Financial Deregulation and Economic Growth: An Inverted-U Causal Relationship*

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Abstract

Using the Chinese financial deregulation experience during the post-reform period, we find robust evidence that growth is inverted-U related to the degree of financial deregulation. The inverted-U shape holds up when we control for conditional convergence, other growth determinants, and time and province effects. Our result is also robust whether we use whole financial deregulation policies or banking sector deregulation policies. The inverted-U relation also holds up when we overcome the potential endogeneity of financial deregulation and all other independent variables by system GMM estimation. Therefore, the inverted-U relation is causal.

JEL Classification: O33, C23

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1 Introduction

There is a long-standing debate on the finance-growth nexus.[1] For instance, authors such as Robinson (1952) and Lucas (1988) argue that financial development follows economic growth, while others including Schumpeter (1961), King and Levine (1993) and Levine and Zervos (1998) show that financial development leads economic growth. One important real world fact is that, over the past several decades, many countries have deregulated their financial service. Typical examples in developing countries are the financial reforms in Vietnam (Riedel and Turley, 1999) and Morocco and Tunisia (Jbili et al., 1997), and those in industrialized countries include European Union's Second Banking Directive in 1993 and Japan's "Big Bang" financial deregulation in 1996 (Cummins and Rubio-Misas, 2006). These real world experiences raise several important questions: Does financial deregulation cause growth? What is the underlying relationship between financial deregulation and growth? To address these questions, we use the financial deregulation[2] experience of China that is appealing for the following reasons.

First, to study the association between financial deregulation and growth, cross-province analysis within a single country is more suitable. On the one hand, financial reforms across countries (see Johnston and Pazarbasioglu, 1995) may be hard to compare and be correlated with unobserved country characteristics. Financial reforms systematically implemented across Chinese provinces are relative more homogenous and more meaningful to compare. Second, the Chinese financial deregulation was conducted following the gradual approach contrast to 'shock therapy' adopted elsewhere, thereby generating substantive variations across time and across provinces in the degree of financial deregulation, illustrated in figures 1 and 2. We exploit the time variations to control for unobserved province effects, avoiding the potential omitted variable bias from unobserved province effects. Third, although our results show that financial reform Granger-causes economic growth in China, we are still able to construct exogenous weather conditions as instruments to deal with the potential endogeneity problem of financial deregulation. The potential endogeneity problem of financial deregulation has been emphasized by Levine (2003). For instance, Jayaratne and Strahan (1996) find that branch reform boosted growth across USA states. However, Levine criticizes that branch reform may be endogenous.

[Figures 1 and 2 Here]

[1] See Levine (2003) for a survey of the literature on the finance-growth nexus. Because of his excellent discussion of it, I shall omit detailed references to the literature.

[2] We refer to financial reform and financial deregulation interchangeably.

Specifically, we employ Chinese panel data to address the aforementioned two issues. We use data for China's 27 provinces from 1981 to 1998. First, we find that financial reform Granger-causes economic growth in China. Second, we find that growth is an inverted-U function of the degree of financial deregulation. The inverted-U relation is robust after controlling for conditional convergence, other common growth determinants as in Mankiw et al. (1992), and time and province effects. The inverted-U relation also holds up when we overcome the potential endogeneity of financial deregulation and all other independent variables by using exogenous weather conditions as instruments. Therefore, the inverted-U relation is causal. Using the regression results, we calculate the threshold of financial deregulation for its marginal effect to be negative on growth. We find that Shanghai's value of financial deregulation during the period 1993-1998 exceeds the threshold, so its marginal effect on growth will be negative. This confirms the inverted-U shape. Shanghai during the period 1993-1998 has the highest degree of financial deregulation, and it is the only datum that exceeds the threshold. Therefore, the inverted-U shape is more of a diminishing returns story than a puzzle. That is, at the low degree of financial deregulation, the marginal effect of financial deregulation on growth is positive. However, as the degree of financial deregulation increases, its marginal effect would decrease and become negative at very high degree of financial deregulation. This complements the findings of Aghion et al. (2005) who show that financial development matters for growth only at the early stage of economic development.

How to explain the inverted-U causal relationship between financial deregulation and economic growth? There may be many possible explanations, but we have built two theories based on endogenous growth models that predict the inverted-U relation in two separate papers. For instance, one theory is based on the distribution of the property rights on inventions between entrepreneurs and households. The theory predicts an inverted-U relation between entrepreneurs' inventive incentive (EII, i.e., their contractual share in the monopolistic profit from each innovation) and growth. China's financial deregulation (Brandt and Rawski, 2008; Lardy, 1998; Shirk, 2003) gives entrepreneurs more incentives to achieve creative destruction, causing its economic success (Li et al., 2009). Following Li et al., we argue that China's financial deregulation gradually increased EII. Therefore, financial deregulation can proxy for EII, which explains the observed inverted-U relation.

The rest of the paper proceeds as follows. After we briefly introduce the Chinese financial reform, section 2 reports the estimating equation and describes the data. Section 3 presents the regression results. Section 4 concludes.

1.1 The Chinese Gradual Financial Reform

Before 1978, China was a command economy in which enterprises as well as financial intermediaries work under the command of the government. The financial system is underdeveloped with the government playing 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. Capital markets were nonexistent. The primary financial intermediaries were state banks. Believing in the gospel of rapid industrialization, the Chinese government obliged state banks to lend to the priority sector, the state-owned industrial sector, with little concern for its profitability (see Naughton, 1995, p.26; Shirk, 2003, p.26).

In 1978, the Chinese government embarked on gradual financial deregulation aimed at establishing a market-based financial system. The Chinese gradual financial deregulation studied by previous works (see Lardy, 1998; Naughton, 1995; Shirk, 2003) 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, the removal of restrictions on their ownership structure, 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. Each year, the government chooses particular financial reforming policies that are performed only in some designated cities and rarely in some designated provinces. After such policies mature, the government may spread them to the whole province, further to several provinces, and finally to the whole country. After decades of gradual reform, state banks have been built into joint-stock commercial banks; various markets like money market and bond and equity market have been created. The role of market in credit allocation is enhanced.

In China, exogenous political, institutional, and geographical factors determine the time and provincial variations in financial reform policies. Shirk (2003, p.129) argues that the path of financial reform in China since 1979 reflects a political logic. The geographical factors will be used to isolate the exogenous component of financial deregulation in explaining growth, as will be argued later.

2 The Data

To test the relation between growth and financial deregulation, we conjecture the following equation with China's cross-province time series data:

$$g_{it} = a_0 g_{i,t-1} + a_1 FD_{it} - a_2 FD_{it}^2 + T_t + \gamma_i + \epsilon_{it} \tag{1}$$

where g_{it} and $g_{i,t-1}$ are the annual growth rates of province i in period t and $t-1$ respectively; FD and FD^2 measure the degree of financial deregulation and its square respectively; T_t and γ_i stand for fixed time and province effects respectively. Therefore, we assume that the growth rate follows an AR(1) (autoregression) process. As is standard in the growth literature, the data are averaged over 6 years to avoid the influence from business cycles. It is a dynamic panel data, so system GMM (Arellano and Bond, 1991; Roodman, 2006) is employed to increase efficiency. Nevertheless, we will check whether our results are robust to alternative specifications such as those derived in Mankiw et al. (1992) and commonly used in growth regressions. That is, we use the conditional convergence specification and drop the lagged dependent variable from the regressors (see section 4.2).

In our empirical analysis we will use the growth rate of real GDP per worker in China that is far from reaching the steady state. That is, physical and human capital accumulations will also affect the growth rate during the transitional dynamics. Therefore, in our augmented model (the derivation is found in Mankiw et al., 1992), we further test whether our results are robust to the controlling for conditional convergence, and physical and human capital accumulations:

$$\begin{aligned} g_{it} = a_0 g_{i,t-1} + a_1 FD_{it} - a_2 FD_{it}^2 + a_3 \ln\left(\frac{Y}{L}\right)_{i,t-1} + \alpha_4 \ln\left(\frac{I}{Y}\right)_{it} \\ + \alpha_5 ln\left(n+g+\delta\right)_{it} + \alpha_6 \ln\left(School\right)_{it} + T_t + \gamma_i + \epsilon_{it} \end{aligned} \tag{2}$$

where $\ln\left(\frac{Y}{L}\right)_{t-1}$ is initial real GDP per worker; $\frac{I}{Y}$ is physical capital investment rate; $ln\left(n+g+\delta\right)$ measures labor force growth; $School$ is human capital investment rate. The potential endogeneity of these variables is overcome in system GMM estimation. Exogenous instruments are used to ensure valid identification. We use China's cross-province time series data on 27 provinces from 1981 to 1998. As discussed, to avoid the influence from business cycle phenomena, the data are averaged over 6 years.

2.1 Constructing Financial Deregulation Indicators

The chapter "Fiscal, Finance, and Insurance" in 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, documents all China's big gradual financial reform policies during the period 1978-1998. Most financial deregulation policies are at the city level and few are at the province level. The attractiveness of financial reform policies in the book is its provision for uniformity and authority.[3] 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 banking/non-bank ones and capital market development ones. This division is consistent with previous literature that commonly measures and studies banking sector and stock market separately (see Demirguc-Kunt and Levine, 2001). Nevertheless, to check the robustness of our results, we construct two indicators for financial deregulation: the first includes all banking/non-bank sectors deregulation policies; the second involves all the financial deregulation policies.

[Table 1 Here]

We use the following formula to quantify those financial deregulation policies, using 1996 as an example:

$$Index = \sum_j (\sum_i \frac{Total\ Population\ of\ City\ i\ in\ 1996}{Total\ Population\ of\ the\ Province\ in\ 1996} \cdot I_{ci}^{1996} + I_p^{1996})$$

where I_{ci}^{1996} is an indicator/dummy variable that equals one if city i receives a domestic financial deregulation policy j; I_p^{1996} is an indicator variable that equals one if a domestic financial deregulation policy j is conducted in the province. Adding together all policies (the $j's$) in and before year 1996 for all the cities (the $i's$) within a province yields its policy index. We use population rather than GDP as weight to lessen the potential endogeneity problem of financial deregulation. The data on the cities' population are from the Statistical Yearbook on China's Cities.

As stated, our first indicator measures the degree of banking deregulation, denoted as FD, which has explicit variations across province and across time as illustrated in figures 1 and 2. Our second indicator involves all financial deregulation policies, denoted as F-total that sums FD and Stock in Table 1.

2.2 Measuring All Other Variables

In equation (2), initial real GDP per worker, $ln(\frac{Y}{L})_{t-1}$, takes the value of the beginning year of each sub-period. All other variables are six-year averages. *School*

[3] There are other books documenting the gradual financial deregulation policies in China during the period 1978-1998, but the big events are similar across those books.

is measured as the provincial secondary school enrollment to the total number of workers in the province following Mankiw et al. (1992). Secondary school enrollment is the sum of student enrollment for middle schools (grades 7 to 9) and high schools (grades 10 to 12). For labor force growth measure: $ln(n+g+\delta)$, we use 0.08 for $(g+\delta)$, where n is labor force growth rate for each province. $\frac{I}{Y}$ is the provincial nominal physical capital investment rate. Young (2003) argues that there are problems with the various deflators of China. The Chinese local statistical bureaus tend to under-report the deflators for investment relative to those of GDP, thus if one uses investment deflators to measure real investment rate, some provinces would have unreasonably high real investment rate.[4] Therefore we assume the deflators of investment and GDP grow at the same rate.[5]

There are 31 provinces in China.[6] Before 1997, Chongqing was a city of Sichuan province, thus 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 many missing data. In summary, the data sample comprises panel data of 27 provinces and 18 years (1981-1998). Though with time fixed effects, there may still be much of a problem using year-to-year data that may be subject to the bias from business cycle phenomena. Therefore, we take six-year averages of the Chinese panel data, which yields three sub-periods: 1981-1986, 1987-1992, and 1993-1998. The grouping of the data in 6-year intervals for the 18 years matches, to some extent, the political business cycle of China identified by previous studies (e.g., Kwan, 2004; Tao, 2003).

Our data are from the provincial statistical yearbooks and Statistical Yearbook of China. Table 2 lists the summary statistics of the final data.

[Table 2 Here]

3 Regression Results with Financial Deregulation being Exogenous

In this section we first run Granger causality tests to show that financial deregulation Granger-causes growth. Then we treat financial deregulation as exogenous and use system GMM estimation to deal with the potential endogeneity problem of other independent variables. Since Granger causality test cannot make sure that

[4] Weeks and Yao (2003) have got a particularly insignificant coefficient for real investment rate.

[5] There are studies (e.g., Young, 2003) providing alternative deflator for investment.

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

financial deregulation is truly exogenous, we will deal with the potential endogeneity of financial deregulation in section 4.1.

3.1 Granger Causality between Financial Deregulation and Growth

We argue that China's financial deregulation policies precede economic growth. This is because China's financial deregulation was influenced by political (see Shirk, 2003, p. 129) as well as geographical factors that are exogenous to the growth process. A formal way of examining the direction of causality between growth and financial reform is to apply tests in Granger (1969) and Sims (1972). 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 405 observations. Following the specification in Dawson (2003) who examines the direct of causality between freedom and growth and that in Blomström et al. (1996), we estimate the following:

$$g_t = f\left(g_{t-1}, g_{t-2}, FD_{t-1}\right) \qquad (3)$$

$$FD_t = f\left(FD_{t-1}, FD_{t-2}, g_{t-1}\right) \qquad (4)$$

where g_t is real GDP per worker at year t,[7] and FD_{t-1} is the average of the quantified domestic financial deregulation policies during year $(t-1)$. We interpret financial deregulation policies to be 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 deregulation. 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).

$$g_t = \underset{(0.037)}{-0.108}g_{t-1} - \underset{(0.442)}{0.045}g_{t-2} + \underset{(0.046)}{0.457}FD_{t-1};\ R^2 = 0.50,\ n = 405$$

$$FD_t = \underset{(0.000)}{0.86}\,FD_{t-1} - \underset{(0.166)}{0.06}\,FD_{t-2} + \underset{(0.198)}{0.006}g_{t-1};\ R^2 = 0.98,\ n = 405$$

3.2 System GMM Estimation Results

Since equations (1) and (2) use dynamic panel data, system GMM (Arellano and Bond, 1991; Roodman, 2006) is employed to increase efficiency. Given that financial

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

reform Granger-causes growth and the causality is unidirectional, we treat financial deregulation indicator and its squared term as exogenous variables; all other variables except the time dummy are treated as endogenous. The regression results are presented in Table 3.

In regression 3.1, we report the results with banking deregulation policies (FD) from estimating equation (1). First, a time dummy is added to control for fixed time effects. Second, the time dummy, the financial deregulation indicator and its square, and some exogenous weather indicators – detailed in subsection 4.1.1 – are chosen as instruments. The estimated coefficient on banking deregulation, FD, is positive and significant at the 5% level, and that on its square (FD^2) is negative and significant at the 10% level. The F-test for the joint significance of banking deregulation and its square shows that the inverted-U relationship between financial deregulation and growth is significant at the 1% level. The estimated coefficient on lagged growth (lagged dependent variable) is positive and significant at the 1% level, confirming that growth significantly follows an AR(1) process. Since we only have 3 time periods, the regression does not report the Arellano-Bond test result for AR(1). The Hansen test of over-identification produces a p-value of 0.11. Therefore, we accept the null that the instruments as a group are valid for our identification.

Regression 3.2 reports the results from estimating equation (2). That is, we further control for conditional convergence and other growth determinants as derived in Mankiw et al. (1992). One can see that the estimated coefficient on banking deregulation, FD, remains positive but becomes significant at the 1% level. The estimated coefficient on its square (FD^2) remains negative, which becomes significant at the 5% level. The F-test for the joint significance of banking deregulation (FD) and its square (FD^2) shows that the inverted-U shape between financial deregulation and growth is significant at the 1% level. The estimated coefficient on initial real output per worker is negative and significant at the 10% level, showing evidence of conditional convergence. The estimated coefficient on ln(School) is positive and insignificant at the 10% level. The estimated coefficient on $ln\left(\frac{I}{Y}\right)$ is positive and significant at the 10% level, as expected. The estimated coefficient on $ln\left(n+g+\delta\right)$ is positive and significant at the 10% level, which is unexpected based on Mankiw et al. (1992). The Hansen over-identification test produces a p-value of 0.12, which means we accept the null that the instruments as a group are valid.

[Table 3 Here]

The results are very similar when we the whole financial deregulation policy indicator, F-total. The results are reported in regressions 3.3 and 3.4 in Table

3. According to regression 3.3, one can observe that the estimated coefficient on financial deregulation, $F\text{-}total$, is positive and significant at the 1% level, and that on its square ($F\text{-}total^2$) is negative and significant at the 5% level. The F-test for the joint significance of financial deregulation and its square shows that the inverted-U relationship between financial deregulation and growth is significant at the 1% level. The estimated coefficient on lagged growth is positive and significant at the 1% level, confirming that growth significantly follows an AR(1) process. The Hansen test of over-identification produces a p-value of 0.14, which confirms the validity of the instruments. The results by further controlling for conditional convergence and other growth factors are listed in regression 3.4. On can see that the estimated coefficient on financial deregulation, $F\text{-}total$, remains positive and significant at the 1% level. The estimated coefficient on its square remains negative, which becomes significant at the 1% level. The F-test for the joint significance of financial deregulation and its square shows that the inverted-U shape between financial deregulation and growth is significant at the 1% level. The estimated coefficient on initial real output per worker is negative and significant at the 5% level, showing strong evidence of conditional convergence. The estimated coefficients on ln(School) is positive and significant at the 10% level. The estimated coefficient on $ln\left(\frac{I}{Y}\right)$ is positive and insignificant at the 10% level. The estimated coefficient on $ln\,(n+g+\delta)$ is positive and significant at the 5% level, which is unexpected based on Mankiw et al. (1992). The Hansen over-identification test produces a p-value of 0.14, which means we accept the null that the instruments are valid.

In summary, the system GMM estimation yields an inverted-U relation between growth and financial deregulation. The inverted-U shape is robust to the controlling for conditional convergence and other growth factors. Using the results from regression 3.4, we calculate the threshold of financial deregulation for its marginal effect to be negative on growth. Given the estimated coefficients, the threshold is 17.31. That is, when the value of $F\text{-}total$ exceeds 17.31, its marginal effect on growth will be negative. We find that, in our data sample, Shanghai's value of $F\text{-}total$ during the period 1993-1998 is 20.5, which confirms the inverted-U shape. Shanghai during the period 1993-1998 has the highest degree of financial deregulation, and it is the only datum that exceeds the threshold. In other words, the majority of the Chinese provinces are located on the left and increasing part of the inverted-U shape. Therefore, the inverted-U shape is more of a diminishing returns story than a puzzle. This is evident by deriving the marginal effect of financial deregulation on growth based on equation (1). According to equation (1) the marginal effect of financial deregulation on growth is $(a_1 - a_2 FD_{it})$. Therefore, at the low degree of financial deregulation, the marginal effect of financial deregulation on growth is positive. However, as the degree of financial deregulation increases, its marginal effect would decrease and become negative at very high degree of financial deregulation. This complements the findings of Aghion et al. (2005) who introduce financial market frictions into an endogenous growth model to show that financial development matters for growth only at the early stage of economic development.

4 Robustness Checks

4.1 Overcoming the Possible Endogeneity of Financial Deregulation

Granger-causality tests cannot make sure that financial deregulation indicators are totally exogenous to the growth process (as is evident that coastal provinces receive more financial deregulation policies). Therefore, we may have the endogeneity problem of financial deregulation. That is, there may exist reverse causality from economic growth to financial deregulation. We use exogenous contemporary weather indicators as instruments for financial deregulation as well. Our identification strategy concurs with Levine (2003, 73-75): "we need a fuller understanding of what determines financial development...This broad spectrum of work suggests that finance may be influenced by ... geographical factors." The weather conditions are possible instruments because when choosing provinces to conduct piece-meal financial deregulation the Chinese government picks those provinces with superior geographical conditions including weather. The is evident from figures 1 and 2, according to which the coast provinces that have superior weather conditions like temperature and rainfall tend to have more deregulation policies. Therefore, we argue that the weather conditions impact economic development via the intermediate channel of financial deregulation.

4.1.1 Constructing weather indicators

The Weather Yearbook of China (WYC) 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 WYC 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 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"[8] 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 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. Generally the weather indicators are significantly correlated with one another.

4.1.2 System GMM estimation results

We treat all the variables (including financial deregulation and its square) except the time dummy in equations (1) and (2) as endogenous and use the constructed seven weather indicators as instruments. In so doing, we can examine whether there is a causal inverted-U relationship between financial deregulation and growth. The results are presented in Table 4.

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

Regression 4.1 reports the results with banking deregulation (FD) with the lagged value of the dependent variable as the sole control variable. One can see that the results are similar to those in regression 3.1 in Table 3. The estimated coefficient on banking deregulation, FD, is positive and significant at the 1% level, and that on its square is negative and significant at the 5% level. The F-test for the joint significance of banking deregulation and its square shows that the inverted-U relationship between banking deregulation and growth is significant at the 5% level. The Hansen test of over-identification produces a p-value of 0.15, showing that the instruments as a group are valid. In regression 4.2 we further control for conditional convergence and other growth determinants as derived in Mankiw et al. (1992). One can see that the estimated coefficient on banking deregulation, FD, remains positive and significant at the 1% level, with similar magnitudes. The estimated coefficient on its square (FD^2) remains negative, which becomes significant at the 10% level. The F-test for the joint significance of banking deregulation (FD) and its square (FD^2) shows that the inverted-U shape between financial deregulation and growth is significant at the 1% level. The estimated coefficient on initial real output per worker is negative and significant at the 5% level, showing strong evidence of conditional convergence. The estimated coefficients on ln(School) and $ln\left(\frac{I}{Y}\right)$ are positive as expected but insignificant at the 10% level. The estimated coefficient on $ln\left(n+g+\delta\right)$ is positive and significant at the 10% level. The p-value of Hansen over-identification test increases to 0.20, which means we accept the null that the instruments as a group are valid. The results are very similar when we use the whole financial deregulation policy indicator, F-total. The results are reported in regressions 4.3 and 4.4 in Table 4. Using the results from regression 4.4, we have calculated the threshold of financial deregulation for its marginal effect to be negative on growth. The threshold value 18.10 is lower than Shanghai's value of F-$total$ during the period 1993-1998 is 20.5, which confirms the inverted-U shape.

[Table 4 Here]

In summary, the inverted-U relation between growth and financial deregulation holds up when we overcome the potential endogeneity problem of financial deregulation. Therefore, the inverted-U relation is causal.

4.2 Alternative Empirical Specification

In the previous sections we assume that the growth rate follows an AR(1) (autoregression) process. Given a dynamic panel data specification, system GMM (Arellano and Bond, 1991; Roodman, 2006) can be used to deal with the potential endogeneity problem of all independent variables including financial deregulation. Nevertheless, it is worth checking whether our results are robust to alternative specifications such as the one derived in Mankiw et al. (1992) and commonly used in growth regressions. That is, we use the conditional convergence specification and drop the lagged dependent variable from the regressors. Following Mankiw et al. (1992), our empirical specification becomes

$$\begin{aligned} g_{it} = a_0 + a_1 FD_{it} - a_2 FD_{it}^2 + a_3 \ln\left(\frac{Y}{L}\right)_{i,t-1} &+ \alpha_4 \ln\left(\frac{I}{Y}\right)_{it} \\ + \alpha_5 ln\left(n+g+\delta\right)_{it} + \alpha_6 \ln\left(School\right)_{it} &+ T_t + \gamma_i + \epsilon_{it} \end{aligned} \tag{5}$$

where $\ln\left(\frac{Y}{L}\right)_{t-1}$ is initial real GDP per worker to capture conditional convergence.

However, with this specification, we cannot deal with the potential endogeneity problem of all independent variables. Especially, we cannot use the weather indicators as instruments to deal with the potential endogeneity problem of financial deregulation. The reason is that, even we use limited-information maximum likelihood (LIML) estimation (see Stock and Yogo, 2002; Hahn and Hausman, 2005) to deal with weak instruments,[9] the under-identification test always yields a p-value much above 10%, meaning the instruments do not have enough identification power besides being weak. Therefore, considering the Granger-causality tests above, we present the OLS (ordinary least squares) regression results.

According to the results in Table 5, the estimated coefficient on banking deregulation, FD, remains positive and significant at the 1% level, and that on its square (FD^2) remains negative and significant at the 5% level. The magnitudes are similar to those in regression 3.2 in Table 3. The F-test for the joint significance of banking deregulation (FD) and its square (FD^2) shows that the inverted-U shape between financial deregulation and growth is significant at the 1% level. The estimated coefficient on initial real output per worker is negative and significant at the 1% level, showing strong evidence of conditional convergence. The estimated coefficient on ln(School) remains positive but becomes significant at the 1% level. The estimated coefficient on $ln\left(\frac{I}{Y}\right)$ is positive but insignificant at the 10% level. The estimated coefficient on $ln\left(n+g+\delta\right)$ becomes negative and significant at the 10% level, which is predicted in Mankiw et al. (1992). The results are weaker with

[9] Andrews and Stock (2005) state that a decade ago 2SLS was always used without thought about the strength of instruments, but now the common approach is to use 2SLS if instruments are strong and to adopt a robust strategy if instruments are weak. Stock and Yogo (2002) show that LIML estimation is far superior to 2SLS when researchers have weak instruments.

financial deregulation (*F-total*). The estimated coefficient on financial deregulation (*F-total*) remains positive and significant at the 5% level, and that on its square remains negative but becomes insignificant at the 10% level. The F-test for the joint significance of financial deregulation and its square shows that the inverted-U shape between financial deregulation and growth is significant at the 10% level.

4 Conclusions

Without existing financial distortions generated in the central planning regime before 1978, there would be little sense for the Chinese government to conduct financial deregulation for higher growth. After those financial distortions are gradually removed, China has experienced large provincial variations in growth performances (see Demurger et al., 2002). It is meaningful to examine whether provincial variation in financial deregulation drives the provincial variation in growth rates. This is not only important for China to reflect on its financial deregulation, but meaningful for other developing countries to learn from the Chinese experience. We find robust evidence that growth is inverted-U related to the degree of financial deregulation. The inverted-U shape holds up when we control for conditional convergence, other growth determinants, and time and province effects. The inverted-U relation also holds up when we overcome the potential endogeneity problem of financial deregulation and other independent variables by system GMM estimation. Therefore, the inverted-U relation is causal. One possible explanation is as follows.

Based on the distribution of the property rights on inventions between entrepreneurs and households, we develop a theory that predicts an inverted-U relation between entrepreneurs' inventive incentive (EII, i.e., their contractual share in the monopolistic profit from each innovation) and growth. We argue that, it is more likely that entrepreneurs' share increases in the gradual financial deregulation process of China. As discussed in section 1.1, before the financial deregulation was initiated in 1978, the Chinese government controlled credit allocation. There was one only giant bank, the People's Bank of China (PBC) that worked as the central bank and commercial banks. PBC worked under the command of the government that favored SOEs (state-owned enterprises) in credit allocation. Private and individual firms were almost non-existent and had no access to bank credit. Since 1978, the Chinese government gradually deregulated the financial system to introduce market forces in credit allocation. The competition among banks is gradually enhanced by setting up four large state-owned banks from the PBC and by allowing the entry of new financial intermediaries. Private, individual and foreign enterprises are gradually allowed and even encouraged to apply for credit from banks (e.g., Branstetter and Freenstra, 2002). From no access to limited access and then to free access to bank credit, we should expect entrepreneurs, especially private and individual ones, to get more inventive incentive as gradual financial deregulation progresses. This is supported by Li et al.'s (2009) finding that entrepreneurs' inventive spirit unleashed by gradual reform has a causal effect on the economic growth of China for the period 1983-2003. Following Li et al., we argue that China's financial deregulation gradually increased EII. Therefore, financial deregulation can proxy for EII, which explains the observed inverted-U relation.

There are other possible explanations, but we leave them to future research. What we try to achieve in the current paper is to identify the relationship between financial deregulation and economic growth. Another next step would be, for instance, identifying the mechanisms/channels by which financial deregulation policies may affect growth.

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Table 1: Financial deregulation policy indicators

Domestic financial deregulation (FD)	Banking Sector	Deregulation policies on existing banks;
		The entry of new banks;
		The other banking sector policies;
	Non-bank Sector	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
growth (annual, %)	6.47	2.26	2.00	12.00
FD	1.41	2.24	0	11.49
$\ln(Y/L)_{t-1}$	7.39	0.62	6.21	9.42
ln(School)	2.25	0.24	1.76	2.84
ln(I/Y)	3.67	0.22	3.14	4.32
$\ln(n+g+\delta)$	2.32	0.14	1.93	2.61

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 growth, FD and $ln(\frac{Y}{L})_{t-1}$, all other variables are multiplied by 100 and then taken logarithms.

Table 3. Regressions between Financial Deregulation and Economic Growth

Dynamic panel-data estimation, one-step system GMM

Dep. Var.: Average Annual Growth Rate of Real GDP per worker 1987-92, 1993-98

	Regression number			
Independent Variable	3.1	3.2	3.3	3.4
FD	0.88**	1.95***		
	(0.35)	(0.53)		
FD^2	−0.06*	−0.08**		
	(0.03)	(0.04)		
F-total			0.54***	1.66***
			(0.20)	(0.51)
F-total^2			−0.02**	−0.05***
			(0.01)	(0.02)
$g_{i,t-1}$	1.34***	−0.30	1.39***	−0.33
	(0.10)	(0.19)	(0.09)	(0.20)
$\ln\left(\frac{Y}{L}\right)_{i,t-1}$		−3.60*		−4.01**
		(1.79)		(1.90)
$\ln(School)$		4.02		5.33*
		(2.85)		(3.12)
$\ln\frac{I}{Y}$		2.82		1.53
		(3.81)		(4.17)
$\ln(n+g+\delta)$		6.79*		9.21**
		(3.60)		(4.20)
Time Fixed Effects	Yes	Yes	Yes	Yes
F-test on FD and FD^2:	9.23	8.08	11.59	5.91
(prob. of F)	(0.001)	(0.002)	(0.0002)	(0.008)
Hansen OverID test (p-value)	13.18 (0.11)	17.96 (0.12)	12.20 (0.14)	17.42 (0.14)
Observations	54	54	54	54

Notes: Endogenous variables:

3.1 and 3.3: $g_{i,t}$ and $g_{i,t-1}$

3.2 and 3.4: $g_{i,t}$, $g_{i,t-1}$, $\ln\left(\frac{Y}{L}\right)_{i,t-1}$, $\ln(School)$, $\ln\frac{I}{Y}$, $\ln(n+g+\delta)$.

Instruments used: in 3.1 and 3.2: ln(Temper), ln(Sunshine), ln(Rainfall), Tempdiff, Tempvar1, Tempvar2, Sunvar, time dummy, FD, and FD^2; in 3.3 and 3.4: ln(Temper), ln(Sunshine), ln(Rainfall), Tempdiff, Tempvar1, Tempvar2, Sunvar, time dummy, F-total and F-total^2.

***Significant at the 0.01 level, ** at the 0.05 level, * at the 0.10 level

(standard errors in parentheses)

Table 4. Regressions between Financial Deregulation and Economic Growth

Dynamic panel-data estimation, one-step system GMM

Dep. Var.: Average Annual Growth Rate of Real GDP per worker 1987-92, 1993-98

	Regression number			
Independent Variable	4.1	4.2	4.3	4.4
FD	1.87^{***}	2.29^{***}		
	(0.59)	(0.65)		
FD^2	-0.10^{**}	-0.11^{*}		
	(0.05)	(0.06)		
F-total			1.51^{***}	1.70^{***}
			(0.54)	(0.54)
F-total^2			-0.04^{**}	-0.05^{**}
			(0.02)	(0.02)
$g_{i,t-1}$	1.02^{***}	-0.31	0.99^{***}	-0.29
	(0.19)	(0.19)	(0.20)	(0.21)
$\ln\left(\frac{Y}{L}\right)_{i,t-1}$		-4.31^{**}		-3.84
		(1.95)		(2.27)
$\ln(School)$		4.67		4.71
		(3.88)		(4.37)
$\ln\frac{I}{Y}$		3.44		2.13
		(3.42)		(4.04)
$\ln(n+g+\delta)$		7.42^{*}		8.05^{*}
		(4.09)		(5.54)
Time Fixed Effects	Yes	Yes	Yes	Yes
F-test on FD and FD^2:	5.30	8.98	3.98	5.55
(prob. of F)	(0.011)	(0.001)	(0.03)	(0.0096)
Hansen OverID test (p-value)	14.63 (0.15)	18.12 (0.20)	13.89 (0.18)	17.46 (0.23)
Observations	54	54	54	54

Notes: Endogenous variables: all independent variables except time dummy

Instruments used:

ln(Temper), ln(Sunshine), ln(Rainfall), Tempdiff, Tempvar1, Tempvar2, Sunvar, time dummy

***Significant at the 0.01 level, ** at the 0.05 level, * at the 0.10 level

(standard errors in parentheses)

Table 5. OLS Regressions between Financial Deregulation and Economic Growth

Dep. Var.: Average Annual Growth Rate of Real GDP per worker 1981-86, 1987-92, 1993-98

	Regression number	
Independent Variable	5.1	5.2
FD	1.10^{***}	
	(0.35)	
FD^2	-0.07^{**}	
	(0.03)	
F-total		0.55^{**}
		(0.26)
F-total^2		-0.019
		(0.012)
$\ln\left(\frac{Y}{L}\right)_{i,t-1}$	-6.50^{***}	-5.51^{***}
	(1.87)	(1.93)
$\ln(School)$	5.63^{***}	5.36^{***}
	(1.68)	(1.76)
$\ln\frac{I}{Y}$	1.21	0.91
	(2.42)	(2.57)
$\ln(n+g+\delta)$	-3.71^{*}	-4.08^{*}
	(2.12)	(2.29)
Time Fixed Effects	Yes	Yes
Province Fixed Effects	Yes	Yes
F-test on FD and FD^2:	5.63	2.61
(prob. of F)	(0.007)	(0.08)
R^2	0.86	0.84
Observations	81	81

***Significant at the 0.01 level, ** at the 0.05 level, * at the 0.10 level

(standard errors in parentheses)

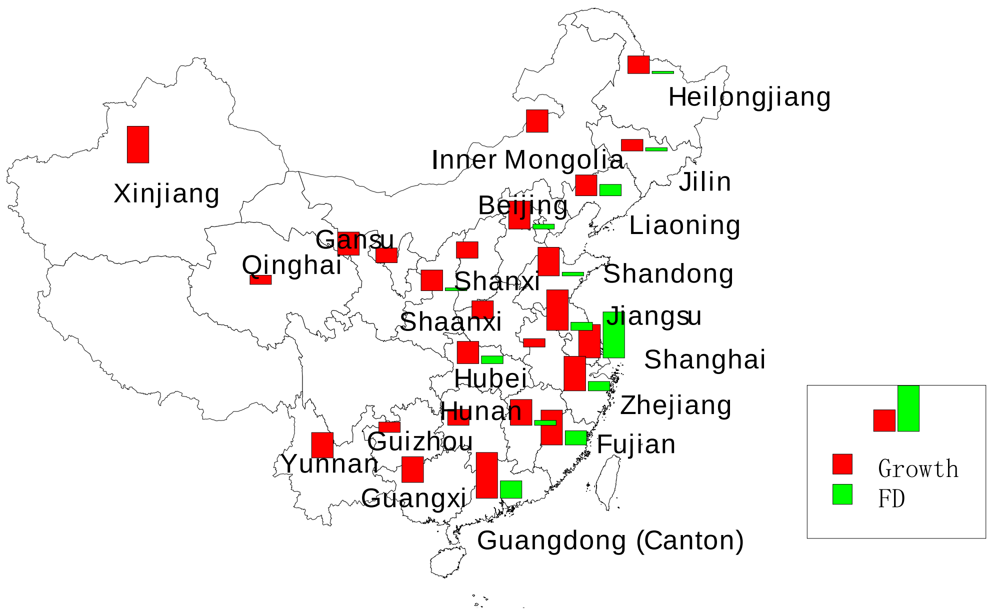

Figure 1. Provincial Variation in Annual Growth and Financial Deregulation (1987-1992)

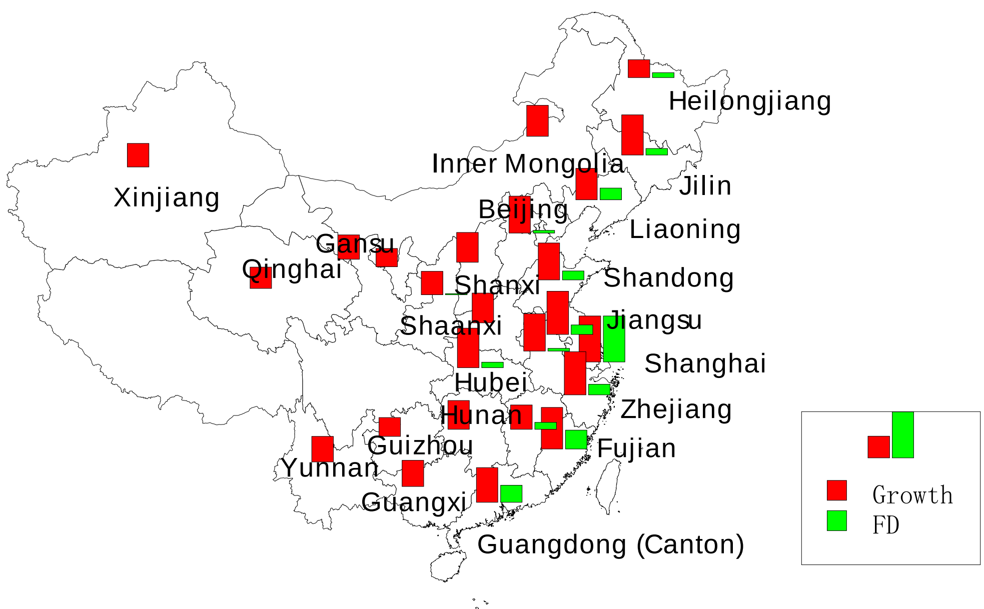

Figure 2. Provincial Variation in Annual Growth and Financial Deregulation (1993-1998)