Interprovincial competitiveness and economic growth: Evidence from Chinese provincial data (1992-2008)

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Abstract

This paper assesses the role of the internal real exchange rate as a competitiveness indicator in economic growth among provinces in China. Using data from 28 Chinese provinces for the period 1992–2008 together with dynamic panel data estimation, the results report a positive effect of real exchange rate appreciation on economic growth. In other words, a competitive internal real exchange rate has not been found supporting provincial economic growth.

Keywords: Real exchange rate, economic growth, China, generalized method of moments

JEL classifications: O53, F31

1 Introduction

China's spectacular growth is often attributed to mercantilist policy followed by Chinese government: keeping the Chinese yuan cheap (i.e. low level of nominal exchange rate expressed as number of foreign currency per yuan) combined with capital controls and intervention, leading to trade surpluses and boosted growth. But if any form of exchange rate has an impact on trade imbalance and growth, what really matters should be the real exchange rate (RER hereafter), though it is rarely mentioned in the policy debate. Defining the RER as the relative price of tradable to nontradable goods, Edwards (1989) claims that it is a fairly good proxy of a country's degree of international competitiveness. Eichengreen (2007) argues that both keeping the RER at competitive levels and avoiding excessive volatility are important for economic growth.[2] If the RER is measured for each Chinese province, it provides an indicator of interprovincial competitiveness and will have some explanatory power on their economic performance (such as real provincial GDP per capital). The reason is that it captures the internal relative price incentive in a particular province for producing or consuming tradable as opposed to nontradable goods. Hence it is also an indicator of domestic resource allocation incentives in that province. Since the RER is used to measure the interprovincial competitiveness, it means that the lower the RER of a province is in contrast to that of another province, the more competitive this province becomes in terms of relative price. Given the increasing disparity of growth rate at the provincial level (Chen and Zheng, 2008), one may wonder whether a competitive RER, a low level of RER, spur provincial economic growth? To answer this question, I study the impact of provincial RER on economic growth and investigate whether an active management of the RER (i.e., provincial policies influencing the domestic prices determination of different types of goods) contributes to rebalance economic growth among provinces.

To assess the impact of the internal RER level on provincial growth, I apply the "*informal growth regression*" to a panel data set of 28 Chinese provinces. Using dynamic panel estimated by the generalized method of moments for system of equations (system-GMM estimation hereafter), I find that an appreciation of the internal RER boosts provincial economic growth. This implies that an increase of price of nontradables (relative to tradables) of a province spurs its growth. Estimate using fixed effect model confirms the relationship. Various channels can account for the positive effect reported here, among which a redistribution of resources between sectors, an improvement of the managerial and technological efficiency of monopolistic state-owned enterprises, a wealth effect stemming from the prosperity of agricultural and service sectors, and/or the rising real wages and productivity of workers. But the results also show - in contrast to the conventional wisdom - that it is not the competitive internal RER - i.e., a low level of internal RER of a province relative to other provinces - that promotes provincial economic growth. Moreover, based on diagnostics of spatial autocorrelation, I do not find a spatial dependence between Chinese provinces during the process of growth once the determinants of growth are controlled for. This implies that there is no growth spillover from one province to its neighbouring provinces and validates the use of system-GMM as the main estimation tool.

This paper is the first to consider the impact of RER on growth rates in China both measured at the provincial level. Compared to papers examining the link between the RER and economic growth across countries,[3] this allows reducing the severity of parameter heterogeneity (Temple, 1999). In this way, the policy implication derived from the regional framework should be more appropriate for China than the conclusion stemming from a heterogeneous cross-country setting. Second, this paper is the first that measures the internal RER of the 28 Chinese provinces, with internal RER defined as the relative price of tradable to nontradable goods (see, e.g., Salter 1959 and Bruno 1976).[4] Because the measures of internal RER have been less readily available for developing countries (Hinkle and Nsengiyumva, 1999b), economists have in fact used external RER measures as a proxy of RER in much of their empirical work , although they often prefer to work with theoretical models using internal RERs (see, e.g., Devarajan, Lewis, and Robinson, 1993; Edwards, 1989 and Elbadawi, 1994).[5]

The remainder of the paper is organized as follows. The next section discusses the theoretical mechanism through which the internal real exchange rate may impact growth. Section three presents the empirical methodology and the specification of the informal growth regression in panel data setting. Section four describes the variables chosen as determinants of China's provincial economic growth and the new data used. Section five presents the results of regressions with the various estimators. The final section concludes.

2 The link between RER and growth: a discussion of channels of transmission

The real exchange rate only recently entered theoretical models of economic growth (see, e.g., Rodrik 2008). There has been a gradual recognition of the real exchange rate's role in the growth process (see, e.g., Eichengreen 2007, for this discussion). Two views maintain the existence of an impact of RER on growth. The first view argues that the persistent misalignments of RER harm growth via the distortions of this key relative price. It also argues that the RER volatility has a harmful effect on growth because it tends to obscure an important macroeconomic relative price signal. This view was concerned with the short-run (or temporary) impact, and was labeled "traditional disequilibrium view" by Montiel and Servan (2010). The other view – pioneered by Hausmann and Rodrick (2004) and labeled the "new view" by Montiel and Servan, focuses on the impact on growth of highly persistent departures of RER from its equilibrium level. In a nutshell, the "new view" stresses the growth effects of the equilibrium RER level, in which a depreciated equilibrium RER promotes economic growth.

A number of papers discuss on the channels that may be effective in generating an impact of RER on growth and on the expected sign of this effect. McDonald (2000) argued that the exchange rate impacts economic growth through their influence on international trade and on investment. Regarding the first channel, real exchange rate movements affect export and import, and specialisation stemming from the international trade can affect growth via resource relocation, TFP growth or technology updating. As for the second one, a depreciated exchange rate tends to increase the domestic saving rate and a higher saving rate simulates growth by increasing the rate of capital accumulation (see, Frenkel and Taylor, 2006; Levy-Yeyati and Sturzenegger, 2010; Gala, 2008; Rodrik, 2008; Montiel and Servén, 2008; Razmi et al., 2012). Overall, the consensus view is that the real exchange rate can facilitate but not by itself sustain economic growth, though an appropriate exchange rate policy can make it easier for a country to capitalize on its growth opportunities (Eichengreen 2007).

Rodrik (2008) takes into account the size of a country's tradable sector to explain the positive impact of an undervalued real exchange rate on economic growth. He argues that the tradable sector suffers more than the nontradable sector from institutional weakness and/or market failure. In that situation a currency undervaluation shifts resources away from nontradable sectors and towards industry and would thus constitute a subsidy policy that have the effect of spurring the production of tradables and generating more rapid growth. There is no doubt that price distortions exist in China's industries and tradable sectors. Yet the changes observed during its transition from a planned to a market economy may be explained by reforms in other sectors besides the undersized tradable sector that characterizes developing countries. For instance, some nontradable sectors in China, including agriculture and service, have suffered from price distortions and have been also undersized (see e.g., Huang et al. 2007). During the post-1978 reforms, the government eliminated many of the price distortions that had been previously imposed. Before China's economic opening, the priority given to industrial development (and the need to ensure a source of fiscal revenues) led the government to set high prices for industrial production; in relative terms, then, agricultural products and services were undervalued. The gradual opening of the economy to competition and international trade—along with the elimination of government price controls—decreased the price of tradable goods relative to the price of services and agricultural products (Naughton 2007, pp. 154–155).

While reducing price distortion, the increase of the prices of the nontradable goods (i.e. a real appreciation) can facilitate economic growth through four channels. First, an internal RER appreciation will reallocate resources between the tradable and the nontradable sectors. Second, it could not only put pressure on monopolistic (or collusively oligopolistic) firms often dwelling in inland provinces to improve their managerial and technical efficiency and spur a more balanced economic growth in the medium and long term. Third, an increasing internal RER generates a wealth effect by enriching the agricultural and service sectors—or the provinces that specialize in these sectors—and increasing the demand and consumption of tradable and nontradable goods both. Fourth, but no less important, an increase in the price of nontradable goods may induce a rise in the real remuneration of workers and hence improvement in 'X-efficiency', as proposed by Leibenstein (1966).

3 Empirical methodology

Empirical research on China's economic growth includes a few studies that use the cross-country approach (with panel and/or cross-sectional data; see Ding and Knight 2009, Li *et al*. 1998, Rodrik 2008), while a large body of empirical studies focuses on interprovincial growth in China. Two main empirical approaches are commonly used.[6] The first amounts to estimating variants of the neoclassical growth model, often the augmented Solow model - as pioneered by Mankiw *et al*. (1992) - which provides a simple theoretical framework for growth regressions.[7] The second widely used approach is the informal growth regressions (Barro 1991, Barro and Sala-i-Martin 2004), which use economic theories of growth as a guide and in which variable selection is driven by previous results in the literature. The empirical approach adopted in this paper is the informal growth regressions extended to a panel data setting (Islam 1995).

The informal growth regression with panel data is written as

$$\Delta y_{i,t} = \alpha + \beta y_{i,t-1} + \delta X_{i;t} + f_t + f_i + \varepsilon_{i,t} \qquad (1)$$

for $i = 1, \ldots, N$ and $t = 2, \ldots, T$, where "i" designates a Chinese province and "t" is a five-year period. Here $\Delta y_{i,t}$ is the average growth rate of the real *per capita* income of a province over a five-year period t, $y_{i,t-1}$ designates the initial level of income of that period (income measured at the end of period *t-1*), X is a vector containing the internal RER and control variables that are averaged during the period for flow variables or measured at its beginning for the stock variables)[8], f_i denotes unobserved province-specific factors reflecting differences in the initial level of technical efficiency, and f_t is a time-specific effect that captures the productivity changes common to all provinces (see Cottani *et al*. 1990, Ding and Knight 2009, Ghura and Grennes 1993). Equation (1) can be rewritten as

$$y_{i,t} = \alpha + (\beta + 1) y_{i,t-1} + \delta X_{i;t} + f_t + f_i + \varepsilon_{i,t} \quad (2)$$

which is a dynamic panel data specification with a lagged dependent variable on the RHS.

Traditional ordinary least-squares (OLS) estimator for equation (2) is biased and inconsistent in the presence of the correlation between the lagged dependent variable and the time-invariant country-specific effects. A fixed-effects estimator allows isolating the effect of "capital deepening" and technological and institutional differences in the process of convergence. It also allows correcting the omitted variable bias. Nevertheless, the coefficient for initial income is likely to be seriously biased downward in a small sample with limited time span (Nickell 1981).

To correct this bias, as suggested by Arellano and Bover (1995) and Blundell and Bond (1998), I use a *system*-GMM estimator which uses moment conditions for a system of both the first-differenced equations and the original ones in levels: lagged levels of the RHS variables are used as instruments in the first-differenced equations, and lagged first-differences are used as instruments in the original equations. This estimator is demonstrated by Bond *et al*. (2001) to have a superior performance on finite samples: including the equations in levels in the system yields efficiency improvements as well as a significant reduction in the large bias suffered by the first-differenced GMM estimator.[9] Moreover, system-GMM approach (as first-differenced GMM) obtains potentially consistent parameter estimates, even in the presence of measurement error and endogenous RHS variables (Bond *et al*., 2001).

4. Variables and data

In this section, I discuss the definition and measurement issue of real exchange rate and control variables, and present how the proxies for those variables are constructed.

4.1 Variables

The measurement of the RER for Chinese provinces is not straightforward and the difficulties are both conceptual and empirical (Montiel and Hinkle 1999).[10] In the standard, two-sector framework of a small open economy in which each of the two sectors produces a different type of goods, the RER is often defined as the relative price of tradable to nontradable goods produced by those two sectors, also known internal RER.[11] I adhere to this framework and directly measure an internal RER for each of the 28 Chinese provinces. This internal RER is expressed in logarithmic form: $\ln RER_i = \ln(P_{i,t}^{T} / P_{i,t}^{NT})$. An increase in the value of the internal RER indicates a real depreciation in a Chinese province. Precisely, I focus the level of the RER rather than its misalignment (overvaluation or undervaluation relative to the equilibrium RER) which is beyond the scope of this paper.[12]

To account for China's provincial economic growth, I include in the growth regressions the following control variables that are widely acknowledged as driving growth.[13]

First, the conditional convergence hypothesis assumes that, countries having a lower per capita GDP relative to other countries grow more rapidly owing to higher marginal returns on physical capital stock, after differences in the steady states across countries have been controlled for (Sala-i-Martin, 1996). I included the initial level of real per capita GDP to control for conditional convergence.[14]

Second, growth is expected to be positively associated with investment and capital accumulation (Solow, 1956) but negatively associated with population growth. High population growth reflects greater resources devoted to child rearing and reduces private and public capital formation.[15] I include the investment share and the population's natural growth rate.

Third, human capital has a positive effect on economic growth (see Lucas 1988). Chen and Fleisher (1996), Fleisher and Chen (1997), and Démurger *et al*. (2002) provide evidence that education at the secondary or collegiate level helps account for observed differences in Chinese provincial growth rates. However, there is no consensus on the measurement of this capital. Previous proxies for human capital measure the rate of gross secondary school enrolment (see Barro 1991, Bond *et al*. 2001, Caselli *et al*. 1996, Mankiw *et al*. 1992) or the average years of schooling in the population.[16] In addition to using the gross secondary enrolment rate, I follow Fleisher *et al*. (2010) and calculate the fraction of those in the total population who have at least a senior high school education as another proxy for the stock of human capital.[17]

Fourth, a major force pushing the economy toward a market economy has been the introduction of foreign ownership through foreign direct investment (FDI) (Fleisher *et al*. 2010). Through its potential to bring in new production and managerial technologies, FDI has facilitated the transformation of China's state-owned and collective sectors (Liu 2008). I include this variable in my growth regressions.

Fifth, both neoclassical trade models and endogenous growth literature argue that the openness has a positive role on economic growth and poverty reduction, either via comparative advantage or via diffusion of technology or economies of scale (e.g., Grossman and Helpman, 1991). Regressions then include provincial trade openness, measured by a simple trade share.[18]

Sixth, provincial disparity in growth rates may be linked to geographical (or locational) factors (Chen and Fleisher 1996): e.g., coastal provinces versus inland ones. Furthermore, the differences in preferential open-door policies at the provincial level might also lead to growth disparity. Various types of economic zones created only in some regions show that the provinces benefited disproportionately from this open-door policy, which consisted of attracting FDI and promoting foreign trade in targeted economic zones. Démurger et al. (2002) constructed an annual index of the level of open-door preferential policies for each province during the period 1978–1998, by giving each province a weight that reflects the type of economic zone that it hosts.[19] Thus, these two factors may combine to yield a direct effect on the openness of trade as well as an indirect effect on other sources of growth (e.g., technological progress) via attracting foreign investment. I include these variables in my regressions.

4.2 Data

The data set is compiled from several sources: the *China Compendium of Statistics 1949–2008* (CCS), published in 2010; the *China Statistical Abstract 2010* (CSA); various issues of the *China Statistical Yearbook* (CSY) and of the *China Population Statistical Yearbook* (CPSY); and the *China Population and Employment Statistics Yearbook 2009* (CPESY).

The sample includes 28 provinces for the period 1992–2008.[20] The first year corresponds to the beginning of second phase of transition during which Chinese economic institutions converge as well towards those of other economies in transition (see Naughton, 2007).[21] The sample ends with the advent of the global financial crisis which had an impact on China's reform and growth processes (e.g., the Chinese central bank returned to pegging the RMB - Chinese currency - to the US dollar in July 2008, the temporary interruption to the reform process that was caused by the global financial crisis (IMF,2010).). The choice of the sample period was also driven by the data availability.

To mitigate the influence of temporary factors associated with business cycles, the variables are measured over a non-overlapping five-year interval, as is common in the literature.[22] The nonstationarity of the annual series of some variables is a second reason for this choice.[23]

The dependent variable is the five-year average growth rate of real income of each Chinese province, measured as the log difference in real per capita GDP over a five-year period divided by five (*g,* see Figure 1). To reduce measurement errors, the series of nominal GDP per capita are constructed using the revised series built in the national economic census of 2008.[24] They are deflated by provincial CPI and calculated in terms of 2000 RMB.

Two measures of internal real exchange rate are used. First I include the logarithm of the relative price of tradable to nontradable goods (*lr1*, see Figure 2) and second the logarithm of the inverse of the price of nontradable goods (*lr2*) – assuming that the law of one price holds for the tradable goods and that the provincial price indexes of tradable goods are the same all over China. The prices of tradable goods (P^{T}) and nontradable goods (P^{NT}) are represented, respectively, by the producer price index[25] and the consumer price index.[26]

The proxies for the control variables entered in the regressions are as follows: The logarithm of real GDP per capita at the beginning of each five-year period (*ly_1*) as the proxy for the initial level of income; the share of the gross capital formation in GDP (*invest*2*gdp1*) and the share of the fixed capital formation in GDP (*invest*2*gdp2*) as proxies for investment share; the ratio of gross secondary school enrolment to total population (*school1*) and the share of those who have at least some senior high school education (*school2*) as proxies for human capital; the population's natural growth rate (*popgr*) as the proxy for population growth; the share of FDI in GDP (*fdi*2*gdp*) and in gross capital formation (*fdi*2*invest*) as proxies for FDI share; and the ratio of total international trade, both export and import, to GDP (*trade*2*gdp*) as the proxy for trade openness. For the location variable, I use a simple indicator equal to 1 for coastal provinces and to 0 otherwise (Ding and Knight 2008).[27] For the level of policy preference, as Maasoumi and Wang (2008), I create two dummy variables (*policy_dum2* and *policy_dum3*) based on the categorical variable (*policy_var*) reported in Pedroni and Yao (2006).[28] The definitions of all variables and their sources are summarized in Table A1.

[[INSERT Figure 1 about Here]]

[[INSERT Figure 2 about Here]]

5 Results

The literature on economic growth has seen a wide application and continued development of GMM estimations, I focus on the regressions based on the system-GMM estimator.[29]

[[INSERT Table 2 about Here]]

[[INSERT Table 3 about Here]]

5.1 Regressions with system-GMM estimator

Here I implement the one-step system-GMM estimator via the 'xtabond2' module of Stata 10 (Roodman 2003).[30] The *p*-values of Hansen tests indicate the overall validity of the instruments used in all models presented in Table 4. The Arellano–Bond AR (2) test confirms that the differenced error term is not second-order serially correlated. (By construction, the differenced error term is probably first-order serially correlated; this is suggested by the *p*-values of the Arellano–Bond AR(1) test.)

[[INSERT Table 4 about Here]]

Table 4 presents the results of this dynamic panel specification. Model 0 is the baseline model estimated via the system-GMM estimator. Model 1 (resp., 1a and 1b) adds the real exchange rate (resp., lr1 and lr2). Model 2 (resp., 2a and 2b) is the same as Model 0 but adds dummy variables for location and policy preference level (resp., *loca_dum*, and *policy_dum2* and *policy_dum3*). Model 3 (resp., Model 4) includes the internal RERs (resp., *lr1*and *lr2*) and the location dummy in addition to the control variables of Model 0; similarly, Models 5 and 6 add the internal RER and the policy preference level variable.

Two points are worth noting. First, the internal RER is significant in several models when proxied by *lr1* (but not by *lr2*). Thus, I focus on the relative price of tradable to nontradable goods that is proved be a better proxy of China's internal RER.[31] The coefficient for this variable is negative, which implies that an appreciation in the internal RER (that is the increase of the relative price of goods in agricultural or/and service sectors) has a positive effect on growth. Second, the fundamental determinants of growth—such as investment rate (*invest2gdp1*) and human capital (*school1*)—are significant in most of these dynamic models: the former in all models and the latter in several. The location dummy and one of the dummies for policy preference level (*policy_dum3*) are also significant, which points that those differences in location and in policy preference level (between the provinces receiving highest policy preference and the ones receiving lowest preference) have significant effects on growth. Other factors being equal, a coastal province will have a higher growth rate than an inland province and benefiting from a greater preference by the central government for opening SEZs increases significantly growth.

[[INSERT Table 5 about Here]]

To clarify the impact of the internal RERs on growth, I investigate further whether its effect differs with the province's location (coastal versus inland) or with the policy preference level. In other words: Does the internal RER have the same impact on growth in coastal provinces as in inland ones? Does it have the same impact in provinces with 'high' as in those with 'low' policy preference levels? To answer these questions, I introduce three interaction terms into the growth regressions (see Table 5). In Model 7, *loca_dum* × *lr1* is the interaction term of internal RER and the location dummy. In Model 8, *policy_dum2* × *lr1* and *policy_dum3* × *lr1* are the respective interaction terms of internal RER and the two dummies for policy preference level. In both models, the nonsignificance of the interaction terms indicates that there is no meaningful difference between these two groups of provinces in terms of how internal RER affects growth. Moreover, introducing these interaction variables does not change the sign of the internal RER and has little effect on its significance: the impact of an appreciation of the internal RER remains positive in both models and is significant in Model 7.

5.2 Spatial dependence diagnostics

Regressions of the previous sections implicitly assumed the cross-sectional independence of each province from each other during their growth process when estimating the growth models. However, there may exist some cross sectional interaction due to spillover effects of provincial growth performance. Here I investigate the regional dependence among the Chinese provinces by focusing on the spatial dimension.[32]

Anselin (2001) presents the spatial autocorrelation in two different ways: spatial error model and spatial lag model. The first model describes how a province's growth can be affected by a shock to the growth rate in surrounding provinces. The second one, often referred to as spatial autoregressive model, characterizes the spatial dependence by the dependent variable of surrounding provinces, which is similar to a lagged dependent variable. A third one, advocated by LeSage and Pace (2009), is the spatial Durbin model that contains a spatially lagged dependent variable and spatially lagged independent variables. In each of these model specifications, a spatial weight matrix (*W*) is used to describe the spatial arrangement of the cross-sectional provinces. To check the presence of spatial autocorrelation with the *W* and to discern its specific form in a panel data setting, one may use classic Lagrange Multiplier (LM) test proposed by Burridge (1980) and Anselin (1988) as well as robust LM tests which are proposed by Anselin et al. (1996) and generalized from a cross-sectional setting to a spatial panel setting (see Debarsy and Ertur, 2010).

Using the Matlab routine of Elhorst (2012) which provides the LM tests for the panel data setting, here I follow the strategy of Elhorst (2012) and estimate first a spatial Durbin model.[33] The construction of the model relies on the spatial weight matrix W, which is based on the spatial weight matrix of Yu (2009). By including alternatively a contiguity matrix, I also check whether the results of LM tests are robust to the use of alternative weight matrix. Table 6a and 6b report the results of LM tests applied to the residuals when adopting non-spatial models (various specifications presented in Table 2 and Table 3 for all provinces) with spatial fixed effects. When using the classic LM tests, neither the hypothesis of no spatially lagged dependent variable nor the hypothesis of no spatially autocorrelated error term can be rejected at 5%. Moreover, I observe similar test results for the two weight matrices (W1 and W2). Base on the spatial regression model selection rule of Anselin (2005), if neither rejects the null hypothesis, one can stick with the non-spatial model result without considering the robust forms of these two tests. In other words, there is no spatial autocorrelation in the growth models specified in the Table 2 and Table 3. Thus, with the similar model specification but estimated with system-GMM estimator (reported in Table 4) and some dummy variables, the estimation results do not suffer from the potential cross-sectional dependence due to the spatial autocorrelation.

Ying (2000, 2003) find some spatial autocorrelation in the growth process of China, however, the negative coefficient for the spatial lag variable suggests a polarizing process undergoing within the Chinese spatial economy (see Ying, 2003). Two possible reasons may explain the difference between his results and the mine in terms of spatial dependence: first, in both of his papers, the spatial models have only a cross-sectional dimension while I have implemented growth regressions in panel data setting with fixed-effects. Second, the dataset used in this paper covers a more recent period which could be qualified as a distinct phase of transition with convergence.

6 Concluding remarks

This paper uses the robust system-GMM estimator to implement a dynamic panel estimation of an informal growth equation applied to 28 Chinese provinces. I find that a real appreciation of the internal RER has a positive influence on provincial economic growth. This positive effect does not differ with the province's location (coastal versus inland) or with the policy preference level. Based on these evidences, it is not the competitiveness of RER that explains the high provincial growth rate. There are many circumstances that may require a deterioration in the competitive position (e.g., a real appreciation) of the tradable goods sector to reallocate resources and restore equilibrium (Lipschitz and McDonald, 1992).

Further studies and evidence are also needed to shed more light on the mechanisms—such as domestic savings and investment—through which the real exchange rate affects economic growth (cf. Bresser-Pereira 2006, Gala, 2008). Such studies would help to clarify the effectiveness of a country's RER policy as a tool for improving the structure of industry specialization and thereby ensuring sustainable growth. Closely related to the economic growth, the regional disparity has long been a concern of policy makers and economists (Hu et al., 1995; NDRC, 2010). Greater social and economic instability created by income disparities may obstruct the growth of China (Yang, 2002) and hence of other, low-income countries (Garroway et al., 2010). The issues at stake are whether this income disparity has been reduced and whether the management of the RER helps reduce the regional disparity and facilitate interprovincial convergence. Further research is needed to explore these issues.

Appendix A : Data

- **PPI**: The missing values from 1992 to 1996 for certain provinces correspond to Shanxi (1992–1994), Jilin (1992–1996), Fujian (1992–1994), Hubei (1992–1994, 1996), Guangdong (1992–1996), Guizhou (1992–1993), Gansu (1992), and Ningxia (1992–1996). The missing values were replaced with the country PPI for the corresponding year (as extracted from the CSY of 2000, 2001, and 2002).
- **Trade openness:** For the period 2005–2008, the values of imports (resp., exports) are calculated in terms of their provinces of destination in China where the imported commodities are consumed, used or transported to (resp., their

provinces of origin in China where the exported commodities are produced or originally delivered); the only alternative statistics available at the provincial level for this period are based on the location (i.e. province) where import or export corporations are situated, i.e., where they have applied and have registered at the Chinese Customs. The calculation method of foreign trade is not specified for the years prior to 2005.

[[INSERT Table A1about Here]]

[[INSERT Table A2about Here]]

Appendix B : Estimations with fixed-effects model

This appendix describes the steps of investigation with fixed-effects estimations. For the baseline model — which includes initial income, the investment ratio, the population's natural growth rate, and the rate of secondary school enrolment — the results are reported in Table 2. Based on the Hausman specification test (Hausman 1978), I choose the fixed-effects model and then estimate equation (1) on three samples (all provinces, the inland ones, and the coastal ones) using two proxies for the ratio of investment and two for human capital. Except for the variable of human capital (see the coefficients for *school1*), every control variable of economic growth is correctly signed; however, the significance levels are not always sufficient to validate the assumptions. Among these regressions, knowing that for each sample three regressions are run using alternative proxies for the investment ratio and for human capital, the significance of the initial income per capita (*ly_1*) indicates that there is conditional convergence for the coastal provinces and the whole sample but not for the group of inland provinces. However, the ratio of investment to GDP (*invest2gdp1* and *invest2gdp2*) and the population's natural growth rate (*popgr*) are significant for the whole sample and for the inland provinces, too. As for human capital, only the proportion of those with at least a senior high school education (*school2*) is significant—and only for the inland provinces.

Next I incorporate the two other control variables (e.g., FDI, trade openness) and the variable of interest, internal RER, into the growth regression; the results are reported in Table 3. There are two main differences relative to the baseline model reported in Table 2. First, the results indicate a conditional convergence for all three samples. Second, the effect of human capital on growth is significant for the sample as a whole and also for the inland provinces. In other words, it is not human capital that drives the economic growth of the most dynamic coastal provinces. This finding may be explained by drawbacks of using *within* estimator under conditions of endogenous explanatory variables and possible measurement error. The latter condition is more prevalent in developing countries, such as China. Similar negative and/or nonsignificant coefficients for human capital are also reported by Romer (1989) and by Levine and Renelt (1992).

Neither foreign direct investment nor trade openness is significantly associated with the disparity in economic growth among Chinese provinces. Hence I have excluded these two variables from the further regression with system GMM. As for the trade openness, one possible explanation for its relative nonsignificance is the heterogeneity of the variable's parameters—that is, the dependence of the trade–growth relation on where a province lies in the distribution of per capita growth. To be precise, openness has a greater impact on growth among low-growth than among high-growth provinces (Dufrénot *et al*. 2010). Finally, the internal RER is negatively associated with economic growth; this impact is significant in nearly all the regressions. In other words: when the internal real exchange rate appreciates (i.e., when the tradable/nontradable price ratio decreases), the economy grows more quickly.

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Table 1. Im–Pesaran–Shin panel unit root test

Variable	***t*-bar statistics**	***p*-value**	**Observations**
g	−2.402	0.000	420
g (no Sichuan)	−2.356	0.000	405
ly_1	−2.231	0.367	420
ly_1 (no Sichuan)	−2.213	0.408	405
invest2gdp1	−2.079	0.705	420
invest2gdp2	−2.447	0.057	420
popgr	−2.190	0.458	420
school1	−1.878	0.954	420
school2	−2.338	0.183	420
open	−1.831	0.975	420
fdi2gdp	−3.704	0.000	420
fdi2invest	−3.385	0.000	420
lr1	−2.713	0.001	420
lr2	−2.541	0.017	420

Notes**:** All variables are demeaned. For *g*, only the constant is included; for other variables, both the trend and the constant are included. The test is augmented by one lag. Annual data are used for running the test.

Table 2. Panel baseline model (fixed effects)

Variable	All provinces			Inland provinces			Coastal provinces		
	a	b	c	a	b	c	a	b	c
ly_1	-0.091***	-0.093***	-0.104***	-0.035	-0.043	-0.053	-0.189***	-0.189***	-0.198***
	(-4.219)	(-4.403)	(-4.808)	(-1.204)	(-1.480)	(-1.906)	(-6.310)	(-6.564)	(-6.550)
invest2gdp1	0.097**		0.115**	0.110*		0.124*	0.060		0.058
	(2.727)		(3.174)	(2.077)		(2.668)	(1.358)		(1.346)
invest2gdp2		0.113**			0.131*			0.082	
		(3.362)			(2.599)			(1.922)	
school1	-0.050	-0.042		0.017	0.093		-0.267	-0.379	
	(-0.184)	(-0.158)		(0.045)	(0.248)		(-0.720)	(-1.033)	
school2			0.223			0.417*			0.089
			(1.817)			(2.462)			(0.746)
popgr	-4.112*	-3.790*	-5.008**	-6.503*	-6.451*	-7.667**	0.908	0.934	1.158
	(-2.159)	(-2.033)	(-2.694)	(-2.427)	(-2.467)	(-2.990)	(0.355)	(0.383)	(0.468)
ip2	0.033**	0.031**	0.032**	0.011	0.009	0.010	0.090***	0.091***	0.089***
	(3.033)	(2.933)	(3.031)	(0.849)	(0.664)	(0.825)	(5.957)	(6.206)	(5.926)
ip3	0.108***	0.102***	0.100***	0.055*	0.048	0.043	0.216***	0.214***	0.211***
	(5.427)	(5.240)	(5.037)	(2.086)	(1.859)	(1.741)	(7.951)	(8.160)	(7.762)
ip4	0.158***	0.152***	0.151***	0.072	0.068	0.060	0.315***	0.310***	0.314***
	(4.801)	(4.693)	(4.645)	(1.673)	(1.606)	(1.472)	(6.907)	(7.033)	(6.861)
Constant	0.817***	0.831***	0.886***	0.364	0.425	0.461*	1.703***	1.701***	1.748***
	(4.701)	(4.943)	(5.136)	(1.621)	(1.919)	(2.159)	(6.455)	(6.782)	(6.633)

Breusch–Pagan LM test	0.1971	0.1255	0.7158	0.3735	0.2332	0.1924	0.4663	0.7081	0.5225
Hausman spec. test	0.0094	0.0014	0.0007	0.9990	0.9990	0.6496	0.0000	0.0000	0.0000
Pesaran's CD test	0.2075	0.1972	0.4668	0.1779	0.1675	0.2468	0.3137	0.2767	0.2251
Time fixed effects test	0.0000	0.0000	0.0000	0.0335	0.0588	0.1548	0.0000	0.0000	0.0000
Observations	112	112	112	72	72	72	40	40	40

***Notes*:** Table entries are *p*-values for four different specifications tests; *t*-statistics are given in parentheses. The variables *ip2*, *ip3*, and *ip4* are period dummies (for the second, third, and fourth 5-year period) that are used to capture time-specific effects. LM = Lagrange multiplier. ***, **, * Significance at 1, 5, and 10 per cent, respectively. a, b, c denote different model specifications.

Table 3. Panel evidence for effect of RER on growth (fixed effects)

Variable	**All provinces**			**Inland provinces**			**Coastal provinces**		
	e	f	g	e	f	g	e	f	g
ly_1	-0.092***	-0.108***	-0.072***	-0.071*	-0.072**	-0.028	-0.201***	-0.189***	-0.169***
	(-4.241)	(-5.170)	(-3.591)	(-2.515)	(-2.749)	(-1.063)	(-6.037)	(-6.253)	(-5.945)
invest2gdp1	0.085*	0.104**	0.130***	0.074	0.101*	0.133**	0.042	0.064	0.081
	(2.252)	(2.954)	(3.859)	(1.441)	(2.274)	(3.091)	(0.918)	(1.220)	(1.842)
popgr	-4.757*	-5.735**	-5.098**	-5.280	-6.426*	-6.043*	-0.118	0.342	-1.089
	(-2.548)	(-3.265)	(-3.117)	(-1.937)	(-2.662)	(-2.512)	(-0.045)	(0.131)	(-0.461)
school2	0.276*	0.201	0.254*	0.288	0.377*	0.355*	0.096	0.094	0.158
	(2.253)	(1.705)	(2.333)	(1.644)	(2.397)	(2.274)	(0.786)	(0.787)	(1.463)
fdi2gdp	0.308	0.379*	0.180	0.079	-0.065	-0.389	0.159	0.205	0.174
	(1.923)	(2.435)	(1.242)	(0.234)	(-0.209)	(-1.205)	(1.137)	(1.519)	(1.456)
open	-0.023			-0.241*			0.008		
	(-1.364)			(-2.175)			(0.623)		
ip2	0.029**	0.030**	-0.182***	0.017	0.016	-0.213**	0.089***	0.081***	-0.050
	(2.694)	(2.933)	(-3.860)	(1.317)	(1.352)	(-3.143)	(5.223)	(5.180)	(-0.896)

ip3	0.095***	0.099***	-0.125*	0.076*	0.063*	-0.179*	0.211***	0.198***	0.057
	(4.845)	(5.273)	(-2.445)	(2.680)	(2.630)	(-2.547)	(7.168)	(7.094)	(0.894)
ip4	0.140***	0.161***	-0.138*	0.117*	0.107*	-0.225*	0.318***	0.298***	0.120
	(4.341)	(5.131)	(-2.043)	(2.472)	(2.638)	(-2.413)	(6.394)	(6.453)	(1.405)
lr1		-0.050**			-0.064**			-0.029	
		(-2.977)			(-3.165)			(-0.962)	
lr2			-0.318***			-0.343**			-0.192*
			(-4.590)			(-3.348)			(-2.470)
Constant	0.790***	0.922***	-0.661	0.639**	0.622**	-1.106*	1.773***	1.660***	0.719
	(4.534)	(5.494)	(-1.841)	(2.863)	(3.046)	(-2.173)	(6.146)	(6.273)	(1.557)
Breusch–Pagan LM test	0.6577	0.3971	0.0936	0.3634	0.0598	0.0799	0.4634	0.5485	0.9027
Hausman spec. test	0.0093	0.0074	0.0000	0.4272	n.a.	0.0116	n.a.	0.0000	0.0000
Time fixed effects test	0.0000	0.0000	0.0000	0.0222	0.0178	0.0017	0.0000	0.0000	0.0000
Pesaran's CD test	0.5641	0.5600	0.3526	0.2538	0.2955	0.1866	0.2147	0.1921	0.2215
Observations	112	112	112	72	72	72	40	40	40

***Notes*: See notes to Table 2. e, f, g denote different model specifications.**

Table 4. Panel evidence for effect of RER on growth (system-GMM)

Variable	Model 0	Model 1a	Model 1b	Model 2a	Model 2b	Model 3	Model 4	Model 5	Model 6
ly_1	-0.012	-0.015	-0.007	-0.037**	-0.026**	-0.047***	-0.028**	-0.031***	-0.017
	(0.319)	(0.291)	(0.583)	(0.001)	(0.009)	(0.001)	(0.037)	(0.010)	(0.097)
invest2gdp1	0.143*	0.152**	0.133**	0.150*	0.155*	0.163**	0.138**	0.165**	0.141**
	(0.013)	(0.012)	(0.012)	(0.013)	(0.015)	(0.012)	(0.012)	(0.013)	(0.014)
popgr	-1.232	-1.438	-1.408	-2.752	-2.292	-3.516	-2.559	-2.840	-2.225
	(0.638)	(0.599)	(0.554)	(0.202)	(0.368)	(0.118)	(0.193)	(0.284)	(0.345)
school1	0.447	0.600*	0.398	0.361	0.378	0.544**	0.332	0.542*	0.345
	(0.112)	(0.059)	(0.140)	(0.103)	(0.160)	(0.026)	(0.122)	(0.065)	(0.189)
lr1		-0.031				-0.044**		-0.038*	
		(0.192)				(0.046)		(0.069)	
lr2			-0.203				-0.257		-0.222
			(0.199)				(0.115)		(0.169)
loca_dum				0.025*		0.030***	0.023**		
				(0.017)		(0.009)	(0.034)		
policy_dum2					0.001			-0.001	-0.001
					(0.940)			(0.937)	(0.871)
policy_dum3					0.018*			0.019*	0.013

					(0.044)			(0.058)	(0.139)
Constant	0.099	0.116	-0.746	0.312**	0.212*	0.387**	-0.782	0.249**	-0.737
	(0.438)	(0.423)	(0.271)	(0.005)	(0.047)	(0.003)	(0.264)	(0.041)	(0.279)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects test	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Arellano–Bond AR(1) test	0.099	0.085	0.016	0.093	0.086	0.073	0.008	0.067	0.010
Arellano–Bond AR(2) test	0.488	0.296	0.253	0.382	0.416	0.154	0.151	0.204	0.199
Hansen statistic	0.451	0.433	0.364	0.530	0.706	0.497	0.455	0.630	0.528
Observations	112	112	112	112	112	112	112	112	112

***Notes*:** *loca_dum* is the dummy variable for location and is set equal to 1 for coastal provinces (and to 0 otherwise). The dummy variables *policy_dum2* and *policy_dum3* capture the policy preference level; the reference group is provinces with a low level (for which the value is set equal to 1; it is set to 0 otherwise). The value of *policy_dum2* (resp., *policy_dum3*) is set equal to 1 when the preference level is medium (resp., high) and to 0 otherwise. Data are for five-year intervals between 1992 and 2008; a one-step system-GMM estimator is used with a small-sample adjustment for standard error. The reported robust standard errors (in parentheses) are the heteroskedasticity-consistent ones. The variable *ly_1* is treated as predetermined; *lr1* and *lr2* are treated as exogenous, and all other nondummy variables are treated as endogenous. The data reported for Arellano–Bond tests and the Hansen statistic are *p*-values. ***, *, * Significance at 1, 5, and 10 per cent, respectively.

Table 5. Panel evidence for effect of RER on growth (system-GMM with interaction terms)

Variable	**Model 7**		**Model 8**	
ly_1	-0.050***	(0.000)	-0.026*	(0.018)
invest2gdp1	0.174*	(0.014)	0.162*	(0.017)
popgr	-4.178	(0.083)	-2.419	(0.307)
school1	0.541*	(0.026)	0.436	(0.086)
lr1	-0.049*	(0.029)	-0.006	(0.869)
loca_dum × *lr1*	0.005	(0.936)		
loca_dum	0.029**	(0.008)		
policy_dum2 × *lr1*			-0.060	(0.122)
policy_dum3 × *lr1*			0.033	(0.570)
policy_dum3			0.016**	(0.009)
Constant	0.412**	(0.001)	0.213*	(0.048)
Time dummies	Yes		Yes	
Time fixed effects test	0.0000		0.0000	
Arellano–Bond AR(1) test: *p*-value	0.074		0.062	
Arellano–Bond AR(2) test: *p*-value	0.151		0.445	
Hansen statistic: *p*-value	0.483		0.597	
Observations	112		112	

***Notes*:** See notes to Table 4. *policy_dum*2 is not included in Model 8 because its coefficients are not significant in previous regressions (see Table 4).

Table 6a: Spatial effect tests (for model specifications of Table 2)

	W1			W2		
	a	b	c	a	b	c
LM spatial Lag stat.	0.6550	0.5920	0.6010	0.0352	0.0138	0.0001
	(0.418)	(0.442)	(0.438)	(0.851)	(0.906)	(0.990)
LM spatial error stat.	1.0536	0.8655	0.9446	0.0007	0.0174	0.1581
	(0.305)	(0.352)	(0.331)	(0.978)	(0.895)	(0.691)
robust LM spatial Lag stat.	2.9595	1.7452	2.0598	0.2680	0.6322	1.1317
	(0.085)	(0.186)	(0.151)	(0.605)	(0.427)	(0.287)
robust LM spatial error stat.	3.3580	2.0187	2.4035	0.2335	0.6358	1.2896
	(0.067)	(0.155)	(0.121)	(0.629)	(0.425)	(0.256)

Notes : P-value in parentheses. W1 and W2 denote alternative spatial weights. a, b, c denote different model specifications reported in Table 2.

Table 6b: Spatial effect tests (for model specifications of Table 3)

	W1			W2		
	e	f	g	e	f	g
LM spatial Lag stat.	0.3411	0.4224	0.4175	0.2212	0.0281	0.0736
	(0.559)	(0.516)	(0.518)	(0.638)	(0.867)	(0.786)
LM spatial error stat.	0.3842	0.4868	0.4600	2.3438	1.1134	0.2888
	(0.535)	(0.485)	(0.498)	(0.126)	(0.291)	(0.591)
robust LM spatial Lag stat.	0.0110	0.0216	0.0093	4.5844	3.0529	2.1948
	(0.917)	(0.883)	(0.923)	(0.032)	(0.081)	(0.138)
robust LM spatial error stat.	0.0542	0.0861	0.0517	6.7070	4.1382	2.4100
	(0.816)	(0.769)	(0.820)	(0.010)	(0.042)	(0.121)

***Notes*:** See notes to Table 6a. e, f, g denote different model specifications reported in Table 3.

Table A1. Definition and sources of variables

Variable	Definition	Sources
gdp_cur	Current-price gross domestic product (100 million yuan, annual)	CCS, 2010 CSA
pop_end	Year-end population (×10,000, annual)	2009 CPESY
g	Growth rate of real GDP per capita (annual, PA)	CCS, 2010 CSA, 2009 CPESY
ly_1	Real GDP per capital (yuan, BP)	CCS, 2010 CSA, 2009 CPESY
*Invest*2*gdp1*	Ratio of gross capital formation to GDP (in current price) (annual, PA)	CCS, 2010 CSA
*Invest*2*gdp2*	Ratio of fixed capital to GDP (in current price) (annual, PA)	CCS, 2010 CSA
popgr	Natural growth rate of the population (annual, PA)	CCS, 1997 CSY
school1	Ratio of gross secondary school enrolment to total population (annual, BP)	CCS, 2006–2009 CSY
school2	Ratio of population with at least a senior high school education to total population (annual, BP)	1997–2000 CSY, 2002–2009 CSY, 1993–1996 CPSY, 2002 CPSY
open	Ratio of combined imports and exports to GDP (in current price) (annual, PA)	CCS, 2010 CSA
*fdi*2*gdp*	Ratio of foreign direct investment to GDP (in current price) (annual, PA)	CCS, 2010 CSA
*fdi*2*invest*	Ratio of FDI to fixed capital formation (in current price) (annual, PA)	CCS, 2010 CSA
lr1	Real exchange rate: ln (PPI ÷ CPI) (annual, BP)	CCS
lr2	Real exchange rate: ln[1 ÷ CPI] (annual, BP)	CCS
loca_dum	Location dummy	Ding and Knight (2008)
policy_var	Policy preference level	Pedroni andYao (2006)

***Key*:** BP = beginning of each five-year period; CCS = China Compendium of Statistics 1949–2008; CPESY = China Population and Employment Statistics Yearbook; CPSY = China Population Statistical Yearbook; CSA = China Statistical Abstract; CSY = China Statistical Yearbook; PA = period average (over five years).

Table A2. List of Chinese mainland provinces (28-province sample)

Province	Location	Dummy value	Policy preference level	Variable value
Beijing	Coastal	1	Medium	1
Tianjin	Coastal	1	High	2
Hebei	Coastal	1	High	2
Shanxi	Interior	0	Low	0
Inner Mongolia	Interior	0	Medium	1
Liaoning	Coastal	1	High	2
Jilin	Interior	0	Medium	1
Heilongjiang	Interior	0	Medium	1
Shanghai	Coastal	1	High	2
Jiangsu	Coastal	1	High	2
Zhejiang	Coastal	1	Medium	1
Anhui	Interior	0	Medium	1
Fujian	Coastal	1	High	2
Jiangxi	Interior	0	Low	0
Shandong	Coastal	1	High	2
Henan	Interior	0	Low	0
Hubei	Interior	0	Medium	1
Hunan	Interior	0	Low	0
Guangdong	Coastal	1	High	2
Guangxi	Interior	0	High	2
Sichuan	Interior	0	Medium	1
Guizhou	Interior	0	Low	0
Yunnan	Interior	0	Medium	1
Shaanxi	Interior	0	Low	0
Gansu	Interior	0	Low	0
Qinghai	Interior	0	Low	0
Ningxia	Interior	0	Low	0
Xinjiang	Interior	0	Medium	1

***Sources*:** Ding and Knight (2008) for location; Pedroni and Yao (2006) for policy preference level.

Figure 1. Five-year average growth of real GDP per capita by provinces (in percentage)

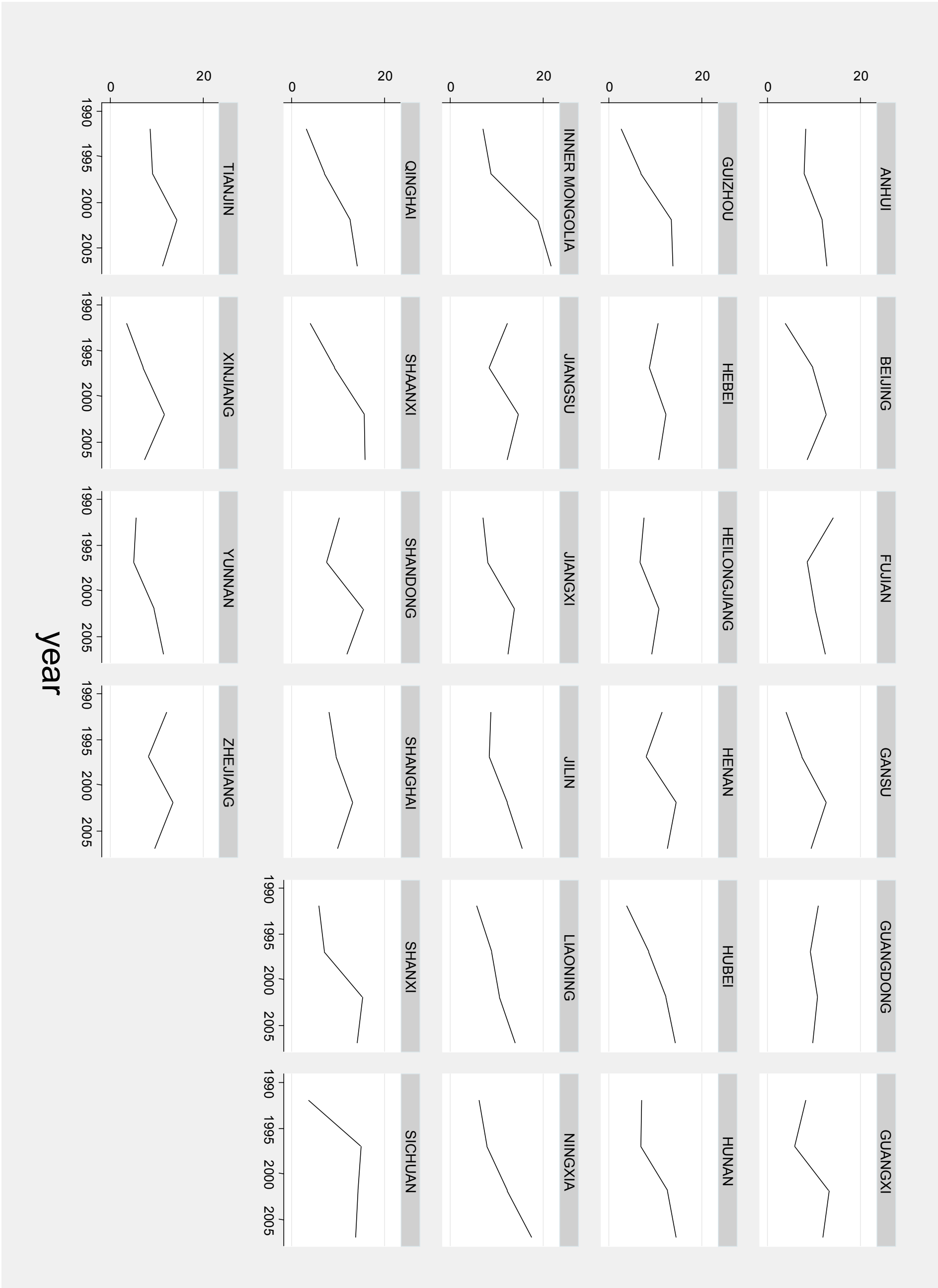
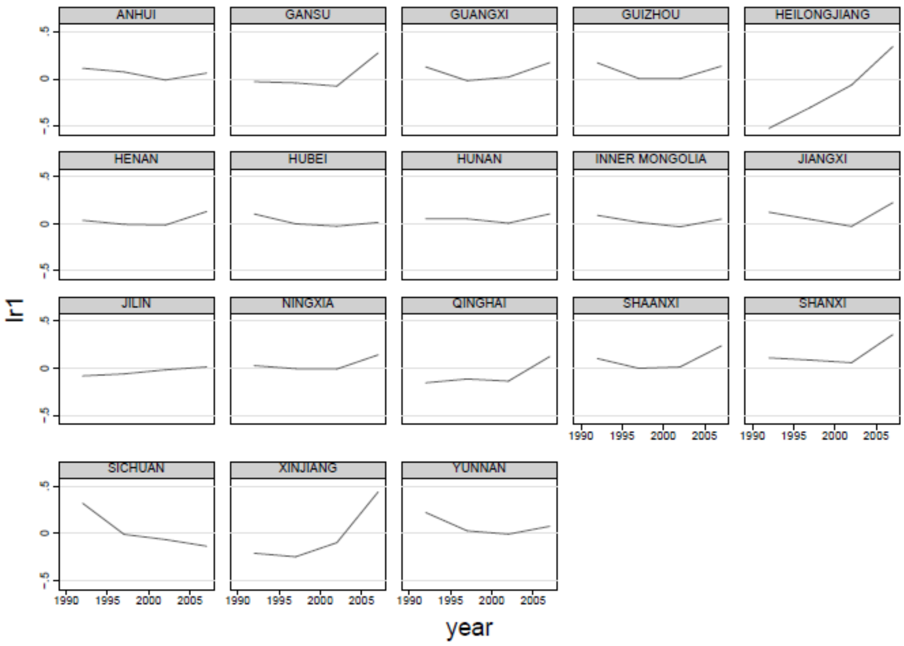
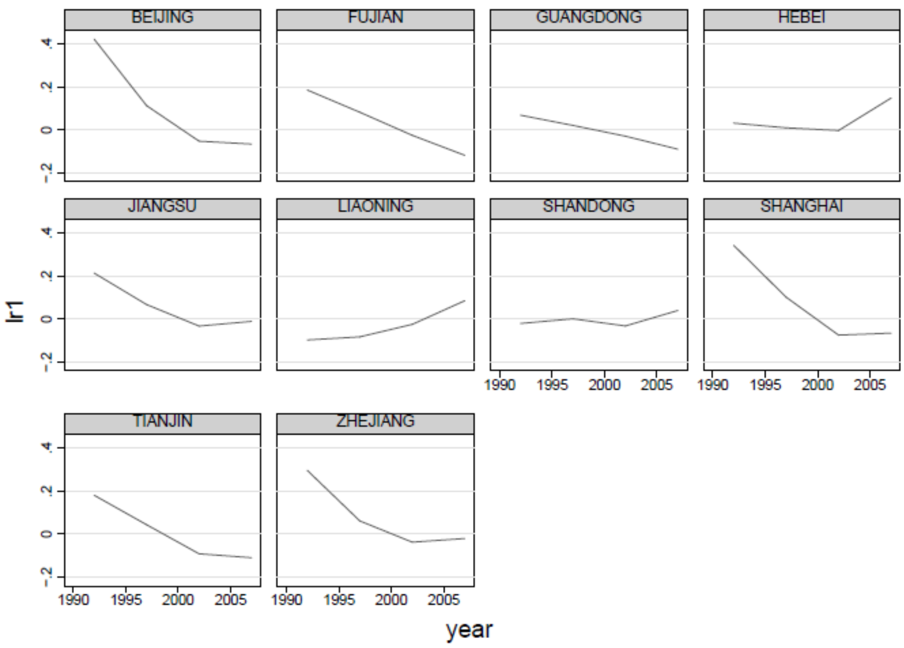


Figure 2. The internal real exchange rate (in logarithmic form)



(a) Inland provinces



(b) Coastal provinces

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[2] However, the evidence for a link between the exchange rate volatility (or variability) and economic growth is less definitive (Aghion et al. 2009, Ghura and Grennes 1993). In addition, other narratives focus on the nexus between the exchange rate regime and growth; Levy-Yeyati and Sturzenegger (2003) found that less flexible exchange rate regimes are associated with slower growth in developing countries but that the choice of a particular exchange rate regime has no statistically significant effect on growth in industrial countries.

[3] The disastrous effects of overvaluation on economic growth are widely documented in the empirical literature (Acemoglu et al. 2003, Benaroya and Janci 1999, Cottani et al. 1990, Dollar 1992, Gala 2008, Ghura and Grennes 1993, Loayza et al. 2004, Razin and Collins 1997). The consensus is less on the effects of undervaluation on growth. For Berg and Miao (2010), undervaluation—when viewed as a misalignment with long run equilibrium levels—reduces growth. In contrast, Rodrik (2008) used an index of undervaluation that was adjusted for the Balassa–Samuelson effect and argued that undervaluation actually facilitates economic growth; however, this relationship holds only for developing countries. For a comprehensive literature review, see Eichengreen (2007).

[4] The real exchange rate is generally defined in the economic literature in two principal ways: (a) in external terms as the nominal exchange rate adjusted for price level differences between countries or (b) in internal terms as the ratio of the domestic price of tradable to nontradable goods within a single country (Hinkle and Nsengiyumva, 1999a).

[5] For example, Guillaumont Jeanneney and Hua (2008) use the real effective exchange rate as a proxy for the real exchange rate of Chinese provinces, in fact, it is a measure of the external RER.

[6] Another empirical approach is the growth accounting method; see Zheng *et al*. (2009) for an application to potential output in China.

[7] See Chen and Fleisher (1996). Li *et al*. (1998) utilized both cross-sectional and panel data on the provinces of China.

[8] See e.g., Barro and Sala-i-Martin (2004, ch. 12) and Edison et al. (2002) for this option.

[9] Because the lagged levels of variables are only weak instruments for subsequent first differences, the downside is the need to add more instruments to the estimation.

[10] Montiel and Hinkle (1999) remark that the empirical measurement of RER in most developing countries involves many practical problems that are seldom encountered in the case of industrial countries.

[11] There are several different definitions of the internal RER based on two-, three, or multi-good models.

[12] See, e.g., Cheung, Chinn, and Fujii (2009) for the reasons for which there is such a wide range of estimation for the RMB undervaluation and it is challenging to estimate it precisely.

[13] Given the relatively small number of observations (N = 28 and T = 4) and in order to guarantee enough degrees of freedom for the estimation, only a few proximate determinants were chosen. Even some potentially explanatory variables of growth are not included in the regression. Note that panel data methods can control for omitted variables.

[14] Different from the Barro's type cross-sectional growth regressions for which a common feature has been the assumption of identical aggregate production functions for all the countries, the panel data framework with province-fixed effects, from the growth theory's point of view, allows us to control for the technological and institutional differences which themselves determine the difference in the aggregate production functions across individual provinces in the process of growth. Persistent differences in technology level and institutions are further sources of difference in the steady state levels of income, and are a significant factor in understanding cross-province economic growth (Islam, 1995). Thus, convergence in the panel data setting is also conditional on these factors. The process of convergence is thwarted to a great extent by persistent differences in technology level and institutions.

[15] This variable is different from the one in Solow's growth model, where the population growth was measured by the rate of growth of the working-age population (and taken exogenously), emphasizing the supply of labour. In this paper, population growth is taken to be endogenous—as in endogenous growth theory, where population growth is negatively associated with growth in human capital and hence with economic growth (Bond *et al*. 2001). The fertility rate is often used as an alternative measure of population growth (Barro 1991).

[16] Ding and Knight (2009) relied on Barro and Lee (2001)'s *average level of human capital* data to calculate the average years of schooling in the population (above age 15) as a direct measure of the stock of human capital. However, this measure is not available at the provincial level.

[17] Here, the senior high school includes the special technical secondary school (*Zhong zhuan* in Chinese) but not the skill school (*Ji Xiao*). The numbers of people with at least some college education and with at least some senior high school education are estimated based on the respective annual flows of enrolments in college and senior high school; these numbers are anchored to periodic population census data and annual population change survey data. The census data (1982, 1990, and 2000) and the annual population change survey data (1993, 1996, 1999, 2002, and 2003) provide the proportions of people sorted by their educational levels.

[18] See Harrison (1996) for a review of studies using this measure.

[19] Their index ranges from 0 to 3, where 3 corresponds to the highest level of central government's policy preference. A weight of 3 was assigned to the Special Economic Zone (SEZ) and Shanghai Pudong New Area; a weight of 2 was assigned to the Economic and Technological Development Zone (ETDZ) and Border Economic Cooperation Zone (BECZ); and a weight of 1 was assigned to the Coastal Open City (COC), Coastal Open Economic Zone (COEZ), Open Coastal Belt, major city on Yangtze (MC), bonded area (BA), and capital city of inland province or autonomous region (CC). A weight of 0 was assigned to each province without an open zone.

[20] From the administrative standpoint, Mainland China consists of 31 provinces, minority autonomous regions, and municipalities. Because Chongqing became a municipal city in 1997, we combined Chongqing with Sichuan for the period 1997–2006 to preserve consistency with earlier observations (cf. Ding and Knight 2008). Hainan and Tibet are excluded because so few data are available for their PPI indices.

[21] In Naughton's view, there have been two distinct phases so far in the process of transition. In the first phase, 1978 to 1992, economic change was characterized by unique experiments and forms of economic organization, such as township and village enterprises promoted by local governments.

[22] See, e.g., Islam (1995). The limited span of the series explains my choice of five-year intervals (1992–1996, 1997–2001, 2002–2006), although the fourth period (2007–2008) allows only for two-year averages. See Hao (2006) for a study in which period-averaged data is based on a three-year interval. One should bear in mind that it is an open question whether using five- or ten-year averages for avoiding business cycle effects or annual data is better. Further investigation is needed on the extent to which averages taken over short time spans reduce such effects (Temple 1999).

[23] The Im–Pesaran–Shin panel unit root test (Im et al. 2003) is applied to check the stationarity of the annual series of each variable from 1992 to 2008. Except for the growth rate, FDI share, and RER, the null hypothesis of nonstationarity cannot be rejected (see Table 1).

[24] The current-price GDP series for 2005–2008 that are published in 2010 CSA have been revised to reflect the second economic census; the series published in CSY report preliminary figures only (which are nevertheless used in some studies).

[25] In China, the PPI is referred to as the Producer Price Index for Manufactured Goods.

[26] Edwards (1990) and Devereux and Connolly (1996) used the CPI as a proxy for the price of nontraded goods.

[27] For a more precise classification of Chinese provinces' locations, see Démurger *et al*. (2002).

[28] Démurger *et al*. (2002) also reports a simple period average of the level of open-door preferential policies for each province (see Table 4 of their paper). Pedroni and Yao (2006) divided these provincial average indexes (which range from 0.33 to 2.86) into three roughly equal quantiles: low, medium, and high (see Table A2 in the Data Appendix). In

the regressions reported here, I include the variable of policy preference level in the categorical form of Pedroni and Yao.

[29] Before applying the system-GMM estimation, I estimate the link between the internal RER and the provincial growth with the fixed-effect model, which helps specifying and fine-tuning the model with various control variables and allows for implementing the spatial dependence diagnostics. See Appendix B for the presentation of the fixed-effect estimations and for the discussion of the corresponding results in Table 2 and Table 3.

[30] In finite samples, asymptotic standard errors associated with the two-step GMM estimators may be strongly biased downward, which makes such estimators an unreliable guide for inference (Bond *et al*. 2001).

[31] The assumption of the law of one price for tradable goods cross provinces is too strict here in that the tradable goods used in composing the PPI for each province may not be the same as a result of specialization and development strategy.

[32] This cross-sectional dependence can arise as well due to unobserved (or unobservable) common factor. I apply Pesaran's CD test (Pesaran, 2004) to test whether the residuals of the models with fixed effect are correlated across entities. The null hypothesis that residuals are not correlated (or dependent) cannot be rejected at the conventional level of significance and the test results are reported in Table 2 and Table 3.

[33] His strategy is the following: in case the non-spatial model is rejected, the spatial Durbin model is estimated to test whether it can be simplified to the spatial lag or the spatial error model. If both tests point to either the spatial lag or the spatial error model, it is safe to conclude that that model describes better the data. By contrast, if the non-spatial model is rejected in favor of the spatial lag or the spatial error model while the spatial Durbin model is not, one better adopts this more general model (Elhorst, 2012).