XVI

Volume XVI, Number 2, November 2013

Journal of Applied Economics

Qichun He
Meng Sun
Heng-Fu Zou

Financial deregulation, absorptive capability, technology diffusion and growth: Evidence from Chinese panel data

UCEMA

Edited by the Universidad del CEMA
Print ISSN 1514-0326
Online ISSN 1667-6726

Journal of Applied Economics. Vol XVI, No. 2 (November 2013), 275-302

FINANCIAL DEREGULATION, ABSORPTIVE CAPABILITY, TECHNOLOGY DIFFUSION AND GROWTH: EVIDENCE FROM CHINESE PANEL DATA

Qichun He*
Central University of Finance and Economics

Meng Sun
Beijing Normal University

Heng-Fu Zou
Development Research Group, World Bank

Submitted November 2011; accepted December 2012

Technological diffusion via FDI is essential for the economic growth of backward economies. However, institutional and policy barriers may slow down technology diffusion. Using a simple theory based on Acemoglu (2009), we predict that inward FDI (pool of available world frontier technologies) and financial deregulation (enhancing absorptive capability via lowering institutional and policy barriers) have a complementary effect on economic growth. We test the predictions using panel data on Chinese provinces during the reform and opening-up period. The Chinese experience is appealing because of the symbiotic financial deregulation and inflow of FDI. We find robust evidence that there is a significant interaction effect between FDI and the level of financial deregulation that promotes economic growth. This furthers our understanding of the reform and opening-up strategy of China.

JEL classification codes: O11, O33, F43, C23
Key words: absorptive capability, gradual financial deregulation, inward FDI, interaction, panel data

---

* Qichun He (corresponding author): China Economics and Management Academy, Central University of Finance and Economics, No. 39 South College Road, Haidian District, Beijing, 100081, China; email: qichunhe@gmail.com. Meng Sun: School of Economics and Business Administration, Beijing Normal University, No. 19, XinJieKouWai St., Haidian District, Beijing, 100875, China; email: sunmeng@bnu.edu.cn. Heng-fu Zou: Development Research Group, World Bank, Washington, DC, USA: email: hzoucema@gmail.com. We are grateful to the editor Jorge M. Streb and an anonymous referee for comments that substantially improved this paper. We thank the 2009 Canadian Economics Association Annual Meeting for accepting our paper for presentation. We also thank the seminar participants at the China Economics and Management Academy, Central University of Finance and Economics for helpful comments. The encouragement and comments from Paul Beaudry are greatly appreciated, as are the comments from seminar participants at University of British Columbia, Hong Kong University of Science and Technology, University of Manitoba, and Central University of Finance and Economics on the measurement of the financial deregulation indicators.

I. Introduction

For developing countries, their rate of economic growth depends on the adoption of new technologies transferred from leading countries (Acemoglu 2009, ch. 18; Barro and Sala-i-Martin 2004, ch. 8). Foreign direct investment (FDI) is considered to be a major channel for technology diffusion (e.g., Findlay 1978; Keller and Yeaple 2003).[1] There are two types of FDI: inward FDI (the direct investment into production in a country by foreign companies) and outward FDI (a country's direct investment abroad). In our paper, we focus exclusively on inward FDI. Therefore, in the rest of our paper, FDI refers to the inflow of FDI (inward FDI). Although theory predicts that FDI spurs the growth of the host country, the empirical evidences are mixed both at the macro-level (Borensztein et al. 1998; Alfaro et al. 2004) and the micro-level (e.g., Aitken and Harrison 1999; Markusen and Venables 1999; Harrison and McMillan 2003). Acemoglu (2009: 614) argues technology diffusion may also depend on the absorptive capability that is affected by institutional or policy barriers besides human capital. Following Acemoglu, we investigate, at the macro-level, the role of relaxing institutional or policy barriers in technology diffusion. To do so, we use the Chinese financial reform and opening-up experience for the period 1981-1998.

The Chinese experience offers a natural experiment that suits our purpose. First, the Chinese economy switched from a closed central-planning regime to an open and market-oriented one in 1978. Since then, the Chinese government has made herculean efforts not only in attracting FDI,[2] but also in reforming its unhealthy financial system.[3] This yields a symbiotic evolution of financial deregulation and FDI inflow. Second, China adopted the gradual approach to reform and opening-up (Naughton 1995), which results in substantial time and province variations in policies and FDI inflows. Figure 1 illustrates some of the large variation in our measure of FDI, which displays yearly FDI to GDP (gross domestic product) ratios for two provinces (GD, i.e., Guangdong, and GS, i.e., Gansu).

[1] There are works studying outward FDI (e.g., Desai et al., 2005). Export and import are also deemed as channels for technological diffusion. For a critical evaluation of this strand of literature, see Rodriguez and Rodrik (2000). Keller and Yeaple (2003) find evidence that FDI raises the productivity of domestic firms more than imports do.

2 Attracting more FDI for technological imitation is emphasized by Mr. Deng, the designer of the reform and opening-up and the leader of China since 1978 (see Deng, 1975). Consequently, the share of world FDI inflow to East Asia increases from 2% in 1979 to 17% in 1994, which is mainly due to the increasing volumes of FDI to China (UNCTAD, 2008). Technological diffusion from abroad is important for the technological progress of China, as emphasized in Barro and Sala-i-Martin (2004: 350).

[3] Brandt and Rawski (2008), Naughton (1995) and Shirk (2003) have reviewed China' s financial reform.

Figure 1. Provincial domestic and foreign direct investment rates (1981-98) for the provinces of Guangdong (GD) and Gansu (GS)

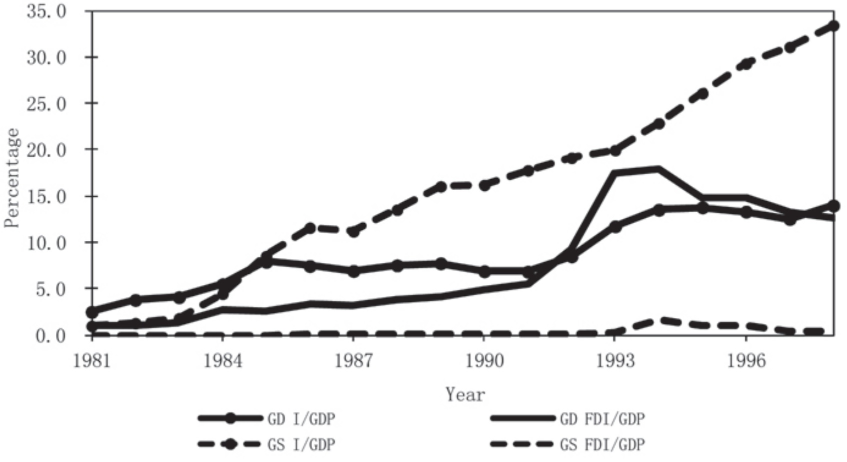

Figure 2 illustrates the substantial provincial variations in our measure of financial deregulation - detailed below. Our empirical work exploits these substantial variations across province and time.

Figure 2. Provincial distribution of financial deregulation (*F-Reform*, 1981-86)

We combine the technology diffusion model based on Acemoglu (2009, ch. 18) and the augmented Solow model (see Mankiw et al., 1992) to illustrate the mechanism. The model shows that the speed of technological progress of a backward economy positively depends on the product of its technological absorption capability and its distance to the world frontier technologies that are available for absorption. Financial deregulation policies positively raise the absorption capability of the backward economy as postulated by Acemoglu. The world frontier technologies are made available for absorption by inward FDI. Taken together, the model predicts an interaction effect between financial deregulation and FDI in increasing the growth rate of output per labor of the backward economy.

We then derive the empirical formulation. Approximating around the steady state, we derive the convergence equation for output per effective labor. Adding together the growth rate of output per effective labor and the growth rate of technological progress yields the growth rate of output per labor. Therefore, our final empirical convergence specification for the growth rate of output per labor is similar to the augmented Solow model (see Mankiw et al. 1992: 423), with some additional independent variables that capture the growth rate of technological progress that depends positively on the interaction between inward FDI and financial deregulation.

We test the theoretical predictions on the panel data of Chinese provinces. The LSDV (Least squares dummy variables) regression shows that the estimated coefficient on the interaction term between financial deregulation and FDI is positive and significant at the 5% level. The result is robust when we overcome the endogeneity of FDI by using suitable instruments in LIML (Limited-information maximum likelihood) regressions. The result holds up when we use system GMM (Generalized method of moments) estimation to deal with the endogeneity of important explanatory variables.

The magnitude of the estimated interaction effect between FDI and financial deregulation is large. For example, having a one standard deviation increase in *ln(FDI/GDP)* would have allowed provinces receiving the mean level of financial reform to experience an annual growth rate increase of 2.9% from 1981 to 1998, and Shanghai - having the highest value of financial deregulation for the period 1993-1998 - would have had an annual rate increase of 12.3%. This not only explains China's substantial provincial variation in growth rates, but also highlights China's successful strategy of conducting financial reform together with attracting FDI inflow (i.e., reform and opening-up) to generate its impressive growth. These have profound implications for other developing countries.

Our finding confirms the prediction of Acemoglu (2009, ch. 18): institutional and policy barriers hinder technology diffusion. This complements previous studies that show other factors such as human capital (Cohen 1993; Romer 1993; Borensztein et al. 1998) and financial development (Alfaro et al. 2004; Hermes and Lensink 2003; Lee and Chang 2009; Eid 2008) are also preconditions for FDI to positively impact the economic growth of the host economy.

The rest of the paper proceeds as follows. Section II discusses the mechanism and derives the empirical formulation. Section III describes the data. Section IV presents the regression results. Section V concludes.

II. Model and empirical specification

We use a simple model of technology diffusion based on Acemoglu (2009, ch. 18). We study a small backward open economy (a representative Chinese province during the reform and opening-up period). Specifically, two factors are crucial in determining its technological progress: the absorptive capability and the advanced technologies available for absorption. Following previous works (e.g., Findlay 1978; Keller and Yeaple 2003), we assume FDI is the main channel for advanced technologies to be transferred to the backward economy. Moreover, we emphasize the role of financial deregulation in enhancing its absorptive capability via eliminating institutional and policy barriers.

For a representative Chinese province i at time t, its aggregate production function for a unique final good is

$$Y_{it} = K_{it}^{\alpha} H_{it}^{\beta} (A_{it} L_{it})^{1-\alpha-\beta}, \tag{1}$$

where K, H, and L are physical capital, human capital, and raw labor respectively. A_{it} is the level of technology, whose movement will be pinned down later. The output per effective labor at t is $y_{it} = k_{it}^{\alpha} h_{it}^{\beta}$, where the effective capital-labor ratio, k_{it}, and the effective human capital-labor ratio, h_{it}, evolve according to

$$\dot{k}_{it} = s_k y_{it} - (n + g_{it} + \delta) k_{it}, \tag{2}$$

$$\dot{h}_{it} = s_h y_{it} - (n + g_{it} + \delta)h_{it} \ , \tag{3}$$

where s_k, s_h are exogenous physical and human capital investment rates respectively, n and δ are exogenous population growth rate and depreciation rate respectively, and $g_{it}= \dot{A}_{it}/A_{it}$ is the growth rate of technology.

The world technological frontier A_t^w is assumed to grow at an exogenous rate g^w. Unlike Acemoglu, we assume that, at any time, the available pool of technology for imitating depends on how many foreign firms conduct direct investment in the backward province *i*, which is measured as inward FDI to GDP ratio (denoted as FDI_{it}). Therefore, we posit the law of motion for technology as

$$\dot{A}_{it} = \sigma_{it} \cdot \left(A_t^w \cdot FDI_{it} - A_{it}\right) + \gamma A_{it} \tag{4}$$

where σ_{it} is the absorptive capability of the backward province *i* at time *t*, and γ measures domestic technological advances.

We argue that financial deregulation would raise the absorptive capability of the backward economy. Using $F\text{-}Reform_{it}$ to denote the degree of financial deregulation for the backward province *i* at time *t*, we postulate that

$$\sigma_{it} = \sigma(F\text{-}Reform_{it}), \text{with} \frac{\partial \sigma_{it}}{\partial F\text{-}Reform_{it}} > 0. \tag{5}$$

The reason is as follows. In backward countries, there often exist different types of financial distortions and protectionist policies (Easterly 1993; Borensztein et al. 1998). These financial distortions may discourage imitative entrepreneurial activities. In other words, financial deregulation aiming at eliminating these financial distortions would raise the absorptive capability of the backward economy. This assumption actually follows Acemoglu (2009: 614). Acemgolu argues that σ varies across countries because of policy barriers affecting technology adoption. We simply apply this assumption to Chinese provincial financial deregulation policies.

Firms in transition countries usually face soft budget constraint as highlighted by Kornai (1986), which may result in bad performance of these firms. Recently

Chan et al. (2012) examine the impact of China's financial liberalization on the financing constraints of publicly-listed Chinese firms. They find that China's financial liberalization has raised the financing constraints for larger firms. They conclude that China's financial reforms may have subjected larger firms to greater market discipline (e.g., reform may have hardened their budget constraint). Building on their findings, we conjecture that financial reforms in China, by subjecting larger Chinese firms to greater market discipline, may enhance their capability of absorbing advanced technologies brought in by inward FDI, supporting our aggregate-level assumption in equation (5).

It is worth noting that our assumption in equation (5) follows Acemoglu. The difference between our model and Acemoglu's is the FDI_{it} term in equation (4). Focusing on different issues, Acemoglu simply assumes that all world frontier technologies are available for absorption for any backward country (i.e., there is no FDI_{it} term in equation 4). In contrast, we argue that world frontier technologies are made available for absorption by inward FDI, which has been emphasized by previous literature (e.g., Findlay 1978; Keller and Yeaple 2003), as discussed in the introduction. Therefore, we introduce only one new assumption, supported by a large literature, into Acemoglu's model. Then the results that economic growth would depend on the interaction term between factors affecting the absorptive capability of the backward economy and FDI follow naturally.

As in Acemoglu, we define the inverse of the distance to the world frontier as $a_{it} = \frac{A_t}{A_t^w}$. Using equation (4), we have

$$\dot{a}_{it} = \sigma_{it} \cdot FDI_{it} - \left(\sigma_{it} + g^w - \gamma\right)a_{it} \ , \tag{6}$$

We begin with the steady state. In the steady state, the technological progress rate of the small economy, g_{it}, is equal to g^w. And in steady state, $\dot{k}_{it} = 0$ and $\dot{h}_{it} = 0$. Then steady state output per effective labor can be solved as

$$y_i^* = (s_k)^{\alpha/1-\alpha-\beta}(s_h)^{\beta/1-\alpha-\beta}\left(n + g^w + \delta\right)^{-(\alpha+\beta)/1-\alpha-\beta} . \tag{7}$$

Approximating around the steady state, the speed of convergence is $\lambda = (1\text{-}\alpha\text{-}\beta)(n+g^w+\delta)$. Following the steps in Mankiw et al. (1992: 423), we end up with

$$\ln(y_{it}) - \ln(y_{it-1}) = -\left(1 - e^{-\lambda}\right)\ln(y_{it-1}) + \left(1 - e^{-\lambda}\right)\ln\left(y_i^*\right), \quad (8)$$

where $\ln(y_i^*)$ can be expressed as exogenous parameters as in equations (7). Since the above equation is output per effective labor, we transform it into output per labor. Output per labor is (Y/L), which is equal to $y \times A$. Hence we have

$$\ln\left(\frac{Y}{L}\right)_{it} - \ln\left(\frac{Y}{L}\right)_{it-1} = \left[\ln(y_{it}) - \ln(y_{it-1})\right] + \left[\ln(A_{it}) - \ln(A_{it-1})\right] \quad (9)$$

Combining equations (8) and (9) yields

$$\ln\left(\frac{Y}{L}\right)_{it} - \ln\left(\frac{Y}{L}\right)_{it-1} = -\left(1 - e^{-\lambda}\right)\ln(y_{it-1}) + \left(1 - e^{-\lambda}\right)\ln\left(y_i^*\right) + g_{it} \quad (10)$$

The technological growth rate of the small economy, g_{it}, is

$$g_{it} = \frac{\dot{A}_{it}}{A_{it}} = \frac{\dot{a}_{it}}{a_{it}} + g^w = \frac{\sigma_{it} \cdot FDI_{it}}{a_{it}} - (\sigma_{it} - \gamma) \quad (11)$$

Substituting out g_{it} from equation (10) using equation (11) and $\ln(y_i^*)$ using equation (7), we have our final empirical specification as

$$\begin{aligned}\ln\left(\frac{Y}{L}\right)_{it} - \ln\left(\frac{Y}{L}\right)_{it-1} = {} & \frac{\sigma_{it} \cdot FDI_{it}}{a_{it}} - (\sigma_{it} - \gamma) - \left(1 - e^{-\lambda}\right)\ln(y_{it-1}) + \left(1 - e^{-\lambda}\right)\frac{\alpha}{1-\alpha-\beta}\ln(s_k) \\ & + \left(1 - e^{-\lambda}\right)\frac{\beta}{1-\alpha-\beta}\ln(s_h) - \left(1 - e^{-\lambda}\right)\frac{\alpha+\beta}{1-\alpha-\beta}\ln\left(n + g^w + \delta\right)\end{aligned} \quad (12)$$

In equation (12), the last four terms are exactly the same as those in augmented Solow model (see Mankiw et al., 1992). The first two terms are new and capture the technological absorption of the backward economy. Given $\frac{\partial \sigma_{it}}{\partial F\text{-}Reform_{it}} > 0$, there is an interaction effect (i.e., a complementary effect) between financial deregulation and inward FDI in promoting economic growth, as reflected in the term $\frac{\sigma_{it} \cdot FDI_{it}}{a_{it}}$. The direct effect of financial reform is negative, as reflected in the term $-(\sigma_{it} - \gamma)$, given that

$\frac{\partial \sigma_{it}}{\partial F\text{-}Reform_{it}} > 0$ The intuition is that financial deregulation raises the absorptive capability of the backward economy, yielding a higher speed of its technological progress. This would decrease the technological gap between this economy and the world technological frontier, ending up with less room for catch-up. In summary, according to equation (12), financial deregulation has two effects on economic growth. The first is a direct one via changing the absorptive capability. The second is an interactive one via interacting with FDI.

Specifically, we use the following empirical formulation:

$$Growth_{it} = \beta_0 + \beta_1 \ln\left(\frac{FDI}{GDP}\right)_{it} + \beta_2 \ln\left(\frac{FDI}{GDP}\right)_{it} \times F\text{-}Reform_{it} + \beta_3 F\text{-}Reform_{it} + \beta_4 \ln\left(\frac{GDP}{L}\right)_{it-1} + \beta_5 \ln\left(\frac{I}{GDP}\right)_{it} + \beta_6 \ln(School)_{it} + \beta_7 \ln\left(n + g^w + \delta\right)_{it} + \beta_8 (Other \;\; Controls)_{it} + u_i + T_t + \varepsilon_{it} , \qquad (13)$$

where $Growth_{it}$ is the average annual growth of real GDP per worker for i^{th} province in period t, *ln(FDI/GDP)* and *F-Reform* — detailed below — are the inward FDI to GDP ratio and the degree of financial deregulation, $ln(GDP/L)_{it-1}$ is real GDP per worker at the beginning of period t to control for conditional convergence, (I/GDP) and *School* measure physical and human capital investment rates, (n+g^w+δ) measures labor force growth. The group of other control variables comprises those that are frequently included as determinants of growth in cross-country studies, namely, government consumption and export to GDP ratios. We control them to avoid omitted variable biases. u_i and T_t stand for fixed province and time effects.

III. Data

A. Measuring FDI

The provincial FDI inflow data and the GDP data are available from the Statistical Yearbook of China (SYC). China has adopted a fixed exchange rate regime in our data sample. 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. We then calculate the ratios of FDI over nominal GDP in each year as our measure of FDI, denoted by *FDI/GDP*.

B. Quantifying financial reform policies

We locate the financial reform policies from the book *The big economic events since China's reform and opening-up (1978-1998)*.[4] Since the book covers the period 1978-1998, our data sample ends at 1998. 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 the financial policies into five categories (see Table 1).

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

Then we use the following formula to turn policies in each of the five categories into five policy indexes. Since most financial deregulation policies are at the city level, we first construct the city level dummy variables. Then we aggregate them to the provincial level, using the ratios of the cities' population to their provincial population as weights:

$$Index = \sum_j \left(\sum_i \frac{\text{Total population of city } i \text{ in year } t}{\text{Total population of the province in year } t} \cdot I_{ci}^{t} + I_{p}^{t} \right), \tag{14}$$

[4] 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.

where I_{ci}^{t} is a dummy variable that equals one if city i receives a financial deregulation policy j in year t; I_{p}^{t} is an indicator variable that equals one if a financial deregulation policy j is conducted in the province. Adding together all policies (the j's) in and before year t for all the cities within a province yields its policy index for year t. The data on the cities' population are from the *Statistical yearbook on China's cities*.

Using population rather than GDP as weight is to lessen the endogeneity problem of financial deregulation indicators. An ideal weight should further consider the quality of the enforcement of the policies. However, finding a quality measure is a daunting task, hence we leave it to future research.

Given the four indicators (three on banking sector and one on non-bank sector), we add them up to get our measure of 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.[5]

C. Measuring other variables

The Chinese GDP data are reliable as Holtz (2003) finds that there is no evidence of data falsification at the national level. Our dependent variable is the average annual growth of real GDP per labor. However, there is a large statistical adjustment in 1990 on labor force (detailed in Young 2003: 1233-1234). Around half of Chinese provinces made the changes in 1990, which is just the change in statistical caliber as detailed in Young. Fortunately, the *Statistical yearbook of China* (SYC) has maintained the original statistical caliber and provided the data on provincial labor force. Therefore, this more consistent series provided by SYC allow us to cover the periods before and after 1990 to avoid "spurious labor force growth" (Young 2003: 1234).

Initial real GDP per worker takes the value of the beginning year of each sub-period. *School* is measured as secondary school enrollment (student enrollments

[5] We also check the robustness of our results by using all financial deregulation policies. That is, we add up all the five indicators. The results are similar and available upon request.

for middle schools, grades 7 to 9, and high schools, grades 10 to 12) divided by labor force following Mankiw et al. (1992). For labor force growth, $\ln(n+g^w+\delta)$, we use 0.08 for $(g^w+\delta)$. That is, we assume a 2% world annual growth and a 6% depreciation rate for China. As in Mankiw et al. (1992), our result is insensitive to the assumed number for $(g^w+\delta)$. *Fiscal* and *Export* are nominal values of the ratios of fiscal expenditure and export to nominal GDP. (*I/GDP*) is the nominal physical capital investment rate, which is to avoid the deflator problem for investment in China (see Young 2003).

In sum, our data sample comprises panel data of 27 provinces and 18 years.[6] Following the standard approach in the empirical growth literature, we take six-year averages of the Chinese panel data to avoid the influence from business cycle phenomena, producing three time periods. Table 2 lists the summary statistics of the final data.

Table 2. Descriptive statistics

	Mean	Standard deviation	Minimum	Maximum
Growth (% per year)	6.47	2.26	2.00	12.00
ln(FDI/GDP)	-1.31	2.40	-7.86	2.72
F-Reform	1.41	2.24	0	11.49
$\ln(GDP/L)_{t-1}$	7.39	0.62	6.21	9.42
ln(School)	2.25	0.24	1.76	2.84
$\ln(n+g^w+\delta)$	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

Note: 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 $\ln(GDP/L)_{t-1}$, all variables are multiplied by 100 before taking logarithms. Qinghai province has no FDI for 1981-1986, and the datum from 1987-1992 is used.

[6] Among China's 31 provincial governments, four are municipalities and four are autonomous regions. We apply the usage `province' to all. Four provinces are dropped due to lack of complete data.

IV. Empirical results

A. LSDV estimation results

We first use LSDV estimation. That is, we use OLS (Ordinary least squares) estimation that includes 27 province dummies and 3 time dummies. Table 3 summarizes the results.

In regression 3.1, to ensure that the interaction term between FDI and financial deregulation does not proxy for FDI, we include FDI in the regression independently as well. The regression results show that the estimated coefficient on the interaction term between FDI and financial deregulation is positive, which is significant at the 5% level. The estimated coefficient on financial deregulation is negative and insignificant, while that on FDI is positive but insignificant. We also test whether these variables affect growth directly or through the interaction term. The hypothesis that the coefficients of both financial deregulation and its interaction with FDI are zeros is rejected at the 5% level. That is, the combined effect of financial deregulation on growth is significant. The hypothesis that the coefficients of both FDI and its interaction with financial deregulation are zeros cannot be rejected outright at the 10% level, which may be due to the endogeneity problem of FDI. The F-test for the joint significance of FDI, financial deregulation and their interaction term shows that these variables jointly significantly impact growth at the 5% level.

One can also observe that the estimated coefficient on initial real GDP per worker is significantly negative, showing strong evidence of conditional convergence of the Chinese provinces. The estimated coefficient on human capital investment rate, ln*(School)*, is positive as expected, but it is insignificant. The estimated coefficient on $\ln(n+g^w+\delta)$ is negative and significant at the 1% level, consistent with Mankiw et al. (1992). The estimated coefficient on physical capital investment rate ln*(I/GDP)* is negative and insignificant.

Table 3. Regressions for growth of real GDP per worker

	Regression number				
Dependent variable: *Growth*	3.1	3.2	3.3	3.4	3.5
	Estimation method				
Independent variables	LSDV	LSDV	LSDV	LSDV	System GMM
ln(FDI/GDP)	0.38 (0.26)	0.03 (0.24)		0.11 (0.23)	3.05* (1.52)
F-Reform	-0.41 (0.43)		0.40** (0.19)	0.42** (0.19)	-0.76 (0.81)
ln(FDI/GDP)×F-Reform	0.22** (0.11)				0.33** (0.14)
$ln(GDP/L)_{t-1}$	-5.16*** (1.87)	-4.36** (2.00)	-4.94** (1.91)	-4.85** (1.94)	0.11 (6.94)
ln(School)	2.89 (1.91)	4.82** (1.84)	4.61** (1.73)	4.72*** (1.77)	1.28 (4.51)
$ln(n+g^{w}+\delta)$	-6.31*** (2.22)	-5.88** (2.29)	-5.16** (2.21)	-5.10** (2.23)	-6.85 (4.21)
ln(I/GDP)	-0.80 (2.65)	1.37 (2.70)	-0.53 (2.72)	-0.64 (2.75)	0.47 (4.38)
ln(Fiscal)	0.07 (1.79)	2.04 (1.76)	0.41 (1.84)	0.38 (1.85)	-3.53 (6.79)
ln(Export)	-0.82 (0.58)	-0.54 (0.61)	-0.57 (0.58)	-0.53 (0.59)	-0.81 (2.69)
Time FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	
F-test on financial deregulation (Prob>F)	4.80 (0.013)				11.01 (0.0003)
F-test on FDI (Prob>F)	2.37 (0.105)				3.71 (0.038)
F-test on ln(FDI/GDP), *F-Reform*, and ln(FDI/GDP)×*F-Reform*	Prob> F =0.032				Prob> F =0.0006
Sargan overID test p-value					0.861
Hansen overID test p-value					0.462
Arellano-Bond test for AR(1)					Pr>z = 0.095
F-test					14.59***
R^2	0.86	0.83	0.84	0.84	

Note: Growth is the average annual growth rate of real GDP per worker over the 1981–86, 1987–92, and 1993–98 periods. Observations: 81. In 3.5, $ln(GDP/L)_{t-1}$ is treated as predetermined. All other independent variables except the time dummies are treated as endogenous. Time dummies are used as instruments. ***Significant at the 0.01 level, ** at the 0.05 level, * at the 0.10 level (standard error in parentheses), To further appreciate our results, we run several additional regressions. In regression 3.2, we drop the interaction term and financial deregulation from the regressions. This is usually done in previous works on the FDI-growth nexus. The results in column 3.2 show that FDI has a positive impact on economic growth. However, the coefficient of FDI in this specification is not statistically significant, consistent with Borensztein et al. (1998) and Alfaro et al. (2004). In regression 3.3, we only put financial deregulation with other control variables in the regression. The results in column 3.3 show that higher degree of financial deregulation contributes positively to growth and the effect is significant at the 5% level. Further, we put FDI and financial deregulation together into regression 3.4 (that is, without their interaction term). The estimated coefficient on financial deregulation is still significant and positive, but it does not alter the insignificance of FDI. The results in columns 3.3 and 3.4 confirm that financial deregulation promotes economic growth. However, in light of the results in regression 3.1 that show the existence of an interaction effect between financial deregulation and FDI, ignoring the interaction term does not allow one to fully understand the mechanism of how financial deregulation impacts the growth of a backward economy.

In summary, the LSDV results show that there is a significant complementary effect between FDI and financial deregulation in promoting the growth of the Chinese provinces.

B. LIML regression

Here we first discuss the endogeneity problem of FDI and its identification strategy. Then, we analyze the direction of causality between growth and financial reform to conclude that financial reform in China leads economic growth. Therefore, we only need to address the endogeneity problem of FDI in our empirical regressions.

Endogeneity of FDI and the identification strategy

As is the case with the previous literature on the FDI-growth nexus (e.g., Borensztein et al. 1998; Alfaro et al. 2004), we are aware that our regressions presented below are also subject to the endogeneity problem of FDI. We address the endogeneity problem of FDI by applying the instrumental variable (IV) technique and using contemporary weather conditions as instruments. We will use LIML estimation to test and deal with the presence of weak instruments.

Here we argue why weather conditions are plausible instruments for FDI. Weather conditions are among the many factors that generate the provincial variation in FDI inflows. The relationship between FDI and weather is discussed in Goldsmith and Sporleder (1998). In analyzing the food and beverage firms' FDI decisions, Goldsmith and Sporleder argue that weather as part of large uncertainty or randomness in transaction will affect firms' FDI decisions. During the period 1978-1998, China is still a backward developing country in which agricultural products consist of a large share of total GDP. Many Chinese scholars have studied the sectoral composition of FDI. The common finding is that some FDI inflows are directed towards agriculture and agriculture-related labor-intensive industries like textile and food-processing. Following Goldsmith and Sporleder's argument, these foreign firms' direct investment in China is partly affected by weather conditions. That is, those FDI inflows tend to locate in Chinese provinces majoring in agricultural production that is heavily affected by weather conditions. This is consistent with the sectoral composition of world FDI, as the World Bank states that the sectoral focus of world FDI has shifted from agriculture to industry and later to services.

Nevertheless, we are aware that the channel that we emphasize here may be weak (see e.g., Stock and Yogo 2002; Hahn and Hausman 2005 for recent econometric progresses on weak instruments). Stock and Yogo (2002) show that LIML is far superior to 2SLS (Two-stage least squares) when instruments are weak. Therefore, we proceed with LIML estimation. Over-identification tests will be employed to check the validity of the instruments. However, it is well-known that these tests have little statistical power. Therefore, first, we use different combinations of weather conditions as instruments. When the results are robust with different subset of instruments, the validity of the instruments is enhanced (see Murray 2006). Second, in section IV.C we use system GMM estimation that only needs "internal instruments" to deal with the endogeneity of all important explanatory variables.

We have seven contemporary weather indicators, namely, yearly temperature, rainfall, and hours of sunshine, three indicators measuring the variation of temperature, and one measuring the variation of hours of sunshine. We find, when available, the monthly average data on temperature, rainfall, and hours of sunshine for the period 1981-1998 from the *Weather yearbook of China* and the Natural Resources Database of the Chinese Academy of Sciences. Based on the monthly data, we calculate the yearly average data and then take six-year averages. Table 4 explains the meaning and construction of the indicators.

Table 4. Correlation among the weather indicators

	ln(Rainfall)	*ln(Temper)*	*ln(Sunshine)*	*Tempdiff*	*Tempvar1*	*Tempvar2*	*Sunvar*
ln(Rainfall)	1.00						
ln(Temper)	0.65***	1.00					
ln(Sunshine)	-0.71***	-0.61***	1.00				
Tempdiff	-0.65***	-0.66***	0.67***	1.00			
Tempvar1	-0.63***	-0.70***	0.67***	0.98***	1.00		
Tempvar2	-0.63***	-0.72***	0.68***	0.98***	1.00***	1.00	
Sunvar	0.17	0.26**	-0.32***	-0.11	-0.08	-0.11	1.00

Note: All data except Tempvar2 are six-year averages. Rainfall, Temper and Sunshine are based on yearly rainfall, temperature and hours of sunshine respectively. Tempdiff is based on the difference between the highest and the lowest monthly temperatures in a year. We calculate the variance for each year based on the monthly data to get the variations for temperature and sunshine, denoted by Tempvar1 and Sunvar respectively. Tempvar2 is calculated as the variance of all six years' monthly temperature. *** indicates significant at the 0.01 level, ** at the 0.05 level.

Granger causality between financial deregulation and growth

China's financial deregulation policies precede economic growth. This is because many exogenous factors such as politics, culture and politician's preferences determine the provincial distribution of financial deregulation policies. Shirk (2003: 129), for example, argues that the Chinese financial liberalization was mainly conducted on a political ground.

A more formal way of examining the direction of causality between growth and financial reform is to apply tests in Granger (1969) and Sims (1972). Let us use *F-Reform* to denote the measure of financial deregulation policies. Since our panel data have only three periods (each of which is a six-year average), it is impossible to lag growth for too many periods. To avoid this problem, we use year-to-year data. After lagging the variables, we end up with 432 observations. Following the specification in Blomström et al. (1996), we estimate $G_t = f(G_{t-1}, G_{t-2}, F\text{-}Reform_{t-1})$, and $F\text{-}Reform_t = f(F\text{-}Reform_{t-1}, F\text{-}Reform_{t-2}, G_{t-1})$, where G_t is the growth rate of real GDP per worker in year t,[7] and $F\text{-}Reform_{t-1}$ is the average of the quantified financial reform policies during year *t*-1. We interpret financial reform to be

[7] The dependent variable is an annual growth rate that is stationary, which avoids the cointegration tests in time series analysis to see whether the variables of interest are cointegrated.

Granger-causing growth when a prediction of growth on the basis of its past history can be improved by further taking into account past financial reform. The results with year-to-year data with 405 observations show that financial reform Granger-causes growth and the causality is unidirectional. The results, after controlling for fixed time and province effects, are reported below (p-values are in parentheses).

$$G_t = -\underset{(0.037)}{0.108} G_{t-1} - \underset{(0.442)}{0.045} G_{t-2} + \underset{(0.046)}{0.457} \textit{F-Reform}_{t\text{-}1}; \mathrm{R}^2 = 0.50, n = 405,$$

$$\textit{F-Reform}_t = \underset{(0.000)}{0.86} \textit{F-Reform}_{t\text{-}1} - \underset{(0.166)}{0.06} \textit{F-Reform}_{t\text{-}2} + \underset{(0.198)}{0.006} G_{t\text{-}1}; \mathrm{R}^2 = 0.98, n = 405.$$

LIML regression results

Table 5 presents the results from LIML regressions. In all regressions, we instrument FDI with the weather indicators. Besides other control variables, the first LIML regression includes FDI, the second includes FDI and F-Reform, and the third includes FDI, F-Reform, and their interaction term. Based on the third, we run an IV LM redundancy test to drop some instruments whose exclusion does not affect the identification. Therefore, the fourth LIML estimation repeats the third, but with only a subset of instruments. The corresponding first stage results are reported in columns 5.1 to 5.4 in Table 5, and the corresponding second stage results are listed in columns 6.1 to 6.4 in Table 6 respectively.

The first stage results in Table 5 show that the p-values of the F-test on the joint significance of the weather instruments are below 5% in columns 5.1 to 5.4. These evidence that the weather indicators jointly have significant effects on FDI. Moreover, in the presence of weak instruments, Hahn and Hausman (2005) show that the ratio between the finite sample biases of two-stage least squares and ordinary least squares with a troublesome explanator is (Murray 2006):

$$\frac{Bias\left(\beta_1^{2SLS}\right)}{Bias\left(\beta_1^{2SLS}\right)} \approx \frac{l}{n\tilde{R}^2},$$

Table 5. LIML regressions for growth of real GDP per worker (first-stage results)

First-stage dependent variable	*ln(FDI/GDP)* 5.1	*ln(FDI/GDP)* 5.2	*ln(FDI/GDP)* 5.3	*ln(FDI/GDP)* 5.4	*F-Reform ×ln(FDI/GDP)* 5.5
	Corresponding second-stage regression number				
Independent variables	6.1	6.2; 6.5	6.3	6.4	6.5
ln(Sunshine)	-3.89** (1.58)	-3.89** (1.54)	-3.15** (1.45)	-3.29** (1.39)	4.82 (4.19)
ln(Temper)	0.16 (0.46)	-0.10 (0.47)	-0.13 (0.44)		-0.22 (1.28)
ln(Rainfall)	1.75** (0.75)	2.03*** (0.75)	1.60** (0.71)	1.47** (0.63)	-2.78 (2.03)
Tempdiff	0.11 (0.34)	0.10 (0.33)	0.21 (0.31)		0.70 (0.89)
Tempvar1	0.07 (0.09)	-0.001 (0.10)	-0.09 (0.10)		0.70 (0.89)
Tempvar2	-0.05 (0.07)	0.15 (0.08)	0.08 (0.08)	0.02* (0.01)	0.42* (0.22)
Sunvar	0.0002 (0.0002)	0.0003 (0.0002)	0.0002* (0.0001)	0.0002 (0.0001)	-0.0001 (0.0004)
Partial R-squared on excluded instruments	0.34	0.37	0.31	0.29	
Bias(β_1^{2SLS})/Bias(β_1^{OLS})≈l/(nR²)	7/27=0.26	7/30=0.24	7/25=0.28	4/23=0.17	
F-test on Instruments (Prob>F)	F(7,39)=2.8 (0.017)	F(7,38)=3.1 (0.010)	F(7,37)=2.3 (0.045)	F(4,40)=4.1 (0.007)	F(7,38)=1.5 (0.185)
IV LM Redundancy Test Chi-sq(3) p-value				1.93 (0.587)	
R^2(Centered)	0.96	0.96	0.97	0.97	0.96

Note: Observations: 81. Other RHS variables in first-stage regressions: 5.1: ln(GDP/L)$_{t-1}$, ln(*School*), ln($n+g^w+\delta$), ln(*I/GDP*), ln(*Fiscal*), ln(*Export*); 5.2, 5.5: F-Reform, ln(GDP/L)$_{t-1}$, ln(*School*), ln($n+g^w+\delta$), ln(*I/GDP*), ln(*Fiscal*), ln(*Export*); 5.3, 5.4: F-Reform, ln(FDI/GDP)×F-Reform, ln(GDP/L)$_{t-1}$, ln(*School*), ln($n+g^w+\delta$), ln(*I/GDP*), ln(*Fiscal*), ln(*Export*). Time and Province FE are included in all the estimates. ***Significant at the 0.01 level, ** at the 0.05 level, * at the 0.10 level (standard error in parentheses).

where l is the number of instruments, n is sample size and $\widetilde{R}^2$ is the first-stage partial R-squared of excluded instruments. According to columns 5.1 to 5.4, all our $n\widetilde{R}^2$ are much larger than our number of instruments, showing that LIML regression is favored over LSDV one. Moreover, the first-stage results also show that some instruments have no significant effects on FDI, so we run the redundancy test for each of the seven instruments. We then run redundancy tests for the three instruments that have the highest p-values in redundancy tests for each instrument (ln(*Temper*)*, Tempdiff, and Tempvar1*). As reported in column 5.4 of table 5, the p-value of redundancy test on ln(*Temper*)*, Tempdiff, and Tempvar1* is 0.586, meaning the three instruments are redundant and excluding them from our group of instruments does not affect our identification. With the four remaining instruments, we report the first-stage results in column 5.4 in Table 5 and second stage results in column 6.4 in Table 6. One can see that the F-test statistic on the instruments gets larger and the associated p-value decreases below 1%, meaning the four instruments have stronger effects on FDI.

The second-stage results of the LIML estimation are reported in Table 6. In regressions 6.1, the estimated coefficient on FDI is positive and significant at the 5% level. In regression 6.2, the estimated coefficient on FDI becomes smaller, which is significant at the 1% level. However, in these two regressions, the p-values of over-identification tests are below 5%. This means that the instruments may be correlated with omitted variables such as financial reform and its interaction with FDI.

In regression 6.3, the estimated coefficient on the interactive term between FDI and financial deregulation remains positive but becomes significant at the 1% level (comparing to 5% level in LSDV regression). The estimated coefficient on FDI remains positive but becomes significant at the 1% level. The estimated coefficient on financial deregulation is still negative but become significant at the 5% level, which is consistent with the theoretical prediction in section II. The endogeneity test on FDI yields a p-value below 1%, showing strong evidence of the endogeneity of FDI. Our weak identification (Cragg-Donald) test statistic is 2.33 that is smaller than the critical value for the 25% maximal LIML size, meaning we accept the null hypothesis that the seven instruments are weak. This justifies our use of LIML estimation. The over-identification test yields a p-value of 0.23, meaning we accept the null that the instruments are valid. The hypothesis that the coefficients of both FDI and its interaction with financial deregulation are zero can be rejected outright at the 1% level. The hypothesis that the coefficients of both financial deregulation and its interaction with FDI are zero is rejected at the 1% level. The test for the joint significance of FDI, financial deregulation and their interaction term yields a p-value of almost zero, showing that these variables jointly significantly impact growth.

Table 6. LIML regressions for growth of real GDP per worker (second-stage results)

Independent variables	6.1	6.2	6.3	6.4	6.5
ln(FDI/GDP)	1.59**	1.16***	1.69***	1.22***	2.07***
	(0.65)	(0.44)	(0.50)	(0.41)	(0.70)
F-Reform		0.56***	-1.26**	-0.96**	-3.18**
		(0.18)	(0.49)	(0.42)	(1.46)
ln(FDI/GDP)×F-Reform			0.49***	0.39***	1.00**
			(0.13)	(0.11)	(0.39)
ln(GDP/L)$_{t-1}$	-2.89	-4.07**	-4.79***	-4.93***	-5.68**
	(2.16)	(1.75)	(1.73)	(1.53)	(2.23)
ln(School)	6.53***	5.81***	1.75	2.16	-2.67
	(2.02)	(1.62)	(1.80)	(1.58)	(3.72)
ln(n+g^w+δ)	-5.44**	-4.55**	-7.22***	-6.90***	-10.11***
	(2.39)	(2.00)	(2.07)	(1.82)	(3.25)
ln(I/GDP)	0.85	-1.67	-1.97	-1.55	-2.11
	(2.82)	(2.48)	(2.48)	(2.18)	(3.10)
Endogeneity test on FDI p-value	0.04	0.03	0.002	0.016	0.016
Endogeneity test on interaction					p-value=0.09
Weak identification test	2.84	3.14	2.33	4.07	0.91
Stock-Yogo critical value:					
10% maximal LIML size	4.18	4.18	4.18	5.44	3.90
15% maximal LIML size	3.18	3.18	3.18	3.87	
25% maximal LIML size	2.49	2.49	2.49	2.98	2.35
Sargan overID test p-value	0.006	0.017	0.23	0.29	0.52
Test on reform *(Prob>chi)*			(0.000)	(0.000)	(0.003)
Test on FDI *(Prob>chi)*			(0.001)	(0.002)	(0.012)
Test on ln(FDI/GDP), F-Reform and ln(FDI/GDP)×F-Reform			Prob >chi =0.0001	Prob >chi =0.0002	Prob >chi =0.0057
R^2(Centered)	0.66	0.77	0.77	0.82	0.64

Note: *Growth* is the average annual growth rate of real GDP per worker over the 1981–86, 1987–92, and 1993–98 periods. Observations: 81. The results on ln(*Fiscal*) and ln(*Export*) are not reported. 6.1-4's endogenous variable: ln(*FDI/GDP*); 6.5's endogenous variables: ln(*FDI/GDP*) and ln(*FDI/GDP*)×*F-Reform*. 6.1-3, 6.5's instruments: *Tempdiff*, *Tempvar1*, *Tempvar2*, ln(*Temper*), ln(*Rainfall*), Sunvar, ln(Sunshine). 6.4's instruments: *Tempvar2*, ln(*Rainfall*), *Sunvar*, ln(*Sunshine*). Time and Province FE are included in all the estimates. ***Significant at the 0.01 level, ** at the 0.05 level, * at the 0.10 level (standard error in parentheses).

In regression 6.4, we repeat the LIML regressions in 6.3, using the subset of four instruments. The p-value of the endogeneity test on FDI is still below 5%, rejecting the exogeneity of FDI. Our weak identification test statistic increases to 4.07, which is larger than the critical value for the 15% maximal LIML size, meaning we can reject the null that the four instruments are weak. When instruments are not weak, LIML estimation is identical to 2SLS estimation. The LIML regression in 6.4 produces size estimates similar to those in 6.3 for our variables of interest. Moreover, the significance levels are identical to those in regression 6.3. The p-value of over-identification test is still above 10%, accepting the null that the instruments are valid. Although over-identification test is known to have little statistical power, our results are robust to different combination of instruments, further justifying the validity of instruments (see Murray 2006).

Although we have argued and shown that financial reform leads economic growth, the interaction term contains FDI so that it is subject to some degree of endogeneity problem. We also instrument FDI and the interaction term with the weather indicators. To avoid under-identification, we use all seven instruments. The first stage results are reported in 5.2 for FDI and 5.5 for the interaction term in Table 5. The second stage results are presented in 6.5 in Table 6. The p-value of the F-test on the joint significance of the weather instruments in 5.5 is much larger than 10%, meaning that the F-test rejects the null hypothesis that the weather instruments jointly have significant effects on the interaction term between FDI and financial reform. Moreover, from regression 6.5, we can see that the endogeneity test p-value for the interaction term is 0.09, meaning we accept the null that the interaction term is exogenous at the 5% level. Therefore, we should prefer treating the interaction term as exogenous to regarding it as endogenous. In other words, regression 6.5 should be put less emphasis. Nevertheless, the estimated coefficients on FDI, financial reform and their interaction term have the same signs as in regressions 6.3 and 6.4 and are all significant at the 5% level.

The following presents an estimate of how important the absorptive capability (i.e., financial deregulation) and available world frontier technologies (i.e., inward FDI) have been in promoting growth. Using regression 6.4, it turns out that having a one standard deviation increase in *ln(FDI/GDP)* would have allowed provinces to experience an annual growth rate increase of 2.9 percentage points during the 18-year-period, where the net effect being measured is [β_1+β_2×mean(*F-Reform*)]

$\sigma_{\ln(FDI/GDP)}$.[8] Similarly, using regression 6.3, 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 growth rate decrease of 2.2 percentage points during the 18-year-period. This is predicted by the simple theory in section II: financial deregulation has a negative direct effect on growth, although it has a positive effect on growth via interacting with inward FDI. Therefore, the combined effect of financial deregulation on growth depends on the level of inward FDI. If we examine individual observations, it turns out that 13 out of the 81 observations would have experienced an annual growth rate increase given a one standard deviation increase in the *F-Reform* variable. This is because these observations have high and positive value of ln(*FDI/GDP*). The highest value of ln(*FDI/GDP*) comes from Guangdong province for the period 1993-1998, and it would have experienced an annual growth rate increase of 1.4 percentage points given a one standard deviation increase in the *F-Reform* variable.

C. System GMM estimation results

Our model has the characteristics listed in Roodman (2006). The dynamic structure of the model allows us to use system GMM estimation. Arellano and Bover (1995) and Blundell and Bond (1998) show that the system GMM estimator can dramatically improve efficiency and avoid the weak instruments problem in the first-difference GMM estimator. Moreover, the advantage of system GMM estimation is that it only needs "internal" instruments. That is, the system GMM estimator estimates a system of two simultaneous equations, one in levels (with lagged first differences as instruments) and the other in first differences (with lagged levels as instruments). Therefore, we re-estimate our model with system GMM estimator. In using the system GMM, we treat initial real GDP per worker as predetermined, and all the other main independent variables (including FDI, financial deregulation and their interaction term) as endogenous. Following Roodman (2006), the province dummies are excluded, while the time dummies are used as exogenous instruments. The results are reported in column 3.5 in Table 3.

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

Both the Sargan and the Hansen tests for over-identifying restrictions confirm that the instrument set can be considered valid. The F-test shows that the overall regression is significant. The Arellano-Bond test rejects the hypothesis of no autocorrelation of the first order. Since our panel data only have three periods, we do not have the test on the autocorrelation of the second order. Moreover, we cannot use deeper lagged variables as instruments. This may explain why the estimated coefficients on the other variables become insignificant. Nevertheless, the estimated coefficient on the interactive term remains positive and significant at the 5% level. Its estimated magnitude is larger than that in LSDV estimation but smaller than that in LIML estimation.

V. Conclusions

For developing countries, their rate of economic growth depends on the extent of adoption of new technologies transferred from leading countries. This highlights the role of two factors: the introduction of world frontier technologies (by attracting inward FDI) and the absorptive capability of the host economy. Developing countries, however, often have different types of financial distortions that may jeopardize their absorptive capability. Eliminating these distortions would increase their absorptive capability, allowing exploiting world frontier technologies transferred by FDI more efficiently. That is, there may exist a complementarity between inward FDI and domestic financial reform in the process of economic development. We test these issues in a sample that comprises Chinese provinces with significant FDI inflows as well as financial deregulation for the reform and opening-up period. We find that there exists a significant interaction between inward FDI and financial deregulation in promoting economic growth.

The economic success of China is important not only because it has significantly raised the welfare of Chinese people, but also because other transitional and underdeveloped countries may be able to learn something useful from the unprecedented Chinese experience. As far as this paper is concerned, the useful lesson is that it may be more desirable to attract more inflows of FDI and at the same time to conduct financial deregulation to exploit FDI more efficiently (that is, to absorb advanced technologies and management practices faster) so as to achieve a faster catch-up with leading economies.

References

Acemoglu, Daron (2009), *Introduction to modern economic growth*, Princeton, Princeton University Press.

Aitken, Brian J., and Ann E. Harrison (1999), Do domestic firms benefit from direct foreign investment? Evidence from Venezuela, *American Economic Review* 89: 605-18.

Alfaro, Laura, Areendam Chandab, Sebnem Kalemli-Ozcanc, and Selin Sayek (2004), FDI and economic growth: The role of local financial markets, *Journal of International Economics* 64: 89-112.

Arellano, Manuel, and Olympia Bover (1995), Another look at the instrumental variables estimation of error-components models, *Journal of Econometrics* 68: 29-51.

Barro, Robert J., and Xavier I. Sala-i-Martin (2004). *Economic growth*, 2nd edition. New York, McGraw-Hill.

Blomström, Magnus, Robert E. Lipsey, and Mario Zejan (1996), Is fixed investment the key to economic growth? *Quarterly Journal of Economics* 111: 269-276.

Blundell, Richard, and Stephen Bond (1998), Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics* 87: 11-143.

Borensztein, Eduardo, Jose De Gregorio, and Jong-Wha Lee (1998), How does foreign direct investment affect economic growth? *Journal of International Economics* 45: 115-135.

Brandt, Loren, and Thomas Rawski (2008), *China's great economic transformation,*. Cambridge, Cambridge University Press.

Chan, Kenneth S., Vinh Q.T. Dang, and Isabel K.M. Yan (2012), Financial reform and financing constraints: Some evidence from listed Chinese firms, *China Economic Review* 23: 482-497.

Cohen, Daniel (1993), Foreign finance and economic growth —An empirical analysis, unpublished manuscript, CEPREMAP.

Demirguc-Kunt, Asli, and Ross Levine (2001), *Financial structure and economic growth: A cross-country comparison of banks, markets, and development*, Cambridge, MA, MIT Press.

Deng, Xiaoping (1975), *Several points on developing industries* (in Chinese) [Guan Yu Fa Zhan Gong Ye de Ji Dian Yi Jian].

Desai, Mihir A., C. Fritz Foley, and James R. Hines Jr. (2005), Foreign direct investment and the domestic capital stock, Working Paper 11075, NBER.

Easterly, William (1993), How much do distortions affect growth? *Journal of Monetary Economics* 32: 187-212.

Eid, Nevine Mokhtar (2008), Financial development: A pre-condition for foreign direct spillover effects in Egypt, Faculty of Management Technology Working Paper 12, German University in Cairo.

Findlay, Ronald (1978), Relative backwardness, direct foreign investment, and the transfer of technology: A simple dynamic model, *Quarterly Journal of Economics* 92: 1-16.

Goldsmith, Peter D., and Thomas L. Sporleder (1998), Analyzing foreign direct investment decisions by food and beverage firms: An empirical model of transaction theory, *Canadian Journal of Agricultural Economics* 46: 329-346.

Granger, Clive W.J. (1969), Investigating causal relations by econometric models and cross-spectral methods, *Econometrica* 37: 424-38.

Hahn, Jinyong, and Jerry Hausman (2005), Instrumental variable estimation with valid and invalid instruments, unpublished paper, Cambridge, MA.

Harrison, Ann E. and Margaret S. McMillan (2003), Does direct foreign investment affect domestic credit constraints? *Journal of International Economics* 61: 73-100.

Hermes, Niels and Robert Lensink (2003), Foreign direct investment, financial development and economic growth, *The Journal of Development Studies* 40: 142-163.

Holtz, Carsten A. (2003), 'Fast, clear and accurate:' How reliable are Chinese output and economic growth statistics? *The China Quarterly* 173: 122-63.

Keller, Wolfgang and Stephen Yeaple (2003), Multinational enterprises, international trade, and productivity growth: Firm-level evidence from the United States, Working Paper 9504, NBER.

Institute of Economic Research, the Chinese Academy of Social Sciences (2000), *Big economic events since China's reform and opening-up* (1978-1998) [Zhong Guo Gai Ge Kai Fang Yi Lai Da Shi Ji Yao (1978-1998)], Beijing, Economic Science Press.

Kornai, Janos (1986), The soft budget constraint, *Kyklos* 39: 3-30.

Lee, Chien-Chiang, and Chun-ping Chang (2009), FDI, financial development, and economic growth: International evidence, *Journal of Applied Economics* 12: 249-271.

Mankiw, Gregory, David Romer, and David Weil (1992), A contribution to the empirics of economic growth, *Quarterly Journal of Economics* 107: 407-37.

Markusen, James R. and Anthony J. Venables (1999), Foreign direct investment as a catalyst for industrial development, *European Economic Review* 43: 335-56.

Murray, Michael P. (2006), Avoiding invalid instruments and coping with weak instruments, *Journal of Economic Perspectives* 20: 111-132.

Naughton, Barry (1995), *Growing out of the plan: Chinese economic reform, 1978-199*, Cambridge, Cambridge University Press.

Rodriguez, Francisco, and Dani Rodrik (2000), Trade policy and economic growth: A skeptic's guide to the cross-national evidence, *NBER Macroeconomic Annual* 15: 261-325.

Romer, Paul (1993), Idea gaps and object gaps in economic development, *Journal of Monetary Economics* 32: 543-573.

Roodman, David (2006), How to do xtabond2: An introduction to "Difference" and "System" GMM in Stata, Working Paper 103, Center for Global Development.

Shirk, Susan L. (2003), *The political logic of economic reform in China*. Berkeley, University of California Press.

Sims, Christopher A. (1972), Money, income and causality, *American Economic Review* 62: 540-52.

Statistical yearbook of China [Zhong Guo Tong Ji Nian Jian] (1981, 1983-1999) [annual], Beijing, China Statistical Press.

Statistical yearbook on China's cities [Zhong Guo Cheng Shi Tong Ji Nian Jian] (1986-1999) [annual], Beijing, China Construction and Consulting and Service Center on Chinese Statistical Information (1986-1989), and China Statistical Press (1990-1999).

Stock, James H., and Motohiro Yogo (2002), Testing for weak instruments in linear IV regression, Technical Working Paper 284, NBER.

UNCTAD (2008), Foreign direct investment section.

Weather yearbook of China [Zhong Guo Qi Xiang Nian Jian] (1985-1999) [annual], Beijing, Weather Press.

Young, Alwyn (2003), Gold into base metals: Productivity growth in the People's Republic of China during the reform period, *Journal of Political Economy* 111: 1220-61.