Does FDI Promote Human Capital Accumulation? The Role of Gradual Financial Liberalization*

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Abstract

We argue that how inward foreign direct investment (FDI) affects domestic human capital accumulation (HCA) depends on the degree of financial deregulation. Utilizing the Chinese experience and its panel data, the OLS (ordinary least squares) regressions suggest that FDI has a significant positive interaction effect with financial deregulation on HCA. Specifically, the estimated coefficient on FDI is positive but insignificant, while that on its interaction with financial deregulation is significantly positive. It means that FDI promotes HCA in China, and higher degree of financial deregulation reinforces the promoting effect. Instrumenting FDI with two sets of instruments grounded on different rationales (which ensures valid identification), our limited-information maximum likelihood (LIML) estimation results are similar to those of OLS. The results are also robust when we control for other factors affecting HCA, and time and province effects.

JEL Classification: C23 F21 J24
Keywords: Foreign Direction Investment; Human Capital; Gradual Financial Deregulation; Interaction; Panel Data

1 Introduction

As globalization accelerates, the foreign direct investment (FDI) to developing countries has increased dramatically over the past several decades (see UNCTADstat, 2010). It has been long argued that technology diffusion via FDI plays an essential role in the process

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of economic development (e.g., Nelson and Phelps, 1966; Grossman and Helpman, 1991, chs 11 and 12; Borensztein et al., 1998). Given the tidal surge of inward FDI, its real effect on the economic development of developing countries is important to understand. In theoretical and especially empirical works, human capital accumulation (HCA) has been shown to be one important and robust predictor of economic performance (see Lucas, 1988; Glaeser et al., 2004). Therefore, in this paper, we are interested in how inward FDI impacts HCA at the economy-wide level.

However, the results are mixed in the literature concerning how inward FDI affects HCA.[1] For example, Gittens (2006), Nunnenkamp (2002) and Mughal and Vechiu (2009) find that inward FDI promotes HCA proxied by primary school enrollment, the level of schooling, and higher education respectively. In contrast, Gittens (2006) evidences that inward FDI does not promote other types of HCA. Ram and Zhang (2002) argue that the FDI-HCA interaction is not important in the 1990s. Beugelsdijk et al. (2008) show that the effect of FDI on HCA may depend on whether the type of FDIs is vertical or horizontal. In this paper, we contribute by arguing that the effect of inward FDI on HCA may depend on financial deregulation.

The reason to consider financial deregulation in the FDI-HCA nexus is two-fold. First, over the past several decades, many countries, developing as well as developed ones, have also deregulated their financial services (e.g., Riedel and Turley, 1999; Jbili et al., 1997; Cummins and Rubio-Misas, 2006). Financial distortions can impose serious barriers on the entry of FDI (Borensztein et al., 1998; Gastanaga et al., 1998). Through eliminating financial distortions, financial deregulation, therefore, promotes the inflow of FDI (Desai et al., 2004). More importantly, financial system was found to interact with FDI in affecting economic development (e.g., Alfaro et al., 2004; Hermes and Lensink, 2003). Given that HCA is one crucial factor in economic development, therefore, there may exist a possible interaction between FDI and financial deregulation in affecting HCA. Neglecting financial deregulation and its interaction with FDI not only imposes one serious source of omitted variable bias, but also does not allow us to fully capture the effect of FDI on HCA. Second, Zhuang (2003) find that FDI decreases high school education while promotes middle school and college education in China. The contradicting results on China may be due to omitting financial deregulation. In this paper, we consider the role of financial deregulation to correctly identify the effect of inward FDI on HCA, and use the Chinese experience that is suitable for the following reasons.

First, the Chinese experience provides a natural experiment with both large inflow of FDI and significant financial deregulation. Since 1978, the Chinese government has not only put attracting more FDI as a priority on its agenda, but also made continuous ef-

[1]For a thorough review, please see Mughal and Vechiu (2009). Because of their excellent discussion of it, I shall omit detailed references to the literature.

forts to reform its backward unhealthy financial system to facilitate the inflow of FDI (see subsection 1.1). Our empirical investigation uses the symbiotic opening-up to foreign investments and financial deregulation experience of China. Second, China has adopted the gradual approach to financial reform and opening-up contrast to 'shock therapy' adopted elsewhere. Resultantly, both China's financial reform and FDI inflows have substantive variations across time and province. Figures 1 and 2 illustrate the substantial variations across time and province in FDI to GDP ratios and degree of financial deregulation – detailed later. The time variation allows us to control for unobserved province effects, presenting a robust result. Third, we can overcome the potential endogeneity problem of FDI to check the robustness of our results. The endogeneity problem can be avoided by applying the instrumental variable (IV) technique. Borenstein et al. (1998), for example, argue that the fundamental problem is that there are no ideal instruments. To ensure valid identification, we use two groups of instruments grounded on different rationales (the first set includes a series of weather indicators and the second set contains the farmland resource abundance indicator). The validity of the instruments is supported by over-identification tests. To deal with weak instruments, we use limited-information maximum likelihood (LIML) estimation (see Stock and Yogo, 2002; Hahn and Hausman, 2005). Fourth, the market-oriented reform since 1978 has put China on the path to sustained industrialization. There is no structural break in China after 1978 as found by previous works (Weeks and Yao, 2003), so we are studying a consistent regime.

[Figures 1 and 2 Here]

The following discusses the possible mechanism at play via which financial deregulation may affect how inward FDI affects the host country's human capital accumulation.

According to previous literature, there are two opposing forces by which inward FDI is driven to affect HCA, which applies to China. On the one hand, multi-national corporations (MNCs) bring higher demand for human capital, which generates incentive for the local population to invest in human capital. This is especially true for horizontal FDI argued by Beugelsdijk et al. (2008). MNCs also directly provide on-the-job training, which directly adds to human capital (Mughal and Vechiu, 2009). Moreover, FDI is conducive to the technological upgrading of local firms. Resultantly, their demand for labor with high levels of human capital expands. Yet on the other hand, there is substantial evidence that the recent globalization process has widened the wage differentials between skilled and unskilled labor in middle-income countries (see Kapstein, 2001). It implies FDI discourages the human capital accumulation of unskilled labor. Moreover, vertical FDI, according to Beugelsdijk et al. (2008), seeks for cheap labor, which provides little incentive for local population to engage in higher education. Last but not least, MNCs compete with domestic firms in labor, product and financial markets. For China, there exists financial

repression in the Chinese economy and many Chinese firms are inefficient state-owned enterprises (SOEs) (see Lardy, 1998; Naughton, 1995). FDI may crowd out inefficient domestic investments in skilled labor market, ending up increasing their relative demand for unskilled labor. The combined effect of FDI on total human capital accumulation depends on the relative magnitude of the two forces. Financial deregulation changes the two forces differently. Firstly, the Chinese financial deregulation has facilitated the inflow of FDI (Head and Ries, 1996; Branstetter and Feenstra, 2002). This extensive margin strengthens both of the two forces, which encourages the human capital accumulation of skilled labor and discourages that of unskilled labor. Secondly, China's financial deregulation gradually attracts more horizontal FDI than vertical FDI. This is because the preferential tax and administrative treatment to foreign firms has been removed, which makes more MNCs with superior technology choose to invest in China. More market-seeking MNCs than cheap-labor-seeking MNCs investing in China provides an intensive margin, which tends to reinforce the first force. Therefore, it is likely that financial deregulation would reinforce the positive effect of FDI on human capital accumulation.

Our object is to examine empirically the effects of FDI on HCA. We employ a framework of cross-province regressions utilizing data on gradual financial deregulation across Chinese provinces and FDI inflows to Chinese provinces from 1981 to 1998. The OLS (ordinary least squares) regressions show the following. FDI has a significant and positive effect on HCA, which depends on the level of financial deregulation. Specifically, the estimated coefficient on FDI is positive but insignificant, while that on its interaction with financial deregulation is significantly positive. It means that financial deregulation has enhanced the positive effect of FDI on HCA. The results are robust when we overcome the potential endogeneity problem of FDI by LIML estimation. The results hold up when we control for the other variables affecting HCA. Particularly, the results are robust to the controlling for time and province effects.

To get an estimate of how important FDI has been in promoting HCA, we find that having a one-standard-deviation increase in ln(FDI/GDP) would have caused a province receiving the mean level of financial reform in the sample to experience an annual domestic human capital investment rate increase of 0.16 standard deviation during the 18-year-period. For Shanghai that receives the highest degree of financial deregulation during the period 1993-98, having a one-standard-deviation increase in FDI would have resulted in an annual increase of 2.62 standard deviations in human capital accumulation. That is, the main promoting effect of FDI on human capital accumulation is through interacting with financial deregulation. In contrast, without considering financial deregulation, the estimated coefficients on FDI are insignificant in both OLS and LIML estimations.

1.1 Gradual Financial Deregulation and Inflows of FDI in China

Since 1978, China has begun the reform and opening-up process that put China on the path of fast and sustained industrialization. China's average annual growth of real GDP (gross domestic product) per worker in the past three decades is roughly 8%, highest in the world. Concerning reform, China has adopted the gradual approach to financial reform contrast to 'shock therapy' adopted elsewhere. The Chinese gradual financial deregulation studied by previous works (Lardy, 1998; Naughton, 1995; Shirk, 2003; Brandt and Zhu, 2007) refers to the following. Across time, it involves a gradual implementation of piece-meal financial deregulation policies over a long period of time. Common themes of the piece-meal policies include the provision of more autonomy in credit allocation to state-owned banks, and the relaxation of geographical and legal restrictions on the entry of new financial intermediaries. Across provinces, it refers to a process that allows some provinces to implement some piece-meal financial deregulation policies first. Most policies are conducted at the city level; few are at the province level. Resultantly, the Chinese financial reform has cross-section and time-series variations.

However, despite the financial reform in 1978, there still exists financial repression in the Chinese economy and the Chinese financial system is still unhealthy (Lardy, 1998; Naughton, 1995; Shirk, 2003). Before 1978, China had an underdeveloped financial system in which the government played a dominant role (Lardy 1998, ch. 3; Naughton 1995, ch. 1). Interest rates were set administratively; monetary policy was conducted through direct allocation of credit and refinancing. The primary financial intermediaries were state banks that were obliged to lend to SOEs with little concern for its profitability. The situation has been only gradually changed since 1978, because of the gradual approach to reform adopted by the Chinese government. Shirk (2003, p. 26) shows: "In China, iron and steel and machine building, the backbone heavy industries, were given priority, consuming more than one-third of total investment in industrial capital construction (Statistical Yearbook 1990, 168)." Given the presence of financial repression, FDI may 'crowd out' investment from domestic sources as argued in Borensztein et al. (1998).

The following presents a brief summary of the most important financial deregulation policies related to FDI. The original source is the book "The Big Economic Events since China's Reform and Opening-up (1978-1998)" edited by the Institute of Economic Research, the China Academy of Social Sciences.

"In 1983, the People's Bank of China announces that foreign financial institutions can apply to set up permanent institutions in Beijing and Special Economic Zones (SEZ). In 1984, the State Council of China (SCC) reduces the tax rates in SEZ and 14 coastal 'Open Door' cities. In 1985, the regulations on foreign banks and sino-foreign joint venture banks in SEZ in the People's Republic of China are announced and implemented to expand international economic and financial cooperation. The aim is to attract foreign investment and technology and promote the economic development of SEZ. In the same year, Xiamen

International Bank opens for business, and the first foreign bank, HSBC Bank (Hongkong and Shanghai Banking Corporation), establishes a branch in Shenzhen city, one of the four SEZ. In 1986, Bank of China sets up four measures to support foreign invested enterprises so as to solve their existing problem of shortage of funds...In 1988, Shanghai sets up foreign exchange market, allowing state-owned enterprises, collective enterprises and foreign invested enterprises to mutually swap foreign exchange. In 1990, the SCC ratifies the Shanghai's administrative solutions on foreign financial institutions, allowing foreign financial institutions to conduct financial business in China..."

As a result, financial liberalization in China has promoted the inflows of FDI. The FDI inflow to China has dramatically increased since 1978 and become one important source of external financing by the late 1990s. China's FDI inflows comprise the dominant share of total FDI inflows to East Asia (see Figure 1). Moreover, the increasing inflow of FDI is unevenly distributed across Chinese provinces. For Guangdong (Canton) province, its ratio of FDI to GDP increases steadily over time. It becomes higher than domestic investment rate after 1992 and reaches 18% in 1994. In contrast, Shanxi province's ratio of FDI to GDP is still below 1.5% in 1998, although it increases over time.

The rest of the paper proceeds as follows. Section 2 describes the empirical formulation and the data used in the empirical analysis. Section 3 presents the regression results. Section 4 concludes.

2 Data

To provide an account of the data needed in the empirical analysis, we first give the empirical specification and then discuss the endogeneity problem of FDI and its identification strategy.

We follow Borensztein et al. (1998) and Wang (2008) to get our empirical specification:

$$ln(HCA)_{i,t} = \beta_0 + \beta_1 ln(\frac{FDI}{GDP})_{i,t} + \beta_2 [ln(\frac{FDI}{GDP}) \times F\text{-}Reform]_{i,t} + \beta_3 F\text{-}Reform_{i,t} + \beta_4 ln(\frac{GDP}{L})_{i,t-1} + \beta_5 ln(\frac{I}{GDP})_{i,t} + \beta_6 ln(n+g+\delta)_{i,t} + \beta_7 ln(Export)_{i,t} + \beta_8 ln(Fiscal)_{i,t} + u_i + \theta_t + \varepsilon_{i,t} \quad (1)$$

where HCA is human capital investment rate; FDI/GDP is foreign direct investment to GDP ratio; F-Reform is the measure of the degree of financial deregulation; $\ln(\text{GDP/L})_{i,t-1}$ is initial real GDP per worker; I/GDP is nominal investment rate; $\ln(\text{n+g+}\delta)$ measures labor force growth; Export and Fiscal are export and fiscal expenditure to GDP ratios respectively; u_i and θ_t are the fixed province and time effect respectively. The subscript i stands for i^{th} province.

The empirical specification is similar to previous works that study how FDI affects domestic investment (see Borensztein et al., 1998, p. 129; Wang, 2008, p. 3) and that on how FDI affects human capital investment (e.g. Mughal and Vechiu, 2009). The control variables are similar to those in Mughal and Vechiu (2009), but we have more control variables due to data availability. It is obvious that growth rate should be included in the regression. Mankiw et al. (1992) theoretically derive that growth can be expressed as a function of initial GDP and the other control variables such as investment rate and labor force growth in equation (1). We include these independent control variables to avoid potential omitted variable biases.

We employ the Chinese panel data from 1981 to 1998 and take six-year averages to avoid the influence from business cycles, ending up with three sub-periods: 1981-86, 1987-92, and 1993-98.

2.1 Endogeneity of FDI and its Identification Strategy

We are aware that our regressions presented below may be subject to the endogeneity problem of FDI. Recent empirical research suggests that firms are attracted to regions in which educational investment is already high and a lack of human capital may deter FDI. This reverse causality would bias the estimated coefficient on FDI in OLS regressions. Moreover, there may exist omitted variables that affect the human capital accumulation and the inflow of FDI simultaneously. A correlation between FDI and the province-specific error term would arise in these circumstances, which would also cause the estimated coefficients in OLS regressions to be biased and inconsistent.

We overcome the endogeneity problem of FDI by applying the IV technique. An ideal instrument would be a variable that is highly correlated with FDI but not with the error term in the regressions. To ensure valid identification, we construct two groups of instruments based on different rationales. The first group is a series of weather indicators, and the second measures farmland resource abundance. Stijns (2001, 2006) provides evidence that natural resource abundance has effects on human capital accumulation. We argue that farmland abundance affects the locational choice of FDI, ending up affecting HCA. This also applies to why weather indicators are plausible instruments for FDI. Following Goldsmith and Sporleder (1998), foreign firms' locational choice in China is partly affected by weather conditions. Some FDI inflows are directed towards agriculture and agriculture-related labor intensive industries since China is a developing country with a large agricultural sector, which is consistent with the sectoral composition of world FDI summarized by World Bank. Although weather and farmland abundance are correlated, they are grounded on different rationales, therefore, passing the over-identification tests means that the instruments are valid ones. In addition, we will use LIML estimation to cope with weak instruments.

2.2 Measuring HCA and FDI

Our dependent variable, HCA, is the human capital investment rate. It is worth pointing out that a major reason behind the divergent results on the FDI-HCA nexus lies in the lack of a common measure of human capital. As pointed out by Mughal and Vechiu (2009), the proxy for human capital in the literature is usually the secondary school enrollment rate (e.g., Mankiw et al., 1992; Borensztein et al., 1998). Therefore, our dependent variable, HCA, is measured as secondary school enrollment rate. Specifically, HCA is measured as secondary school enrollment divided by the total number of workers following Mankiw et al. (1992). Secondary school enrollment is the sum of student enrollments for middle schools (grades 7 to 9) and high schools (grades 10 to 12).

The provincial FDI inflow data and the GDP data are available from the Statistical Yearbook of China. The FDI data are in US dollars, we multiply them by the fixed exchange rate of the Chinese currency (yuan) against the US dollar in each year to get the FDI data in Chinese currency. China has adopted the fixed exchange rate regime until year 2005 in which the government allows its currency to appreciate gradually each year. We then calculate the ratios of FDI over nominal GDP in each year as our measure of FDI, denoted by FDI/GDP.[2]

2.3 Instruments for FDI

The first group of instruments is a series of weather indicators. The Weather Yearbook of China provides monthly data on temperature, rainfall, and hours of sunshine for the capital city of the Chinese provinces from 1985 to 1998. The data before 1985 are not available since the Weather Yearbook of China started from 1985. Since we employ the Chinese panel data from 1981 to 1998 and take six year averages to avoid the business cycle phenomena, we will have three sub-periods: 1981-1986, 1987-1992, and 1993-1998. In China most provincial capital city is located in the middle of the province, so we treat the data for capital city as the average for the whole province. Since sub-periods 1987-1992 and 1993-1998 have complete data, we calculate the weather indicators as follows. We take averages of the six-year's monthly temperature data to get average yearly temperature, denoted by Temper. We calculate "temperature yearly difference"[3] for each year and then average over six years to get average "temperature yearly difference", denoted by Tempdiff. For rainfall and hours of sunshine, we take sum of each year's monthly data to get yearly data. We then take six-year averages of the yearly data to get average yearly rainfall and hours of sunshine, denoted by Rainfall and Sunshine respectively. We calculate the variance for each year based on the 12 month data and then take six year

[2] Qinghai province does not have any FDI for 1981-1986, and the datum from 1987-1992 is used.

[3] "Temperature yearly difference" is the difference between the highest and lowest monthly average temperatures, which measures the fluctuations of temperature.

averages to get the variations for temperature and sunshine, denoted by Tempvar1 and Sunvar respectively. For temperature, we get an additional variation by calculating the variance of all six years' monthly temperature, denoted by Tempvar2.

Since sub-period 1981-986 only has data for 1985-1986, we get the weather indicators from the Natural Resources Database of China Academy of Sciences (denoted by CAS-NRD). CAS-NRD provides weather data for around 600 weather observatories across China. Each weather observatory has monthly data points on temperature and hours of sunshine for the period of 1951-1980, instead of monthly data for each year. Given the 24 data points each weather observatory has, we calculate its average temperature, temperature yearly difference, hours of sunshine, variance of monthly temperatures, and variance of monthly hours of sunshine. Since each province has around 20 weather observatories in 20 cities/counties, we take averages of the data over the weather observatories to get the provincial data on Temper, Tempdiff, Sunshine, and Sunvar. We impose the same temperature variation data for Tempvar1 and Tempvar2. From CAS-NRD, we calculate the provincial yearly average rainfall of 1951-1980 as the average rainfall for 1981-1986. Since CAS-NRD does not provide monthly rainfall data, we cannot measure the variation of rainfall. The seven weather indicators are significantly correlated with one another.

The second group consists of one instrument, the farmland resource abundance. We propose quality-adjusted farmland per capita, QFARMLAND, as a preferred measure of farmland resource abundance. Quality-adjusted farmland per capita is more of a natural endowment indicator than previous measures of agricultural dependence and abundance that use agricultural value-added. Quality-adjusted farmland per capita is quality-adjusted farmland divided by total population, where quality-adjusted farmland is measured as the area of farmland multiplied by the quality of farmland. The data on the area of farmland are also from CAS-NRD. CAS-NRD provides data on the areas of farmland for years 1985, 1990 and 1996. We use the provincial yearly average yield of food crops per hectare from the China Agricultural Economic Statistical Yearbook[4] as the measure of the quality of farmland, denoted as QUALITY. The Malthusian trap was confronting the backward China before 1978. For example, the Great Leap famine in 1959-61 caused the lives of tens of millions (see Yang, 1996). Therefore, the majority of agricultural land is used for food production, which makes the average yield of food crops per hectare a suitable measure of the quality of agricultural land. As is common in the literature, we take six-year averages of the Chinese cross-province time series data (from 1981 to 1998) to avoid the influence from business cycle phenomena. We use the data on QFARMLAND of year 1985 for sub-period 1981-1986, those of year 1990 for sub-period 1987-1992, and those of year 1996 for sub-period 1993-1998.

[4]The Chinese title is "Zhongguo Nong Ye Jing Ji Tong Ji Nian Jian".

2.4 Measuring financial reform policies

Since 1978, China adopted the gradual approach to reform its backward financial system. We locate the financial reform policies from the chapter "Fiscal, Finance, and Insurance" in the book "The Big Economic Events since China's Reform and Opening-up (1978-1998)".[5] Since the book covers the period 1978-1998, our data sample ends at 1998. Most policies are conducted at the city level; few are at the province level. Following the division by the Chinese Economists Society's international symposium on Chinese financial reform at the University of Southern California in 1997, we divide China's financial deregulation policies into five categories (see Table 1). We get the data on the population of Chinese cities from the Statistical Yearbook on China's Cities.

[Table 1 here]

Then we use the following formula to turn policies in each of the five categories into five policy indexes, using 1992 as an example:

$$Index = \sum_{j}(\sum_{i} \frac{Total\ Population\ of\ City\ i\ in\ 1992}{Total\ Population\ of\ the\ Province\ in\ 1992} \cdot I_{ci}^{1992} + I_{p}^{1992}) \qquad (2)$$

where I_{ci}^{1992} is an indicator variable that equals one if city i receives a financial reform policy j; I_{p}^{1992} is an indicator variable that equals one if a financial reform policy j is conducted in the province. Adding together all policies (the $j^{'}s$) in and before year 1992 for all the cities (the $i^{'}s$) within a province yields its policy index.

Based on the five financial deregulation policy indexes, we build our measures for F-Reform. Specifically, we only include banking and non-bank sector financial deregulation policies. Given the four indicators (three on banking sector and one on non-bank sector), we add them up to get our measure for the degree of financial deregulation (F-Reform). We use this indicator for the following reasons. First, Demirguc-Kunt and Levine (2001) show that there is no evidence that banking sector (and/or non-bank sector) is worse than stock market in promoting growth. Previous literature commonly measures and studies banking sector and stock market separately. Second, for the period 1981-1998, the majority of financial reform policies are in the banking and non-bank sectors.

2.5 Measuring other control variables

Control variables are those standard growth factors in growth regressions, which are built as follows. Initial real GDP per worker, $ln(\frac{GDP}{L})_{t-1}$, takes the value of the beginning

[5] The attractiveness of the financial reform policies in the book lies in its provision for authority and uniformity. There are other books documenting the financial reform policies in China. The main financial reform policies are quite similar across those books.

year of each sub-period. All other variables are six-year averages. For labor force growth measure, $ln(n + g + \delta)$, we follow Klenow and Rodriguez-Clare (1997) to use 0.08 for $(g + \delta)$.[6] $Fiscal$ is fiscal expenditure to GDP ratio. $Export$ is nominal value of export to abroad divided by nominal GDP.

There are 31 provinces in China.[7] Before 1997, Chongqing was a city of Sichuan province, so both of them are excluded from the sample. Hainan was part of Guangdong before it became an independent province. Since there is a complete set of data for Guangdong, it is kept in the data sample while Hainan is dropped. Tibet is excluded because there are no data on FDI and financial deregulation. For financial reform, its complete data after 1998 are not available. Therefore, we use data from 1981 to 1998. In summary, the data sample comprises panel data of 27 provinces and 18 years.

We take six-year averages for the Chinese panel data to avoid the influence from business cycle phenomena, which is a common practice in the literature. The data are gathered from various sources. We use the provincial statistical yearbooks and Statistical Yearbook of China for the data on real GDP per worker, secondary school enrollment rate, fiscal expenditure, physical capital investment rate, labor force growth, and export. All of our variables have explicit variations across-province and across time. Table 2 lists the summary statistics of the final data.

[Table 2 Here]

3 Empirical Results

The purpose of our empirical investigation is to estimate the effects of FDI on domestic human capital accumulation. In particular, as discussed in the introduction, we examine whether FDI interacts with the level of domestic financial liberalization to affect domestic human capital accumulation. The OLS regression results indicate that FDI has a positive and significant effect on domestic human capital accumulation, and the magnitude of this effect depends on the level of financial deregulation. The LIML regression results are similar to those of OLS ones. The over-identification tests on our instruments based on different rationales yield p-values much larger than 10%, meaning that we accept the null hypothesis that the instruments are valid.

The nature of the interaction of FDI with financial deregulation is such that on the one hand, because the direct effect of FDI is positive, higher level of financial deepening

[6] Klenow and Rodriguez-Clare (1997) assume the growth rate is 0.02 and depreciation rate is 0.06. Chow (1993) assumes the depreciation rate for China is 0.04, so do we. Young (2003) shows that the TFP growth of China's state sectors is still impressive and comparable to those of four Asian Tigers. The family-responsibility system greatly raised the productivity growth of agriculture in China (Lin, 1992). It is reasonable for us to assume the balanced-growth-path TFP (total factor productivity) growth is 0.04.

[7] In China, out of the 31 provincial governments, four are municipalities and four are autonomous regions. This paper delegates the usage 'province' to all.

strengthens the positive effect of FDI on domestic human capital accumulation, making the overall enhancing effect of FDI on domestic human capital accumulation even larger. In other words, the positive effect on FDI on human capital accumulation is higher in provinces with higher degree of financial deregulation. On the other hand, because the direct effect of financial reform is negative, higher level of FDI inflow mitigates the negative effect of financial reform on domestic human capital accumulation. That is, the total effect of financial reform on HCA is positive in provinces with large inflow of FDI.

3.1 OLS estimation results

The OLS results for the effects of FDI on domestic human capital accumulation (HCA) are reported in Table 3. In column 3.1 in Table 3, we only include FDI together with other control variables (including fixed time and province effects), the estimated coefficient on FDI is negative and insignificant. It means that higher inflow of FDI does not promote HCA in China. First, this is not surprising given the contradictory and divergent results in previous literature listed in the introduction. For example, Gittens (2006) shows that in Asia, FDI has no impact on secondary school enrollment. Second, as we add more variables concerning financial deregulation as in equation (1) that is supposed to be our correct specification, the results would be different. The estimated coefficient on initial GDP per worker is positive and significant at the 5% level, meaning rich provinces tend to have higher level of human capital accumulation. The estimated coefficient on physical capital investment rate (ln(I/GDP)) is positive and significant at the 10% level, meaning higher level of physical capital investment rate tends to increase human capital accumulation. The estimated coefficients on labor force growth, export, and fiscal expenditure are all insignificant. The R-squared is 0.90, meaning our specification is significant in describing the factors affecting HCA.

In regression 3.2, we replace FDI with financial deregulation and run the regressions again. The results on other variables are almost identical to those in regression 3.1. The estimated coefficient on financial reform is positive, which is very insignificant. That means financial deregulation promotes HCA, but the effect is not statistical significant. In regression 3.3, we include both FDI and financial deregulation in the regression. One can see that the results on other variables are almost identical to those in regressions 3.1 and 3.2. The estimated coefficient on FDI is negative and insignificant, as in regression 3.1, and that on financial deregulation is positive and insignificant, as in regression 3.2.

In column 3.4 that is supposed to be our correct specification, we interact FDI with financial deregulation and use this as an additional regressor. To ensure that the interaction term does not proxy for FDI or the level of financial deregulation, both of the latter variables were included in the regression independently. In that way, we can test jointly whether these variables affect human capital accumulation by themselves or through the

interaction term. It shows that the coefficient on FDI becomes positive, which is still insignificant. The estimated coefficient on financial deregulation becomes negative and significant at the 1% level. The negative coefficient on financial deregulation is not unexpected. Some studies on the FDI-growth nexus include an interaction term, and also find a negative estimated coefficient on financial system (see Alfaro et al. 2004) or a negative estimated coefficient on FDI (see Borensztein et al., 1998). Although the direct effect is negative, the net effect of financial deregulation on human capital accumulation may still be positive. That is, the indirect enhancing effect of financial deregulation on human capital accumulation could dominate its direct negative effect, which is shown in the following.

In regression 3.4, the estimated coefficient on the interaction term between FDI and financial deregulation is positive, which is significant at the 1% level. The hypothesis that the coefficients of both FDI and its interaction with financial deregulation are zero can be rejected at the 1% level, meaning FDI has an overall significant effect on human capital accumulation. The hypothesis that the coefficients of both financial deregulation and its interaction with FDI are zero can be rejected at the 1% level, which shows that financial reform has an overall significant effect on human capital accumulation. The F-test for the joint significance of FDI, financial deregulation and their interaction term shows that these variables jointly significantly impact domestic human capital investment at the 5% level. The R-squared increases to 0.92 compared to 0.90 in regressions 3.1, 3.2, and 3.3, which further supports that regression 3.4 (that is, equation 1) is the correct specification.

To get an estimate of how important FDI has been in promoting domestic human capital accumulation, one can ask the hypothetical question of how much a one-standard-deviation increase in the FDI variable would increase the domestic human capital investment rate of a province receiving the mean level of F-Reform in the sample.[8] Using regression 3.4, we find that having a one-standard-deviation increase in FDI would have caused provinces with the mean level of financial deregulation to experience an annual domestic human capital rate increase of 0.16 standard deviation during the 18-year-period, where the net effect being measured is $(\beta_1 + \beta_2 \times mean(F\text{-}Reform))\sigma_{\log(FDI/GDP)}$. For Shanghai that receives the highest degree of financial deregulation (for the period 1993-98), having a one-standard-deviation increase in FDI would have resulted in an annual increase of 2.62 standard deviations in human capital accumulation. That is, the main promoting effect of FDI on human capital accumulation is through interacting with financial deregulation.

Similarly, we can get an estimate of how important financial deregulation has been in affecting human capital accumulation. Using regression 3.4, if provinces receiving the

[8] In this paper we centered the data of FDI and financial reform to avoid multicollinearity problem. Therefore, the mean value of log(FDI/GDP) and that of F-Reform are zero. The standard deviation of log(FDI/GDP) is 2.40, and that of F-Reform is 2.24.

mean level of ln(FDI/GDP) in the sample had a one-standard-deviation increase in the F-Reform variable, they would have experienced an annual human capital investment rate decrease of 0.8 standard deviation during the 18-year-period. However, for Guangdong province that receives the highest level of ln(FDI/GDP) during the period 1993-98, having a one-standard-deviation increase in financial deregulation would have resulted in an annual increase of 0.1 standard deviation in its human capital investment rate.

3.2 Endogeneity issues and LIML estimation

We have already argued that our panel data regressions may be subject to the endogeneity problem of FDI. To avoid the bias on the estimated coefficients, we apply instrumental variable techniques to avoid the endogeneity problem. For the Chinese panel data, we can find two sets of instruments that are grounded on different rationales, namely, one set of contemporary weather indicators and the other containing farmland resource abundance. Then over-identification tests can verify whether the instruments are valid.

As mentioned in Andrews and Stock (2005), a decade ago 2SLS (two stage least squares) was always used without thought about the strength of instruments. Now the common approach is to use 2SLS if instruments are strong and to adopt a robust strategy if instruments are weak. Moreover, in the presence of many instruments, Stock and Yogo (2002) provide critical values for testing weak instruments that are an improvement over Staiger and Stock's rule of thumb that instruments be deemed weak if the first-stage F is less than ten. Stock and Yogo (2002) show that LIML estimation is far superior to 2SLS when researchers have weak instruments. Therefore, we proceed with LIML estimation.

We run corresponding LIML regressions for Table 3. Moreover, to ensure valid identification, we treat both FDI and fiscal expenditure (ln(fiscal)) as endogenous variables (otherwise, the estimated coefficients on FDI, financial reform and their interaction term are all significant. However, the over-identification test yields a p-value below 10%). The first stage results on ln(FDI/GDP) are reported in Table 4, and the second stage results are reported in Table 5. From the first stage results in Table 4, one can see that the associated p-values of the F-test on the joint significance of the instruments are below 10% in the first stage regression for 5.1 and below 5% in the first stage regressions for 5.2 and 5.3. These evidence that the instruments jointly have a significant effect on FDI.

The second-stage results of the LIML estimation are reported in Table 5. The LIML estimation yields results similar to those in OLS estimation. Without the financial reform and the interaction term in the regression, the estimated coefficient on FDI is still insignificantly but becomes positive (see regression 5.1). The endogeneity test on FDI shows that we accept the null that it is exogenous at the 10% level. The weak identification test statistic is 0.86, which is larger than the 25% maximal LIML size Stock-Yogo critical value, meaning we accept the null that the instruments are weak. The p-values of

both Sargan and Anderson-Rubin over-identification tests are much above 10%, meaning we accept the null that the instruments are valid. The estimated coefficient on initial GDP per worker is positive and significant at the 10% level, meaning rich provinces tend to have higher level of human capital accumulation. The estimated coefficient on fiscal expenditure (ln(fiscal)) becomes positive and significant at the 1% level, meaning higher level of government spending promotes human capital accumulation. After we include financial reform in regression 5.2, the estimated coefficient on FDI is still positive and insignificant. The estimated coefficient on financial deregulation is negative and significant at the 10% level. The results on other variables are similar to those in regression 5.1.

In regression 5.3, we add financial reform and the interactive term between FDI and financial deregulation. The endogeneity test on FDI shows that we reject the null that FDI is exogenous at the 10% level. The estimated coefficient on FDI remains insignificantly positive at the 10% level with larger magnitude. The estimated coefficient on financial deregulation is still negative, which becomes significant at the 1% level with larger magnitude. This is similar to that in the OLS regression in 3.4 in Table 3. The estimated coefficient on the interaction term is significantly positive at the 5% level, which has almost identical magnitude as that in OLS regression 3.4 in Table 3. After overcoming the endogeneity problem of FDI, the hypothesis that the coefficients of both FDI and its interaction with financial deregulation are zero cannot be rejected at the 10% level. The hypothesis that the coefficients of both financial deregulation and its interaction with FDI are zero can be rejected at the 1% level. The F-test for the joint significance of FDI, financial deregulation and their interaction term shows that these variables jointly significantly impact human capital accumulation at the 5% level. The p-values of both Sargan and Anderson-Rubin over-identification tests are above 80%, meaning there is strong evidence that the instruments are valid.

Since the LIML results are similar to those of OLS regressions, the potential endogeneity problem of FDI is not very serious. Nevertheless, it is useful to get an estimate of how important FDI has been in promoting human capital accumulation in LIML regressions. Using regression 5.3, we find that having a one-standard-deviation increase in FDI would have caused provinces with the mean level of financial deregulation to experience an annual domestic human capital rate increase of 0.63 standard deviations during the 18-year-period. For Shanghai that receives the highest degree of financial deregulation (for the period 1993-98), having a one-standard-deviation increase in FDI would have resulted in an annual increase of 3.15 standard deviations in human capital accumulation. That is, the main promoting effect of FDI on human capital accumulation is through interacting with financial deregulation. Similarly, we can get an estimate of how important financial deregulation has been in affecting human capital accumulation. Using regression 5.3, if provinces receiving the mean level of ln(FDI/GDP) in the sample

had a one-standard-deviation increase in the F-Reform variable, they would have experienced an annual human capital investment rate decrease of 1.36 standard deviation during the 18-year-period. However, for Guangdong province that receives the highest level of ln(FDI/GDP) during the period 1993-98, having a one-standard-deviation increase in financial deregulation would have resulted in an annual decrease of 0.2 standard deviation in its human capital investment rate. One can expect that as FDI inflows continue to increase, the net effect of financial deregulation on human capital investment rate in Guangdong province would soon become positive.

4 Conclusions

Technology diffusion via FDI plays an essential role in the process of economic development (e.g., Nelson and Phelps, 1966; Findlay, 1978; Borensztein et al., 1998). In this paper, we examine how inward FDI affects domestic human capital accumulation. The results are mixed in previous literature (Gittens, 2006; Nunnenkamp; 2002; Mughal and Vechiu, 2009; Ram and Zhang, 2002; Beugelsdijk et al., 2008). We intend to contribute by considering the role of financial liberalization and its interaction with FDI using the Chinese gradual financial reform and opening-up experience. We investigated these issues in a sample that comprises FDI inflows from abroad to the Chinese provinces following the reforming and opening-up in 1978. Both OLS and LIML estimation results suggest that there is a significant interaction effect between FDI and financial deregulation in promoting human capital accumulation. The nature of the interaction of FDI with financial deregulation is such that, because the direct effect of FDI is positive, higher level of financial deepening strengthens the enhancing effect of FDI on domestic human capital accumulation. The results are robust even after controlling for other factors affecting human capital accumulation, and time and province effects. One policy suggestion is that, to fully utilize the positive effect of FDI on human capital accumulation, it is desirable for the host country to carry out financial deregulation when opening up to foreign investment.

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Table 1: Domestic Financial Deregulation Policy Indicators

Domestic financial deregulation	Indicators	Description
Banking Sector	*Bank*	Banking sector general reforms and policies; Banking deregulation policies that might affect sectoral allocation of credit;
	Newbank	The set-up of specific new banks;
	Resi-bank	The remaining banking sector policies;
Non-bank Sector	*Nonbank*	Non-bank deposit-taking institutions; Insurance market;
Capital Market	*Stock*	Capital (bond and stock) market reform policies

Table 2: Descriptive Statistics

	Mean	Standard deviation	Minimum	Maximum
ln(HCA)	2.25	0.24	1.76	2.84
ln(FDI/GDP)	−1.31	2.40	−7.86	2.72
F-Reform	1.41	2.24	0	11.49
$\ln(\text{GDP/L})_{t-1}$	7.39	0.62	6.21	9.42
$\ln(n+g+\delta)$	2.32	0.14	1.93	2.61
ln(I/GDP)	3.67	0.22	3.14	4.32
ln(Fiscal)	2.51	0.38	1.68	3.48
ln(Export)	2.02	0.90	−0.11	4.49

Observations: 81. The panel data comprise 27 provinces and 18 years.
We cut the 18 years into three sub-periods and take six-year averages to avoid the influence from business cycles. Except for F-Reform and $\ln(\frac{GDP}{L})_{t-1}$, all other variables are multiplied by 100 before taking logarithm.

Table 3: OLS Regressions between Human Capital Accumulation and FDI
Dependent Variable: ln(HCA): 1981-86; 1987-92; 1993-1998

	Regression number			
Independent Variable	3.1	3.2	3.3	3.4
$\ln(\frac{FDI}{GDP})$	−0.019		−0.018	0.016
	(0.019)		(0.019)	(0.020)
F-Reform		0.005	0.003	−0.091***
		(0.016)	(0.016)	(0.031)
$(\ln(\frac{FDI}{GDP}))\times$F-Reform				0.025***
				(0.007)
$\ln(\frac{GDP}{L})_{t-1}$	0.32**	0.34**	0.32**	0.22
	(0.15)	(0.15)	(0.16)	(0.14)
$\ln(n+g+\delta)$	0.28	0.30	0.28	0.09
	(0.18)	(0.18)	(0.18)	(0.18)
$\ln(\frac{I}{GDP})$	0.39*	0.37	0.38	0.28
	(0.21)	(0.22)	(0.26)	(0.21)
ln(Fiscal)	0.19	0.18	0.18	0.11
	(0.14)	(0.15)	(0.15)	(0.14)
ln(Export)	−0.02	−0.01	−0.02	−0.04
	(0.05)	(0.05)	(0.05)	(0.05)
Time FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
F-statistic for FDI				6.19
(Prob>F)				(0.004)
F-statistic for financial deregulation				5.64
(Prob>F)				(0.006)
F test on FDI, F-Reform				4.17
and FDI × F-Reform				(0.011)
R^2	0.90	0.90	0.90	0.92
Observations:	81	81	81	81

***Significant at the 0.01 level, ** at the 0.05 level, * at the 0.10 level
(standard errors in parentheses)

Table 4: LIML Regressions between FDI and Human Capital Accumulation

First-Stage Results. First-stage dependent variable is $\ln\frac{FDI}{GDP}$. Observations: 81

	First-stage results for regressions in Table 5		
Independent Variable	For 5.1	For 5.2	For 5.3
ln(QFARMLAND)	−0.26	−0.21	−0.62
	(0.98)	(0.94)	(0.85)
ln(Sunshine)	−3.56**	−3.66**	−3.06**
	(1.64)	(1.57)	(1.41)
ln(Temper)	−0.04	−0.27	−0.01
	(0.49)	(0.48)	(0.43)
ln(Rainfall)	1.89**	2.13**	1.44**
	(0.79)	(0.76)	(0.71)
Tempdiff	−0.15	−0.05	0.14
	(0.36)	(0.35)	(0.32)
Tempvar1	0.06	−0.02	−0.06
	(0.11)	(0.11)	(0.10)
Tempvar2	−0.02	0.05	0.06
	(0.08)	(0.08)	(0.07)
Sunvar	0.0001	0.0002	0.0002
	(0.0002)	(0.0002)	(0.0002)
F-test on Instruments	F(8,40)=2.0	F(8,39)=2.5	F(8,38)=2.3
(Prob>F)	(0.07)	(0.03)	(0.04)
Time FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
R^2(Centered)	0.96	0.96	0.97

Notes: Other RHS variables in first-stage regressions:
For 5.1: $\ln(\frac{GDP}{L})_{t\text{-}1}$, $\ln(n+g+\delta)$, $\ln(\frac{I}{GDP})$, ln(Export).
For 5.2: F-Reform, $\ln(\frac{GDP}{L})_{t\text{-}1}$, $\ln(n+g+\delta)$, $\ln(\frac{I}{GDP})$, ln(Export).
For 5.3: F-Reform, $(\ln\frac{FDI}{GDP})\times$F-Reform, $\ln(\frac{GDP}{L})_{t\text{-}1}$, $\ln(n+g+\delta)$, $\ln(\frac{I}{GDP})$, ln(Export).
***Significant at the 0.01 level, ** at the 0.05 level, * at the 0.10 level
(Standard error in parentheses)

Table 5: LIML Regressions between Human Capital Accumulation and FDI
Dependent Variable: ln(HCA): 1981-86; 1987-92; 1993-1998

	Regression number		
Independent Variable	5.1	5.2	5.3
$\ln(\frac{FDI}{GDP})$	0.029	0.042	0.063
	(0.058)	(0.050)	(0.050)
F-Reform		-0.060^{*}	-0.146^{***}
		(0.033)	(0.050)
$(\ln(\frac{FDI}{GDP}))\times$F-Reform			0.025^{**}
			(0.013)
$\ln(\frac{GDP}{L})_{t-1}$	0.46^{*}	0.56^{**}	0.42^{**}
	(0.24)	(0.24)	(0.21)
$\ln(n+g+\delta)$	0.14	0.07	-0.10
	(0.28)	(0.28)	(0.25)
$\ln(\frac{I}{GDP})$	-0.71	-0.24	-0.25
	(0.55)	(0.38)	(0.33)
ln(Fiscal)	1.78^{***}	1.78^{***}	1.50^{***}
	(0.67)	(0.60)	(0.54)
ln(Export)	-0.13	-0.10	-0.12
	(0.09)	(0.08	(0.07)
Endogeneity Test on FDI: P-Value	0.16	0.09	0.08
Weak Identification Test	0.86	0.92	0.87
Stock-Yogo Critical value:			
25% maximal LIML size	2.27	2.27	2.27
Sargan OverID Test P-Value	0.60	0.85	0.86
Anderson-Rubin OverID Test P-Value	0.58	0.85	0.86
Test on FDI (Prob>chi)			(0.14)
Test on F-Reform (Prob>chi)			(0.01)
Test on $\ln\frac{FDI}{GDP}$, F-Reform			prob. >chi
and $(\ln\frac{FDI}{GDP})\times$ F-Reform			= 0.03
Time FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
R^2 (centered)	0.61	0.65	0.73
Observations:	81	81	81

Notes: Endogenous variables in all regressions: $\ln(\frac{FDI}{GDP})$ and ln(Fiscal).
Instruments: ln(QFARMLAND), Tempdiff, Tempvar1, Tempvar2, ln(Temper), ln(Rainfall), Sunvar, ln(Sunshine)
***Significant at the 0.01 level, ** at the 0.05 level, * at the 0.10 level
(standard errors in parentheses)

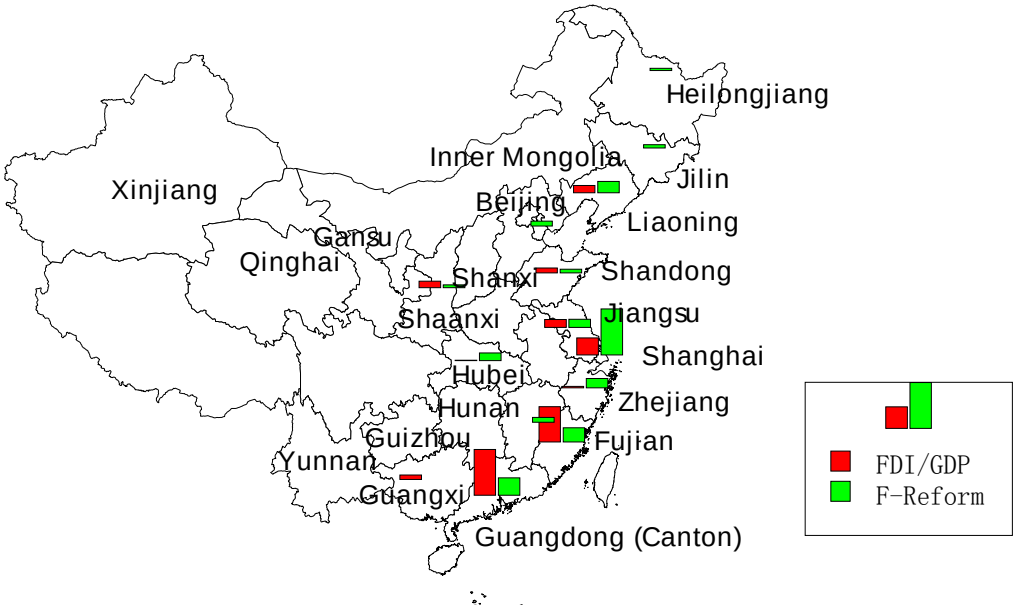

Figure 1. Provincial Variation in FDI and Financial Deregulation (1987-1992)

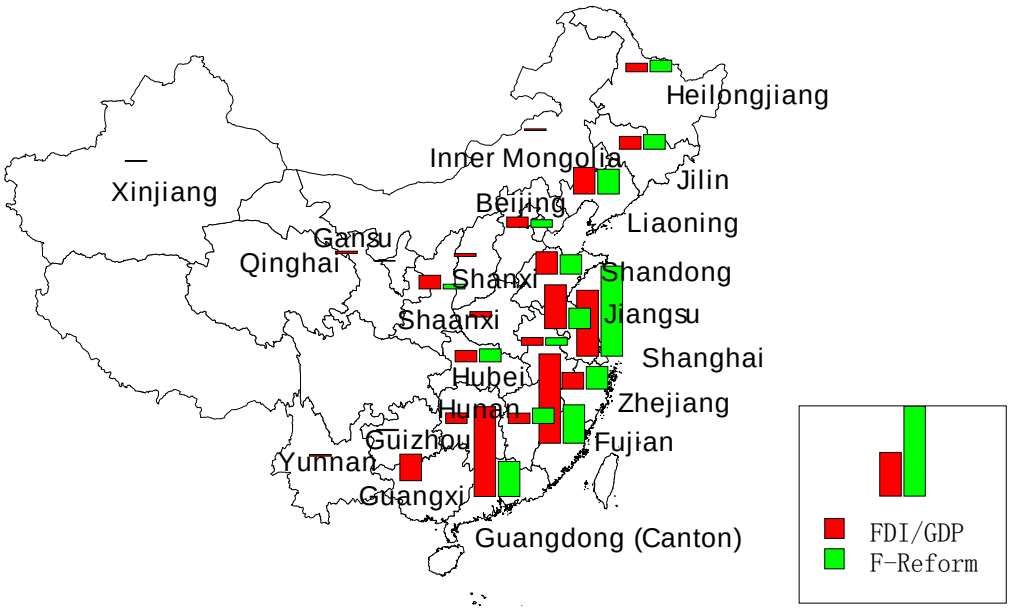

Figure 2. Provincial Variation in FDI and Financial Deregulation (1993-1998)