsilon_{i,2001} \\ \vdots \\ \varepsilon_{i,2007} \end{bmatrix},
 \end{aligned}$$

where  $y_{it} = (I_{it}/Y_{it})$  and  $x_{it} = (S_{it}/Y_{it})$ . For the estimation methodology, the seemingly unrelated regression (SUR) method and the generalized method of moments (GMM) were applied to each period. When there are no correlations between the regressor  $S_{it}/Y_{it}$  and  $\varepsilon_{it}$ , the SUR method results in consistent estimates; however,  $\varepsilon_{it}$  usually consists of an unobservable individual effect  $\mu_i$  and a random effect  $\eta_{it}$ , i.e.,  $\varepsilon_{it} = \mu_i + \eta_{it}$ . If  $\mu_i$  is correlated with  $S_{it}/Y_{it}$ , or if  $\varepsilon_{it}$  (or  $\eta_{it}$ ) represents some productivity shock affecting  $Y_{it}$ , then correlations between  $S_{it}/Y_{it}$  and  $\varepsilon_{it}$  arise and the SUR estimates lose their consistency.

Fortunately, consistent estimates of  $\beta$  can be obtained by using the first-order difference of Equation (2) to cancel  $\mu_i$ , and then applying the GMM method. For the instrumental variables  $\mathbf{z}_{it}$  used in the GMM estimation, the following variables can be used:

$$\begin{aligned}\mathbf{z}'_{it} &= [x_{i,t-2}] & (t=1983), \\ \mathbf{z}'_{it} &= [x_{i,t-3}, x_{i,t-2}] & (t=1983), \\ \mathbf{z}'_{it} &= [x_{i,t-4}, x_{i,t-3}, x_{i,t-2}] & (t=1984, 1985, \dots, 2007).\end{aligned}$$

In the next approach used to investigate the year-to-year changes of  $\beta$ , we carried out two estimations. The first was an equation-by-equation OLS and GMM estimation using each of the cross-section samples, where the instrumental variables for the GMM are:

$$\mathbf{z}'_{it} = [x_{i,t-3}, x_{i,t-2}, x_{i,t-1}] \quad (t = 1984, 1985, \dots, 2007).$$

The second was an SUR estimation conducted separately for periods (a), (b), and (c). For example:

$$\begin{aligned}\text{Period (a)} \quad \begin{bmatrix} y_{i,1980} \\ y_{i,1981} \\ \vdots \\ y_{i,1989} \end{bmatrix} &= \begin{bmatrix} \alpha_{1980} \\ \alpha_{1981} \\ \vdots \\ \alpha_{1989} \end{bmatrix} + \begin{bmatrix} x_{i,1980} & 0 & \cdots & 0 \\ 0 & x_{i,1981} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & x_{i,1989} \end{bmatrix} \begin{bmatrix} \beta_{1980} \\ \beta_{1981} \\ \vdots \\ \beta_{1989} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,1980} \\ \varepsilon_{i,1981} \\ \vdots \\ \varepsilon_{i,1989} \end{bmatrix} \\ \text{Period (b)} \quad \begin{bmatrix} y_{i,1990} \\ y_{i,1991} \\ \vdots \\ y_{i,1999} \end{bmatrix} &= \begin{bmatrix} \alpha_{1990} \\ \alpha_{1991} \\ \vdots \\ \alpha_{1999} \end{bmatrix} + \begin{bmatrix} x_{i,1990} & 0 & \cdots & 0 \\ 0 & x_{i,1991} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & x_{i,1999} \end{bmatrix} \begin{bmatrix} \beta_{1990} \\ \beta_{1991} \\ \vdots \\ \beta_{1999} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,1990} \\ \varepsilon_{i,1991} \\ \vdots \\ \varepsilon_{i,1999} \end{bmatrix} \\ \text{Period (c)} \quad \begin{bmatrix} y_{i,2000} \\ y_{i,2001} \\ \vdots \\ y_{i,2007} \end{bmatrix} &= \begin{bmatrix} \alpha_{2000} \\ \alpha_{2001} \\ \vdots \\ \alpha_{2007} \end{bmatrix} + \begin{bmatrix} x_{i,2000} & 0 & \cdots & 0 \\ 0 & x_{i,2001} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & x_{i,2007} \end{bmatrix} \begin{bmatrix} \beta_{2000} \\ \beta_{2001} \\ \vdots \\ \beta_{2007} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,2000} \\ \varepsilon_{i,2001} \\ \vdots \\ \varepsilon_{i,2007} \end{bmatrix},\end{aligned} \tag{3}$$

By applying the SUR method separately to each period, estimates were obtained for  $\alpha_i$  and  $\beta_i$  ( $t = 1980, 1985, \dots, 2007$ ).

### 3.2 Data

Provincial data for 28 Chinese provinces during 1980-2007 was used in this study. The provinces of Chongqing, Tibet, and Ningxia were excluded from the data. The dataset of output  $Y_{it}$ , investment  $I_{it}$ , and savings  $S_{it}$  is constructed as follows:  $Y_{it}$  and  $I_{it}$  are a provincial gross value-added and gross capital formation in current prices. Following the methodology of previous studies, the provincial savings data  $S_{it}$  is defined as  $Y_{it}$  minus household and government consumption expenditures. The above data are taken from Kato and Chen (2002) for a period from 1980 to 1998 and the *China Statistical Year Book* for the remaining period from 1999 to 2007.

### 3.3 Empirical Results

Table 1 shows the estimation results of the first approach mentioned in Section 3.1.<sup>2</sup> All of the parameter estimates, with the exception of  $\beta$  for 2000-2007, are significant at the 1% or 5% level. The  $J$  statistic is used to test over-identifying restrictions (Hansen, 1982). The  $m_2$  statistic is used to test second-order serial correlation in  $\Delta\varepsilon_{it}$  ( $=\varepsilon_{it} - \varepsilon_{it-1}$ ), where a standard normal distribution is followed asymptotically under the null hypothesis of no second-order serial correlation (Arellano, 2003, p. 121). These statistics from the GMM estimation suggest no problematic results, except for the  $m_2$  in 2000-2007.<sup>3</sup> The SUR estimates of  $\beta$  using the level equations are 0.061 (1980-1989), 0.390 (1990-1999), and 0.020 (2000-2007); the SUR estimates of the first-order difference equation are 0.150, 0.463, and 0.107; and the GMM estimates are 0.174, 0.546, and -0.001.

These results demonstrate that  $\beta$  increases from the 1980s to 1990s, then decreases to nearly zero in the 2000s. In other words, the capital flow among China's regions exhibits a high mobility during both the 1980s and 2000s, but a lower mobility in the 1990s. The results show a decline in capital mobility in China during the 1990s that corresponds with the results of previous studies (Boyreau-Debray and Wei, 2004; Watanabe, 2006). The results showing a sharp improvement in China's capital mobility during in the 2000s, an improvement to a level comparable to that of developed countries, had not been demonstrated before.

Figure 1 displays the estimation results of the second approach, plotting the behavior of  $\beta$  every year estimated by the OLS, GMM, and SUR methods. There are some differences in the variance of the OLS, GMM, and SUR estimates, but as the figure shows, the behavior of these estimates makes little difference. The  $\beta$  parameter is not significantly different than

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<sup>2</sup> Before proceeding with the estimation, panel unit root tests for both  $I_{it}/Y_{it}$  and  $S_{it}/Y_{it}$  were carried out. As a result, the null hypothesis, which states that unit roots exist, was rejected for each of the variables.

<sup>3</sup> Since the  $m_2$  statistic in 2000-2007 indicates a suspicion of the serial correlation of  $\varepsilon_{it}$ , the consistency of the GMM estimates for 2000-2007 cannot be ensured.

zero during the first half of the 1980s, but during the latter half of the decade it becomes more significant. The  $\beta$  parameter decreases around 1990, but it seems to exhibit an increasing trend from the latter half of the 1980s until 1995. The  $\beta$  parameters in 1995 are 0.595 (OLS), 0.653 (GMM), and 0.486 (SUR), and they steadily decrease from 1995 and return to insignificant levels in the 2000s.

According to the estimation results in Table 1 and Figure 1, it seems natural to conclude that China's capital mobility among regions had two phases: 1) a high capital mobility phase during the early 1980s and 2000s, and 2) a low capital mobility phase during the 1990s. Moreover, the latter phase includes a period of declining capital mobility (from the latter half of the 1980s to 1995) and a period of rising capital mobility (from 1996 to the end of the 1990s). The decline of capital mobility during the early 1990s can probably be attributed to two factors: a weakening of the function of redistribution by central government expenditures and the underdevelopment of China's domestic financial system at that time.

The increase of capital mobility after 1995 can be associated with the changes to China's regional development strategy. In 1996, China's development strategy switched from an unbalanced regional development strategy that focused on coastal regions to a balanced regional development strategy that promotes the growth of inland regions. As a result, public expenditure for the development of inland regions has increased since 1996. Expenditure levels have increased even more since 2000, when China began implementing a new policy for the development of the western region. These increases in public expenditure may have helped to promote capital mobility among regions. Additionally, it should be noted that the inflow of foreign capital has increased since 1992, the year when Deng Xiaoping took his southern tour of China, and that a national unified call market was established in 1996. These two events may have also facilitated capital mobility.

#### **4. Conclusion**

Panel data from individual Chinese provinces during 1980-2007 was used to estimate the saving-investment model used by Feldstein and Horioka (1980), and to analyze trends in China's domestic capital mobility since the adoption of the Open Door Policy. Results show that there have been both high and low trends in China's domestic capital mobility since 1980. High capital mobility was observed through the first half of the 1980s and since the year 2000. Low capital mobility was seen until the 1990s. An examination of secular changes in capital mobility clearly shows that a downward trend began in the latter half of the 1980s and generally continued through 1995. 1996 experienced a reversal in the trend, which led to another period of high capital mobility at the end of the 1990s. Boyreau-Debray and Wei (2004) and Watanabe (2006) reached similar conclusions regarding the decline of capital mobility in the 1990s. The results of this study show that capital mobility began to gradually



increase around 1996, reaching levels similar to those of leading industrialized countries during 2000s. The increase in capital mobility that began during the mid-1990s may have been affected by increased foreign capital inflows, financial system maturation, and expanded central government spending.

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**Table 1: Estimation Results**

I. Seemingly Unrelated Regression (Level)			
	<u>1980-1989</u>	<u>1990-1999</u>	<u>2000-2007</u>
$A$	0.248***	0.162***	0.411***
(S. E.)	(0.013)	(0.019)	(0.023)
$\beta$	0.061**	0.390***	0.020
(S. E.)	(0.026)	(0.046)	(0.045)
II. Seemingly Unrelated Regression (Difference)			
	<u>1980-1989</u>	<u>1990-1999</u>	<u>2000-2007</u>
$\beta$	0.150***	0.463***	0.017
(S. E.)	(0.033)	(0.068)	(0.052)
III. Generalized Method of Moments (Difference)			
	<u>1981-1989</u>	<u>1990-1999</u>	<u>2000-2007</u>
$\beta$	0.174***	0.546***	-0.001
(S.E.)	(0.035)	(0.003)	(0.037)
$J$ statistics	25.679	27.026	24.589
( $p$ value for $J$ )	(0.177)	(0.408)	(0.218)
$m_2$ statistics	0.143	-0.156	3.245***
( $p$ value for $m_2$ )	(0.886)	(0.876)	(0.001)

Note: S.E. is the standard error, and the asterisks \*\*\* and \*\* denote 1% and 5% significance, respectively. The statistics of  $J$  are used to test over-identifying restrictions (Hansen 1982). The  $m_2$  statistics are used to test second-order serial correlation in  $\Delta \varepsilon_{it}$  ( $= \varepsilon_{it} - \varepsilon_{it-1}$ ), where a standard normal distribution is followed asymptotically under the null hypothesis of no second-order serial correlation (Arellano 2003, p. 121).

**Figure 1: Behavior of Savings-Retention Coefficient**

