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FDI in Chinese Cities: Spillovers and Impact on Growth

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1. INTRODUCTION

THIS paper provides a case study of whether foreign direct investment (FDI) promotes economic growth. We rely on data at the sub-national level across cities within China to estimate a dynamic panel growth equation taking into account the issue of spatial dependence. We explicitly consider the fact that Chinese cities can take advantage not only of local FDI but also of FDI flows into surrounding locations. We determine whether FDI is characterised by a substitution or a complementary pattern across Chinese cities.

In line with the claim made by multilateral development agencies that FDI brings considerable benefits, many developing and transition economies have placed attracting FDI high on their reform agenda. Policy leaders expect FDI inflows to bring technology transfers, management know-how, and export marketing access, thus encouraging increased productivity and competitiveness of domestic industries. Attracting FDI has become a priority for developing countries with the aim of closing the technology gap with high-income countries.

However, empirical studies have so far produced inconclusive results regarding spillovers (Agenor, 2003). Rodrik (1999) is often quoted on this issue:

> today's policy literature is filled with extravagant claims about positive spillovers from FDI, but the hard evidence is sobering.

Indeed the difficulties associated with disentangling different effects at play and data limitations have prevented researchers from providing conclusive evidence of positive externalities resulting from FDI (Javorcik, 2004).

An extensive empirical literature exists on the impact of openness to trade or to FDI on economic growth. Most of these analyses are based on cross-country

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regressions (Agosin and Mayer, 2000; Bosworth and Collins, 2000; Carkovic and Levine, 2002; and Edison et al., 2002). This literature has been criticised by Rodriguez and Rodrik (2001) for failing to consider the possible reverse causation from growth to openness. Another possible shortcoming of these studies is that differing cross-country changes in legal systems and other institutions could impact growth in addition to FDI inflows, thus their effects may be incorrectly attributed to FDI. Finally, the analyses traditionally assume each region to be an isolated entity. The role of spatial dependence[1] is completely neglected, even though it is an important force in the process of convergence (Rey and Montouri, 1999) and ignoring it could result in serious misspecification (Abreu et al., 2005). Past research on the impact of FDI on economic growth ignores these potential problems and, as a result, previously measured parameter estimates and statistical inferences are questionable.

The current paper aims at exploring regional variations within a single country (China), mitigating the common shortcomings of the literature. Notably, the omitted variable problem is limited as the legal system and other institutions are much more similar within a single country. Furthermore, institution changes follow a similar pattern across the country.[2] A per capita income growth model is estimated, relying on dynamic panel generalised method of moments estimations that control for endogeneity, variable omission and spatial dependence problems.

We choose China as the focus of our study since, from being an economy with virtually no foreign investment in the late 1970s, China has become the largest recipient of FDI among developing countries and, for many years, has been the second largest FDI recipient in the world after the United States. FDI inflows exploded from US$2.3 billion over the 1984–89 period to US$50 billion in 2003 (Tseng and Zebregs, 2002).

We wonder whether FDI inflows in one locality promotes growth locally, whether it occurs at the expense of economic growth in surrounding localities, or whether localities benefit from higher income around them.

Our results show that spatial relationships between Chinese cities matter significantly. Estimates suggest that economic growth responds positively to FDI received locally as well as in proximate cities. We find that a one-standard-deviation (seven percentage points) increase in the local FDI rate raises income per capita in the same proportion as a one-standard-deviation (four percentage points) increase in the FDI rate in the surrounding localities, i.e. by around five per cent. Moreover, we also find evidence of a positive and significant impact of the level of income per capita in surrounding areas on cities' own income per capita. A one-standard-deviation (50 per cent) increase in real GDP per capita in the surroundings could increase local income per capita by around ten per cent.

[1] Spatial dependence, for example in terms of income, refers to the correlation of incomes across space. Income in one location may be correlated with that of neighbouring localities.

[2] Differences in reform pace across China will be accounted for through locality and time fixed effects.

As such, our results show that spatial relationships between Chinese cities matter significantly.

This paper proceeds as follows: Section 2 presents the main features of FDI in China and discusses its impact. Section 3 analyses the data and develops the empirical strategy used to investigate the impact of FDI on economic growth in China while accounting for spatial interdependence. Section 4 discusses the results obtained on a panel of 180 Chinese cities over four sub-periods between 1990 and 2002 period. Section 5 concludes.

2. FDI IMPACT AND SPILLOVERS IN CHINA

a. FDI Trends and Policies

Since economic reforms launching in 1979, China has received a large part of international direct investment flows.[3] China moved from restrictive to permissive policies in the early 1980s, then to policies encouraging FDI in general in the mid-1980s to policies encouraging more high-tech and more capital-intensive FDI projects in the mid-1990s (Fung et al., 2004). During the permissive period, the Chinese government established four Special Economic Zones (SEZs) in Guangdong and Fujian provinces and offered special-incentive policies for FDI in these SEZs. While FDI inflows were highly concentrated within these provinces, the amounts remained rather limited (Cheung and Lin, 2004). After 1984, Hainan Island and 14 coastal cities across ten provinces were opened, and FDI levels really started to take off. The realised value of inward FDI to China reached US$3.49 billion in 1990. This kind of preferential regimes policy resulted in an overwhelming concentration of FDI in the east. The expected spillover effects from coastal to inland provinces failed to materialise. In reaction to the widening regional gap, more broadly-based economic reforms and open-door policies were pushed forward in the 1990s. In the spring of 1992, Deng Xiaoping adopted a new approach which turned away from special regimes toward a more nationwide implementation of open policies for FDI inflows. New policies and regulations encouraging FDI inflows were implemented and produced remarkable results. Since 1992 inward FDI in China has accelerated and reached the peak level of US$45.5 billion in 1998. After a drop due to the Asian crisis, FDI inflows into China surged again, so that by 2003 China received more than US$50 billion in FDI, surpassing the United States to become the world's largest single recipient of FDI (Forbes, 2005). China's entry to the WTO in 2001 is likely to deepen China's integration in the international segmentation of production processes and as such should reinforce the FDI attractiveness position of China.

[3] For an in-depth presentation of FDI trends in China, refer to OECD (2000).

b. FDI Impact and Spillover Channels

Because of its unique nature and its importance, the economic literature and research attributes significant economic effects to FDI. A recent IMF study estimates that FDI has increased China's annual potential growth rate by about three per cent – with about 80 per cent of the benefits coming from increased productivity (Tseng and Zebregs, 2002).

(i) Direct impact of FDI

FDI has played a major role in transforming the Chinese economy. Several direct effects of FDI are usually mentioned in the literature.[4] Evidently, FDI brings about capital. A sufficient amount of capital has been necessary to build-up China's economy and FDI has made a substantial contribution to this. The ratio of FDI to GDP rose to 15 per cent of domestic gross investment in 1994, stayed around 13 per cent up to 1998 and stabilised around 11 per cent in the late 1990s. However, as stressed by OECD (2005), FDI has not been necessary to counter insufficient domestic saving. Indeed, the current account (which measures the difference between domestic saving and investment) has been in surplus for all but one year since 1991. Rather, the role of foreign companies has been to use management skills and technology, together with local labour, to increase exports and improve the overall productivity of the economy.

OECD (2000) notes that the creation of employment opportunities – either directly or indirectly – has been one of the most prominent impacts of FDI on the Chinese economy. The report evaluates that foreign firms employed around 20 million workers (three per cent of China's total employment) at the end of the 1990s.

FDI has been at the core of China's foreign trade expansion. It has furthermore been a decisive factor in China's involvement in the international segmentation of the production process. OECD (2000) emphasises the role of foreign investment enterprises (FIEs) in the modification of China's industrial structure, the diversification of labour-intensive product exports and the strengthening of China's competitive position in rapidly expanding markets.

An important specificity of FIEs is that while investment in Chinese firms is mostly devoted to the expansion of production capacities, FDI incorporates much more equipment and technology knowledge. This is consistent with findings of greater allocative and technical efficiency in labour utilisation in production in FDI firms compared to domestic firms. FIEs have improved the overall efficiency with which resources are used. Their efficiency can be judged from the level of their overall productivity, which was over 90 per cent greater than that of directly

[4] It is clearly beyond the scope of the present paper to review the vast literature on the FDI-growth relationship and the determinants of FDI. The interested reader should refer to de Mello (1997 and 1999) for a comprehensive survey of the nexus between FDI and growth as well as for further evidence on the FDI-growth relationship.

controlled state companies (OECD, 2005). An important difference in industrial structure between FIEs and domestic firms is that FIEs are relatively more concentrated in the newly developing and fast growing industries such as electronics and telecommunications equipment. By contrast, domestic firms are more present in the conventional basic capital-intensive and large-scale industries.

As emphasised by Fung et al. (2004), there are also concerns that FDI may bring about detrimental effects. Some claim that foreign companies can crowd the access to credit of domestic firms (Harrison and McMillan, 2003). FDI can also have a negative impact on the local economy by substituting for domestic savings or exacerbating balance-of-payment deficits as a result of rising debt repayment obligations.

(ii) Spillover channels

As recognised in the literature, there are several channels through which inward FDI can benefit innovation activity of domestic firms in the host country. Several channels of spillovers are identified in the literature (see Görg and Greenaway, 2004, for a complete description of these channels):[5]

- The imitation of new products and process brought in by foreign firms is a classic transmission mechanism through reverse engineering. Its importance is tied to product/process complexity. Hence, imitation may improve local technology and result in a spillover enhancing productivity of local firms.
- Competition may generate spillovers (Glass and Saggi, 2001). Except in a monopoly situation, incoming MNEs increase competition. This new competition compels them to adapt their technology and production processes. By reducing X-inefficiency, greater competition improves productivity.
- Export spillovers are an additional source of productivity gain. Domestic firms learn from multinationals to implement an exporting strategy (Aitken et al., 1997; and Görg and Greenaway, 2004). Exporting involves fixed costs in the form of establishing distribution networks, creating transport infrastructure, learning about consumer tastes, etc. Collaboration and imitation generate productivity gains and may help local firms to penetrate new markets.
- Spillovers may take place vertically through the acquisition of human capital from foreign firms. MNEs transfer their know-how or enhance staff training by two means. First, MNEs demand relatively skilled labour in the host country. Hence they invest in technological know-how transfer or staff training. As a result, labour turnover from MNEs to local firms can generate productivity improvement by means of complementary workers or by stealing

[5] However, these transmission channels are constrained by the technology gap between local and foreign firms (Blomström et al., 2001; and Javorcik, 2002). The scope of positive FDI spillovers is all the greater the smaller the technology gap between foreign and local firms.

their skilled workers. Several studies argue that this is the most important channel for spillovers (Fosfuri et al., 2001). Second, FIEs can increase demand for inputs produced by local upstream suppliers and thereby transfer technology and management practices to local firms (Rodriguez-Clare, 1996; and Javorcik, 2004). These vertical spillovers may constrain local suppliers to improve their innovation capability in order to keep or gain new clients.

The geographic proximity is of crucial importance for the process linking knowledge spillovers to innovative activity (Audretsch, 1998). For instance, the closer a local firm is located to an FDI firm, the more likely and the more frequently their employees interact with each other, and the more frequently labour moves between these two firms. This spatial link may also be important for vertical spillovers between firms and their local suppliers, which often are located close to one another. It is furthermore well recognised that geographic proximity facilitates flows of knowledge. The probability that knowledge flows from one agent to another decreases with geographic distance. As a result, high productivity locations as well as low productivity areas tend to be geographically clustered, thus creating strong spatial links or dependence between locations (Anselin, 2001).

These spillovers, whether they are due to the mobility of goods, workers and capital or to spatial externalities, induce a particular organisation of economic activity in space. As expressed in Tobler's (1970) first law of geography:

> everything is related to everything else, but near things are more related than distant things (p. 236).

Many studies show the importance of spatial patterns (Fingleton, 1999; and Rey and Montouri, 1999). These spatial aspects are especially important to account for, as ignoring them could result in serious misspecification (Abreu et al., 2005).

c. Evidence on Spillovers in China

Empirical evidence is still limited on FDI spillovers in China, but generally presents a positive FDI spillover (Hu and Jefferson, 2001; and Tong and Hu, 2003). There is evidence of positive intra- and inter-industry productivity spillovers within regions in the Chinese manufacturing sector (Wei and Liu, 2006) as well as a positive effect of FDI on the number of domestic patent applications in China (Cheung and Lin, 2004). However, Hale and Long (2006) show that FDI has different spillover effects on different firms. Estimating production functions, Hale and Long (2006) find that the presence of foreign firms in China is positively associated with the performance of private firms but has no or a negative effect on the performance of state-owned enterprises. In particular, domestic firms with higher absorptive capacity (higher initial total factor productivity) experience positive spillovers while those with low initial total factor productivity have negative spillovers.

Buckley et al. (2002) find positive spillovers only for collectively owned firms while Hu and Jefferson (2002) evidence that, for China's textile industry, FDI presence depresses productivity of state-owned enterprises but not of domestic firms in general. To our knowledge, only three papers use spatial econometric techniques to examine FDI activity. They focus on FDI motivations as well as the spatial correlation between local FDI and that received in alternative regions (Blonigen et al., 2004; and Egger et al., 2007). Coughlin and Segev (2000) consider US FDI across Chinese provinces and find a positive spatial lag coefficient. These authors argue that it accounts for agglomeration economies. To our knowledge, no empirical work has directly tested the presence of FDI spillovers between Chinese cities applying appropriate econometric techniques.

Labour and goods mobility constitute two straightforward channels through which spillovers from FDI would occur between cities. The labour mobility mechanism, through the movement of skilled workers from foreign firms to domestic firms, helps to transfer advanced technology and management skills. Djankov and Hoekman (2000) and Görg and Strobl (2005) present evidence demonstrating the existence of the labour mobility effect in the Czech Republic and Ghana, respectively. In the case of China, Hale and Long (2006) find empirical evidence that the labour market channel facilitates FDI spillovers in Chinese cities. Labour migration (intra- and inter-province) in China is becoming one of the most obvious and influential social factors which is profoundly changing the current system and society as a whole. Between 1990 and 1995, 13 million people (out of a recorded total of 33 million migrants) engaged in an urban-urban migration either within the same province (9.6 million) or between two separate provinces (2.2 million) (Poncet and Zhu, 2005). These figures grew even further in the last decade. It is very likely that these massive migratory flows between cities fostered the exchange of skills and technology. Inter-city exchanges of goods provide an additional means of embedded technology transmission. Reform advances, especially in terms of output rationalisation and price liberalisation, have prompted further integration of domestic markets and intensified already intense trade flows within China (Naughton, 2003).

3. SPATIAL DEPENDENCE IN CHINA: DATA AND EMPIRICAL METHOD

a. Data

The dataset comes mainly from two sources: (1) *Urban Statistical Yearbook*, various issues, published by China's State Statistical Bureau, and (2) *Fifty Years of the Cities in New China: 1949–1998*, also published by the State Statistical Bureau.

Our dataset covers 180 cities spread over the entire territory except for the provinces of Qinghai and Tibet. In order to explain the dataset clearly, it is useful to provide a brief description of the Chinese administrative structure (see

Figure A1 in Appendix A). The entire country is divided into 27 provinces plus four province-status 'super-cities' – Beijing, Chongqing, Shanghai and Tianjin.[6] In each province (or super-city), the population is further divided into prefecture-level cities and lower-level cities and rural counties. Our dataset consists of information on the urban part of those prefecture-level cities.[7] In the rest of this paper, the term 'city' is used to refer to the urban area under the jurisdiction of either prefecture-level cities or super-cities.

Table A1 in Appendix A lists the various cities by province covered by the dataset. Figures A2 and A3 (in Appendix A) show the geographic pattern in 2002 of the ratio of FDI inflows to GDP and of GDP per capita, respectively. The fewer number of cities at the prefecture level in the western part of China is evident. The western part of China is clearly under-represented since it includes fewer prefecture-level cities. As an illustration, in Xinjiang province, only two cities in 2002 have this level of power, against 12 in Hubei province. Moreover, these cities are more recent and are thus characterised by a greater amount of missing observations. However, cities, regardless of where they are located (with the exception of a few located in Guangdong province), appear to share a comparable level of GDP per capita. The average GDP per capita in current terms in 2002 is 18,177 yuan. Heterogeneity is greater across cities in terms of the FDI to GDP ratio. Greater values are observed in provinces that contained the original four Special Economic Zones (Guangdong and Fujian), with significant FDI flows going also to Beijing and Shanghai. This distribution is in line with original policies but also with efforts made since 1992 to ease foreign investment restrictions and attract FDI to other parts of the country (refer to Section 2). Numerous cities in the interior provinces are shown to have a ratio of FDI over GDP above three per cent.

b. The Model

Our study of the impact of FDI on economic performance relies on a traditional cross-country empirical framework. Regressions are made using a dataset of 180 cities between 1990 and 2002. We estimate the autoregressive form of the augmented Solow growth model as proposed by Mankiw et al. (1992) and add the FDI rate in order to determine its influence on growth. Our strategy follows Easterly and Levine's (1998) strategy:

[6] The official term for super-cities is 'directly administered cities', meaning that the city officials report directly to the central government just as the officials in other provinces. Since 1997, Chongqing has become the fourth 'super-city'. Note that the dataset does not include Hong Kong SAR, Macau SAR and Taiwan Province of China.

[7] In other words, the data do not cover the rural counties that are attached to these cities. Since one can expect spillovers to be a more likely urban phenomenon due to greater agglomeration, more developed infrastructure and denser interaction between non-agricultural activities, our study may overestimate the impact of FDI on growth.

$$\ln y_{i,t} = \alpha_0 \ln y_{i,t-T} + \alpha_1 \ln s_{K_{it}} + \alpha_2 \ln s_{H_{it}} + \alpha_3 \ln(n_{it} + g + \delta) + \alpha_4 \ln \mathrm{FDI}_{it} + \eta_i + \gamma_t + \varepsilon_{it}, \quad (1)$$

where the dependent variable, y_{it}, is the per capita real GDP in city i at time t. Explanatory variables are measured as an average over the period between t and $t - T$: $y_{i,t-T}$ is the lagged dependent variable T years ago. The saving rate, s_K, is proxied by the ratio of fixed investment to GDP while the rate of investment in human-capital-enhancing activities, s_H, is measured by the share of the population studying at university level. The third term corresponds to n_{it}, the average population growth rate over the period, plus 0.05 (see Mankiw et al., 1992), where 0.05 represents the sum of a common exogenous rate of technical change (g) and a common depreciation rate (δ). We test for the impact of FDI on economic performance based on the city's ratio of FDI over GDP (FDI_{it}).

The disturbance term consists of an unobservable city fixed effect that is constant over time η_i, an unobserved period effect that is common across cities γ_t and a component that varies across both cities and periods which we assume to be uncorrelated over time ε_{it}.

c. Econometric Issues and Estimation Techniques

Equation (1) confronts us with five econometric problems. First, some of the indicators may be measured with error. Second, the introduction of the lagged dependent variable together with cities' fixed effects renders the OLS estimator biased and inconsistent, as the lagged dependent variable is correlated with the error term even in the absence of serial correlation between ε_{it}. The third difficulty is that of omitted variables. Differences in economic growth across China reflect a variety of factors other than factor accumulation and FDI. To the extent that these factors are correlated with FDI, the significance of FDI in the growth regression in which they are omitted may simply reflect FDI serving as a proxy for other policies and institutions that are conducive to growth. The fourth concern arises from the fact that most of the explanatory variables may be endogenous with respect to economic growth. Notably, localities may choose to liberalise and reduce impediments to financial flows when growth performance is good. Finally, the equation ignores the role of spatial dependence, even though ignoring it could result in serious misspecification (Abreu et al., 2005).

(i) Spatial dependence

Spatial dependence can take two forms.[8] The first form is spatial autocorrelation, which describes how a city's income per capita can be affected by a shock

[8] See Anselin and Bera (1998) for an excellent introduction to spatial econometrics.

to income per capita in surrounding cities: shocks in neighbouring localities are correlated and so is the error term. If the spatial autocorrelation is erroneously ignored, standard statistical inferences are invalid; however, the parameter estimates are unbiased. The second form, of particular interest in testing the theories of economic growth (Blonigen et al., 2004), is a spatial lag model. In the spatial lag form, spatial dependence is captured by a term that is similar to a lagged dependent variable and thus is often referred to as spatial autoregression. Using standard notation, such a regression model can be expressed as: $y = \rho Wy + \beta X + \varepsilon$, where y is an n element vector of observations on the dependent variable, W is an $n \times n$ spatial weighting matrix, X is an $n \times k$ matrix of k exogenous variables, β is a k element vector of coefficients, ρ is the spatial autoregressive coefficient that is assumed to lie between −l and +1, and ε is an n element vector of error terms. The coefficient ρ measures how neighbouring observations affect the dependent variable.

Ignoring a spatial autoregressive term means that a significant explanatory variable has been omitted. The consequence is that the estimates of β are biased and all statistical inferences are invalid.

(ii) Spatial dependence diagnostic

The robust Lagrange multiplier tests for spatial dependence hint at spatial dependence at a very high probability level. The tests reported in Table B1 (in Appendix B) fail to reject the null hypothesis of no error autocorrelation while they do not reject the presence of a spatial autoregressive pattern at the one per cent confidence level. We therefore proceed with the spatial lag model. The construction of the model relies on the weight matrix W, of major importance since it defines how space is accounted for. The construction of our weight matrix is discussed in Appendix C. We verify that our results are robust to the use of alternative weight matrices.[9]

We further rely on the Moran I-test (Moran, 1950) to check the presence of spatial dependence for all explanatory variables separately. This test is the most generally used to detect spatial interdependence patterns (Anselin, 2001). Significant presence of spatial dependence was found for the FDI-to-GDP ratio and for the income per capita. No spatial dependence was detected for the other right-hand-side variables (investment in human and physical capital and population growth).[10] We therefore augment equation (1) to include spatial lags of FDI and per capita income. Our model therefore explicitly accounts for deterministic sources of third-city effects for income and FDI. These effects enter as spatially

[9] As robustness checks, we used different cut-off points for spillovers such as the median distance in the sample, which is traditionally used in the literature. Results, available on request from the authors, remain virtually unchanged.

[10] This lack of spatial dependence may in part relate to the poor quality of the data, notably on schooling rate or physical investment. Notably, these indicators do not take into account the quality aspect.

weighted averages of these regressors. Weights, as discussed above, are based on distances between cities i and j:

$$\ln y_{i,t} = \alpha_0 \ln y_{i,t-T} + \alpha_1 \ln s_{K_{it}} + \alpha_2 \ln s_{H_{it}} + \alpha_3 \ln(n_{it} + g + \delta) + \alpha_4 \ln \mathrm{FDI}_{it} + \alpha_5 \ln Wy_{i,t} + \alpha_6 \ln \mathrm{WFDI}_{it} + \eta_i + \gamma_t + \varepsilon_{it}. \quad (2)$$

The last two control variables, ln $Wy_{i,t}$ and ln WFDI_{it} are defined in line with our efforts to account for spatial dependence within China. We successively introduce the spatially lagged[11] dependent variable (income per capita) and the spatially lagged FDI rate which are computed and based on the exogenous spatial weight matrix W.[12]

The estimation of equation (2) will determine whether income per capita in a given city is directly affected by income and FDI in surrounding regions. Results will shed light on the substitution or complementarity patterns of FDI and income as well as their strength through the estimated spatial lag coefficient.

Our results will be informative both in terms of convergence and growth as well as in terms of economic geography forces at play. We will observe the nature of income convergence processes once spatial effects are controlled for. From the economic geography perspective, our results will show how the growth rate of per capita GDP in a city is affected by that of neighbouring cities. As far as the impact of FDI on growth is concerned, we will obtain estimates of both the direct effect and the indirect effect on the growth rate, through the inclusion of the local and the spatially lagged FDI-to-GDP ratio, respectively.

(iii) Empirical strategy

As underlined by Abreu et al. (2005), including a spatially lagged dependent variable causes a simultaneity problem, which in spatial econometrics is typically solved by estimating a reduced form of the model using maximum likelihood or, as in Easterly and Levine (1998), by instrumenting the spatial lag. Elhorst (2005) proposes a first-differenced model to eliminate fixed effects and then derives an unconditional likelihood function. He claims this method is superior to the generalised method of moments (GMM) estimator. However, if the serially lagged variable is considered endogenous, other explanatory variables are not.

[11] The spatial lag of a variable X for a given locality i corresponds to the sum of spatially weighted values of X for surrounding locations. They are computed as spatially lagged $WX = \Sigma_{j \neq i}(X_j w_{ij})$, with w_{ij} being the spatial weights defined by W. The spatially-weighted variable has the simple interpretation of a proximity-weighted average of the variable in alternative cities.

[12] Spatial lags for all other explanatory variables of the model, such as physical and human capital investment and population growth, are not included since tests based on the Moran I statistics rejected the presence of spatial dependence for these indicators. As a cautionary procedure, we nevertheless introduced them in the regression. We find not only that they failed to be significant both individually and jointly but also that their introduction induces a decrease in the sample size because of numerous missing values. As a consequence, we only report results with spatially lagged FDI and income.

Hence, if they are endogenous, which is very likely in our case, no instrumental treatment is implemented to control for this econometric problem. In this situation, the GMM thus appears to be the best estimator as it corrects for the potential endogeneity of other explanatory variables.[13] We adopt the generalised method of moments, which is the prominent way to address the problems of estimating growth regressions and rely on the system GMM estimator as proposed by Arellano and Bover (1995) and Blundell and Bond (1998) to overcome the problem of weak instruments observed in first-difference GMM.[14]

The basic idea of system GMM is to estimate equation (2) as a system of two equations, one in first differences and the other one in levels. Lagged first differences and lagged levels are used as instruments for equations in levels and for equations in first differences, respectively. The use of instrumental variables allows consistent estimation of the parameters even in the presence of measurement error and endogenous right-hand-side variables (such as investment, schooling rates and openness to FDI in our context of economic growth).

Bond et al. (2001) and Caselli et al. (1996) establish a bound for the autoregressive parameter in growth models analysis. Observed biases in the OLS and within estimators in growth models are used as references to define upper and lower bounds for the autoregressive parameter. As Hsiao (1986) shows, omitting unobserved time-invariant cities effects in a dynamic panel data model causes OLS-level estimates to be inconsistent and biased upward. This is due to the positive correlation between the lagged dependent variable and the permanent cities fixed-effect. The within estimator, however, which takes into account the unobserved location-specific effects, produces the opposite, a downward bias with the extent of attenuation increasing when exogenous covariates are added (Nickell, 1981).

4. EMPIRICAL ESTIMATION RESULTS

a. Validity Tests

The consistency of the system GMM estimator depends on whether lagged and first-differenced values of the explanatory variables are valid instruments in the growth regression. We address this issue by considering two specification tests.

The overall validity of the instruments can be tested using the standard Hansen test of over-identifying restrictions. It analyses the sample analogue of the moment conditions used in the estimation process. The figures reported in the result tables for the Hansen test are the χ^2 values for the null hypothesis of valid specification.

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[13] Another drawback of the maximum likelihood method is that it does not control for the presence of measurement errors.

[14] Refer to Badinger et al. (2004), Bond et al. (2001) and Weeks and Yudong (2003), among others, for a good discussion of this issue.

We also report tests for first-order and second-order serial correlation in the first-differenced residuals. If the disturbances ε_{it} are not serially correlated, there should be evidence of a significant negative first-order serial correlation in differenced residuals and no evidence of second-order serial correlation in the first-differenced residuals. Significant second-order serial correlation of the first-differenced residual indicates that the original error term is serially correlated and thus that the instruments are misspecified. Alternatively, if the test fails to reject the null hypothesis of no second-order serial correlation, we conclude that ε_{it} is serially uncorrelated and the moment conditions are well specified.

The Sargan test of over-identifying restrictions does not indicate a serious problem with the validity of the instrumental variables. Failure to reject the null hypothesis of no second-order serial correlation attested by the test statistics insignificance provides further support to the model.

b. Results

Results are displayed in Tables 1 and 2. We check the robustness of our results by proceeding successively to cross-section, pooling, (fixed effects) panel and GMM estimations. Table 1 reports OLS regressions in cross-section of average

TABLE 1
OLS

Between Estimations	*Dependent Variable: Real GDP Per Capita*			
	Column 1	*Column 2*	*Column 3*	*Column 4*
Initial income	0.789 (0.072)***	0.711 (0.074)***	0.781 (0.065)***	0.720 (0.072)***
Physical capital investment	–0.007 (0.058)	0.026 (0.059)	0.022 (0.061)	0.038 (0.061)
Human capital investment	0.030 (0.029)	0.060 (0.029)**	0.061 (0.031)*	0.073 (0.030)**
Population growth+g+δ	–0.402 (0.154)***	–0.378 (0.153)**	–0.479 (0.150)***	–0.432 (0.155)***
Foreign direct investment	0.167 (0.027)***	0.111 (0.027)***	0.100 (0.034)***	0.079 (0.032)**
Spatially lagged income per capita		0.366 (0.106)***		0.294 (0.107)***
Spatially lagged FDI			0.174 (0.056)***	0.112 (0.059)*
Constant	1.311 (0.554)**	–0.368 (0.730)	1.360 (0.508)***	0.009 (0.705)
No. of observations	175	175	175	175
R-squared	0.71	0.73	0.72	0.74

Notes:
Heteroscedastic-consistent standard errors in parentheses, with ***, ** and * denoting significance at the 1, 5 and 10 per cent level, respectively.

TABLE 2
Estimations Pooling, Panel and GMM

Estimations	*Pooling*			*Within*			*System GMM*				
	Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*	*Column 8*	*Column 9*	*Column 10*	*Column 11*
Initial income	0.949 (0.021)***	0.913 (0.025)***	0.912 (0.028)***	0.186 (0.053)***	0.172 (0.057)***	0.172 (0.057)***	0.979 (0.058)***	0.879 (0.045)***	0.788 (0.057)***	0.868 (0.045)***	0.787 (0.052)***
Physical capital investment	–0.001 (0.014)	0.013 (0.015)	0.001 (0.016)	–0.058 (0.062)	–0.066 (0.061)	–0.066 (0.061)	0.116 (0.062)*	0.069 (0.033)**	0.204 (0.061)***	0.067 (0.035)*	0.129 (0.040)***
Human capital investment	0.017 (0.009)*	0.027 (0.010)***	0.034 (0.011)***	0.126 (0.025)***	0.127 (0.032)***	0.127 (0.032)***	0.086 (0.049)*	0.053 (0.029)*	0.074 (0.035)**	0.055 (0.024)**	0.039 (0.023)*
Pop. growth+g+δ	–0.092 (0.025)***	–0.089 (0.023)***	–0.078 (0.021)***	–0.017 (0.020)	–0.029 (0.021)	–0.032 (0.020)	–0.240 (0.035)***	–0.197 (0.035)***	–0.201 (0.034)***	–0.178 (0.032)***	–0.127 (0.063)**
Foreign direct investment	0.037 (0.007)***	0.025 (0.006)**	0.019 (0.007)**	0.014 (0.008)**	0.015 (0.008)**	0.015 (0.008)**		0.052 (0.026)**	0.028 (0.015)*	0.022 (0.012)*	0.022 (0.013)*
Spatially lagged income		0.148 (0.031)***	0.154 (0.029)***		0.579 (0.098)***	0.581 (0.098)***				0.619 (0.094)***	0.208 (0.099)**
Spatially lagged FDI			–0.019 (0.017)			–0.006 (0.031)			0.063 (0.037)*		0.109 (0.043)**
Constant	0.384 (0.123)***	–0.133 (0.151)*	–0.479 (0.206)**	3.282 (0.407)***	0.653 (0.644)	0.629 (0.573)	–1.130 (0.431)***	–0.058 (0.384)	–3.217 (0.545)***	0.130 (0.307)	–0.351 (0.592)
Hansen test							12.28	40.01	21.80	51.00	38.82
AR(1) test							–5.67***	–5.25***	–5.30***	–5.19***	–5.35***
AR(2) test							–1.08	–1.01	–1.47	–1.42	–1.45
No. of observations	709	709	709	709	709	709	704	704	704	704	704
R-squared	0.91	0.91	0.91	0.96	0.96	0.96					

Notes:
Heteroscedastic-consistent standard errors in parentheses, with ***, ** and * denoting significance at the 1, 5 and 10 per cent level, respectively.

real GDP per capita growth over the period from 1990 to 2002. Average real per capita income is regressed on lagged income, population growth, physical and human capital investment and on FDI rate. Spatially lagged FDI and income are then added to the benchmark specification. Our results show that FDI has a beneficial impact on economic growth. The positive and significant impacts of spatially lagged FDI and income per capita provide initial evidence of the spatial complementarity of FDI and income benefits in China. The remainder of the analysis relies on the decomposition of our 12-year sample between 1990 and 2002 into four sub-periods of three years.

Table 2 yields initial results based on the pooled observations. The middle panel reports within regressions while the right-hand-side panel provides system GMM estimates. GMM coefficients are based on the one-step GMM estimator,[15] with standard errors that are not only asymptotically robust to heteroscedasticity but have also been found to be more reliable for finite sample inference (Blundell and Bond, 1998).[16]

Regression results are presented following a similar logical order of determinants introduction. Local FDI rate and spatially lagged FDI and income are successively added to the restricted augmented Solow model.

As expected by the Solow model, the proxy for investment in education enters positively and significantly in all regressions except in the first column of Table 1. Consistent with theory, population growth is generally associated with lower per capita GDP growth. The proxy for physical investment fails to enter significantly with the exception of the GMM specifications. The lack of significance of the proxy of fixed capital investment is deceptive but is not inconsistent with other studies (Boyreau-Debray, 2003). However, estimated parameters become positive and significant once the GMM estimator is used. The results therefore suggest that the initial lacking significance of capital investment is due to econometric problems such as endogeneity and measurement errors that are controlled for when GMM estimators are used.

Results of the traditional augmented Solow model are robust to the introduction of inter-city heterogeneity in terms of FDI inflows. The FDI-to-GDP ratio appears to be a positive and significant determinant of per capita GDP in all specifications. As widely recognised in the empirical literature on China's growth (Démurger and Berthélemy, 2000), higher FDI rates promote Chinese cities' growth. Note that the strength of FDI impact on growth is slightly reinforced when the GMM estimator controls for endogeneity and other econometric problems. Our results underline that the larger a city's FDI-to-GDP ratio, the greater its economic growth.

The system GMM estimator is expected to address the inconsistency of both OLS and within estimators due to endogeneity. As explained above, pooled and

[15] Estimations are computed with the xtabond2 stata command provided by Roodman (2005).
[16] In finite-sample samples, the asymptotic standard errors associated with the two-step GMM estimators can be seriously biased downwards and thus be an unreliable guide for inference.

within estimator results provide the upper and lower bounds for the autoregressive parameter as recommended by Bond et al. (2001). As argued by Hsiao (1986), OLS yields an upward bias while the within estimator produces a downward bias (Nickell, 1981). While OLS values are around 0.92, they drop sharply to values of around 0.17 when the within estimator is used. As expected, the autoregressive coefficients estimated based on GMM fall between these bounds: they lie close to 0.80. Relying on these results and on validity tests, we consider system GMM estimates as our preferred specification.

We now shed light on estimates of spatially lagged variables. The introduction of spatially lagged indicators of per capita income and FDI ratio confirms that income per capita and FDI-to-GDP ratio in a given city relate positively to that in surrounding cities. The coefficient estimates for spatially lagged variables are positive and significant when endogeneity problems are controlled for by the system GMM estimator. The spatial autoregressive parameter lies between −1 and +1, as assumed in the spatial lag model discussed in Section 3. All estimators clearly provide evidence in favour of spreading effects both in terms of FDI and income per capita. Hence, our results signal the importance of including spatially lagged variables in growth estimations.

We can note that the coefficient on the lagged GDP per capita decreases when spatially lagged variables are accounted for. These findings support the idea that controlling for spatial interdependence in terms of income and FDI produces a faster estimated speed of convergence. Therefore, they support an underestimation bias when spatial relations due to geographic proximity are not accounted for. The speed of convergence rises from 0.7 per cent per annum in Column 7 to more than eight per cent in Column 11 when spatially lagged variables are both included (four per cent when only the spatial FDI variable is introduced). These estimates yield a higher speed of convergence than those of Weeks and Yudong's (2003) study on China's growth for the 1978–97 period. They found a maximum convergence speed equal to 2.5 per cent using first-difference and system GMM estimators without spatial dimension.

The positive and significant coefficient on the spatially lagged FDI points out that cities benefit from the FDI flows received by neighbouring cities. We also state that FDI rate coefficients remain significant confirming the importance of local as well as proximate FDI flows. Our results therefore suggest intensive positive spatial spillover effects of FDI inflows on economic growth. In other words, higher FDI-induced income in a given location does not appear to occur at the expense of surrounding cities.

Table B4 in Appendix B computes the average impact on the explained variable from a one-standard-deviation increase in the various explanatory variables. Minimum and maximum values of the coefficients are taken from GMM estimations. We find the impact of an increase in the level of income per capita in surrounding areas to be almost double since our results indicate that a one-standard-deviation (50 per cent) increase in real GDP per capita in the surroundings could increase local income by around ten per cent. Our results thus provide some evidence of spatial dependence in terms of economic development as shown by the positive and significant impact of the spatial lag of per capita income. They are in line with positive and significant wealth spillovers in China. The strength of complementarity patterns brought to light by the positive and large coefficient of the spatial variable gives good reason to think that wealth of the richest cities will ultimately benefit not only surrounding but also more distant cities.

Our point estimates suggest that a one-standard-deviation (seven percentage points) increase in the local FDI rate increases income per capita in the same proportion as a one-standard-deviation (four percentage points) increase in the FDI rate in the surrounding localities, i.e. by around five per cent. Our results indicate that a policy of promoting FDI can be justified since they highlight inter-city spillover effects of FDI presence in addition to direct positive effect on local income per capita.

5. CONCLUSION

This study reconsiders the question of the impact of FDI on China's recent growth experience from a spatial econometric perspective. Our analysis covers 180 Chinese cities over the period 1990–2002. While the growth literature has largely treated the endogeneity problem of dynamic panels thanks to GMM estimators, it has almost never addressed the joint problem of endogeneity and omitted variable bias due to spatial dependence between cities.

We estimate a per capita income convergence model that incorporates an explicit consideration of these spatial dependence effects. We include spatially lagged levels of FDI and per capita GDP since we have significantly detected the presence of spatial dependence in these two variables. We verify the robustness of our results as we rely successively on cross-section, pooling, panel and GMM estimations. Moreover, incorporating spatial effects into our dynamic panel data estimation significantly raises the speed of convergence in comparison with findings of the literature on China's growth. Our empirical approach significantly corrects the estimated annual beta convergence speed upwards from two to eight per cent per annum.

It is also revealed that Chinese cities take advantage not only of their own FDI inflows but also of FDI flows received by their neighbouring cities. They further benefit from income per capita spillover effects, evidencing a spatial dependence in terms of economic development. We find that a one-standard-deviation increase in the local FDI rate increases income per capita in the same proportion as a one-standard-deviation increase in the FDI rate in the surrounding localities, i.e. by around five per cent. We also find evidence of a positive and significant impact of the level of income per capita in surrounding areas on cities' own income per capita. As a consequence, we can conclude that a policy of promoting FDI can be justified since Chinese cities appear to benefit from FDI flowing locally and in the surroundings.

APPENDIX A

FIGURE A1
Administrative Structure in China

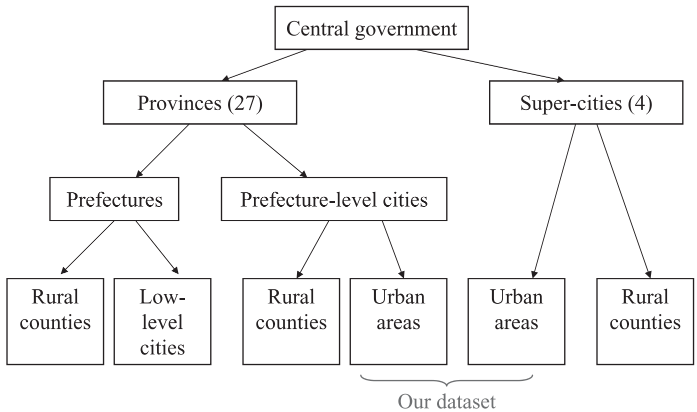

FIGURE A2
Spatial Distribution of FDI to GDP Rate (2002)

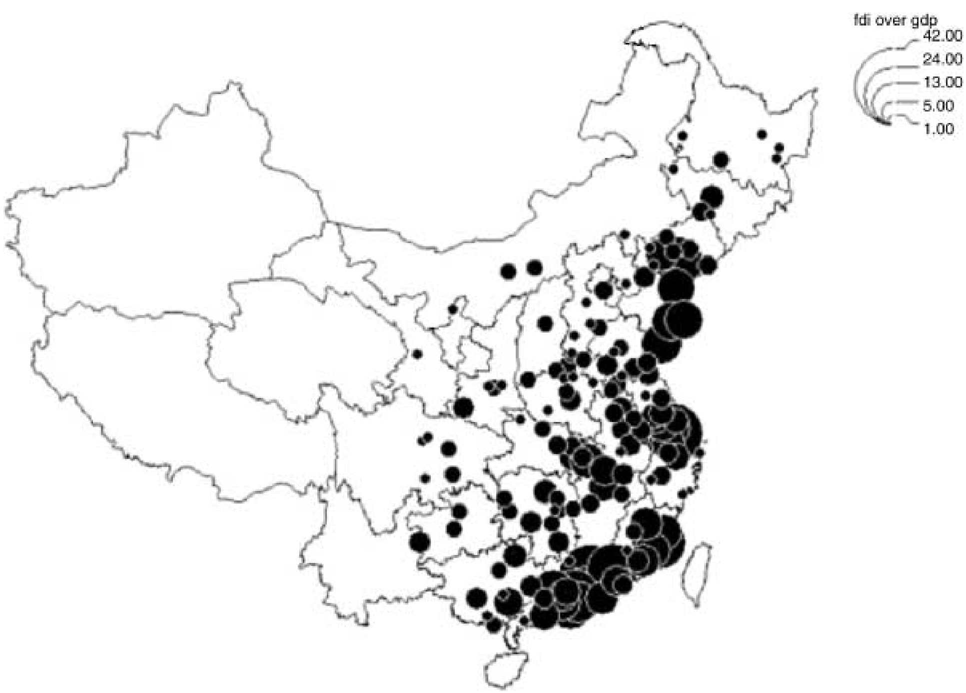

FIGURE A3
Spatial Distribution of GDP Per Capita (2002)

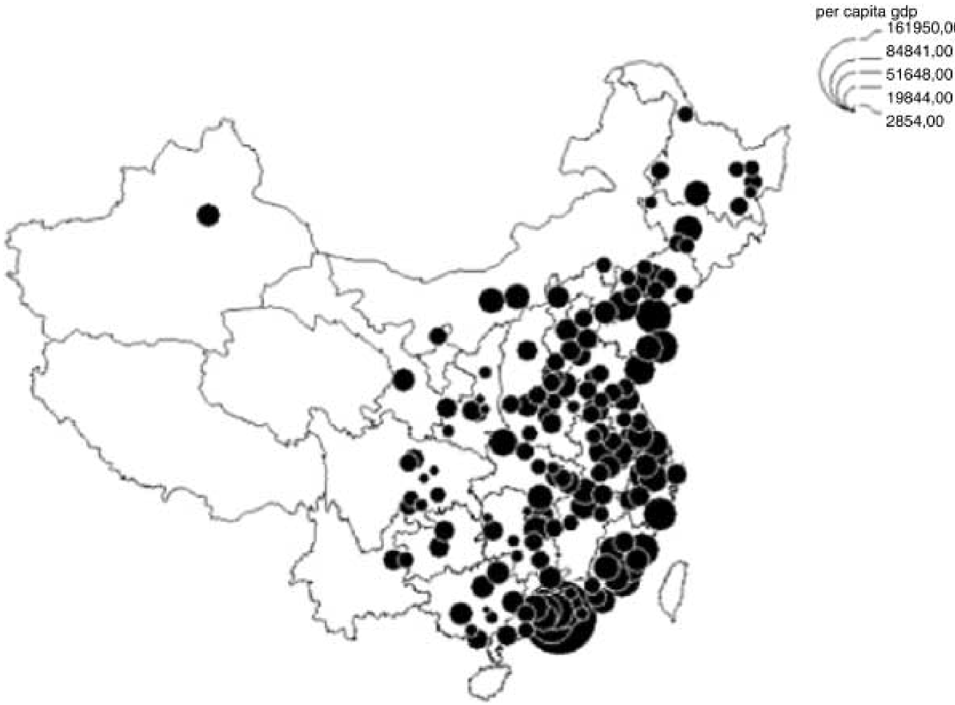

TABLE A1
List of Cities

Province	*City*	*Province*	*City*	*Province*	*City*	*Province*	*City*
Beijing	Beijing	Shanghai	Shanghai	Shandong	Weifang	Guangdong	Zhanjiang
Tianjin	Tianjin	Jiangsu	Nanjing	Shandong	Jining	Guangdong	Maoming
Hebei	Shijiazhuang	Jiangsu	Wuxi	Shandong	Taian	Guangdong	Huizhou
Hebei	Tangshan	Jiangsu	Xuzhou	Shandong	Dezhou	Guangdong	Zhaoqing
Hebei	Qinhuangdao	Jiangsu	Changzhou	Shandong	Weihai	Guangdong	Chaozhou
Hebei	Handan	Jiangsu	Suzhou	Shandong	Linyi	Guangdong	Meizhou
Hebei	Xingtai	Jiangsu	Nantong	Shandong	Laiwu	Guangdong	Zhongshan
Hebei	Baoding	Jiangsu	Liayungang	Shandong	Rizhao	Guangdong	Dongguan
Hebei	Zhangjiakou	Jiangsu	Huayin	Henan	Zhengzhou	Guangdong	Shanwei
Hebei	Chengde	Jiangsu	Yancheng	Henan	Kaifeng	Guangdong	Heyuan
Hebei	Cangzhou	Jiangsu	Yangzhou	Henan	Luoyang	Guangdong	Yangjiang
Hebei	Langfang	Jiangsu	Zhenjiang	Henan	Pingdingshan	Guangdong	Qingyuan
Hebei	Hengshui	Jiangsu	Taizhou	Henan	Anyang	Guangdong	Jieyang
Shanxi	Taiyuan	Zhejiang	Hangzhou	Henan	Hebi	Guangdong	Yunfu
I. Mongolia	Hohhot	Zhejiang	Ningbo	Henan	Xinxiang	Guangxi	Nanning
I. Mongolia	Baotou	Zhejiang	Wenzhou	Henan	Jiaozuo	Guangxi	Liuzhou
I. Mongolia	Chifeng	Zhejiang	Jiaxing	Henan	Puyang	Guangxi	Guilin
Liaoning	Shenyang	Zhejiang	Huzhou	Henan	Xuchang	Guangxi	Wuzhou
Liaoning	Dalian	Zhejiang	Shaoxing	Henan	Luohe	Guangxi	Beihai
Liaoning	Anshan	Zhejiang	Jinhua	Henan	Sanmenxia	Guangxi	Yulin
Liaoning	Fushun	Zhejiang	Quzhou	Henan	Shangqiu	Guangxi	Qinzhou
Liaoning	Dandong	Zhejiang	Zhoushan	Henan	Nanyang	Guangxi	Guigang
Liaoning	Jinzhou	Anhui	Hefei	Hubei	Wuhan	Hainan	Haikou
Liaoning	Yingkou	Anhui	Wuhu	Hubei	Huangshi	Hainan	Sanya
Liaoning	Fuxin	Anhui	Bengbu	Hubei	Shiyan	Chongqing	Chongqing
Liaoning	Liaoyang	Anhui	Huainan	Hubei	Jingzhou	Sichuan	Chengdu
Liaoning	Panjin	Anhui	Maanshan	Hubei	Xiangfan	Sichuan	Zigong
Liaoning	Chaoyang	Anhui	Huaibei	Hubei	Ezhou	Sichuan	Luzhou
Liaoning	Huludao	Anhui	Tongling	Hubei	Jingmen	Sichuan	Deyang

Jilin	Changchun	Anhui	Anqing	Hubei	Xiaogan	Sichuan	Mianyang
Jilin	Jilin	Anhui	Huangshan	Hubei	Huanggang	Sichuan	Guangyuan
Jilin	Siping	Anhui	Chuzhou	Hunan	Changsha	Sichuan	Suining
Jilin	Liaoyuan	Fujian	Fuzhou	Hunan	Zhuzhou	Sichuan	Neijiang
Jilin	Tonghua	Fujian	Xiamen	Hunan	Xiangtan	Sichuan	Leshan
Jilin	Baishan	Fujian	Putian	Hunan	Hengyang	Sichuan	Yibin
Jilin	Baicheng	Fujian	Sanming	Hunan	Shaoyang	Sichuan	Nanchong
Heilongjiang	Harbin	Fujian	Quanzhou	Hunan	Yueyang	Guizhou	Guiyang
Heilongjiang	Gigihaer	Fujian	Zhangzhou	Hunan	Yiyang	Guizhou	Luipanzhui
Heilongjiang	Jixi	Fujian	Nanping	Hunan	Changde	Guizhou	Zunyi
Heilongjiang	Hegang	Fujian	Longyan	Hunan	Chenzhou	Yunnan	Kunming
Heilongjiang	Shuangyashan	Jiangxi	Nanchang	Hunan	Yongzhou	Yunnan	Qujing
Heilongjiang	Daqing	Jiangxi	Jingdezhen	Hunan	Huaihua	Shaanxi	Xian
Heilongjiang	Yichun	Jiangxi	Pingxiang	Hunan	Zhangjiajie	Shaanxi	Tongchuan
Heilongjiang	Jiamusi	Jiangxi	Jiujiang	Guangdong	Guangzhou	Shaanxi	Baoji
Heilongjiang	Qitaihe	Jiangxi	Xinyu	Guangdong	Shaoguang	Shaanxi	Xianyang
Heilongjiang	Mudanjiang	Jiangxi	Yingtan	Guangdong	Shenzhen	Shaanxi	Yanan
Heilongjiang	Heihe	Shandong	Jinan	Guangdong	Zhuhai	Shaanxi	Hanzhong
		Shandong	Qingdao	Guangdong	Shantou	Shaanxi	Weinan
		Shandong	Zibo	Guangdong	Foshan	Gansu	Lanzhou
		Shandong	Zaozhuang	Guangdong	Jiangmen	Ningxia	Yinchuan
		Shandong	Dongying			Xinjiang	Urumqi
		Shandong	Yantai				

APPENDIX B

TABLE B1
Spatial Dependence Diagnostics

Test	*Statistic*	*p-Value*
Spatial error		
Moran's I	2.748	0.006
Lagrange multiplier	5.339	0.021
Robust Lagrange multiplier	0.138	0.710
Spatial lag		
Lagrange multiplier	11.731	0.001
Robust Lagrange multiplier	6.530	0.011

TABLE B2
Summary Statistics

Variable	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
Income per capita	81.55	70.92	6.99	972.57
FDI over GDP	0.05	0.07	0.00	0.62
Human capital investment	0.02	0.02	0.00	0.10
Spatially lagged income per capita	81.43	37.40	18.67	276.48
Spatially lagged FDI over GDP	0.05	0.04	0.00	0.30
Population growth+g+δ	0.03	0.04	–0.03	0.29

TABLE B3
Correlation Matrix

	Income Per Capita	*Initial Income Per Capita*	*Human Cap. Inv.*	*FDI Over GDP*	*Phys. Cap. Inv.*	*Pop. Growth*	*Spat. Lagged FDI*
Initial income	0.9385*	1.0000					
Human capital inv.	0.4414*	0.4520*	1.0000				
FDI over GDP	0.4429*	0.2705*	0.2278*	1.0000			
Physical capital inv.	0.3970*	0.4764*	0.3289*	–0.1205*	1.0000		
Population growth+g+δ	0.1941*	0.2907*	0.1748*	0.1739*	0.0100	1.0000	
Spat. lagged FDI	0.4125*	0.1930*	–0.0445	0.6650*	–0.2609*	0.1712*	1.0000
Spat. lagged income	0.6572*	0.5941*	0.2143*	0.5036*	0.5266*	0.1142*	0.6269*

Note:
* denotes significance at the 10 per cent level.

TABLE B4
Impact of One Standard Deviation Increase Over Mean of Explanatory Variables on Income Per Capita Statistics

Variable	*Minimum (Per cent)*	*Maximum (Per cent)*
FDI over GDP	3.0	7.2
Human capital investment	3.9	8.5
Spatially lagged income per capita	9.6	28.5
Spatially lagged FDI over GDP	5.3	9.1

APPENDIX C

SPATIAL WEIGHT MATRIX

The spatial weight matrix is used to evaluate the covariance of characteristics across locations. It contains information about the relative dependence between the cities in our sample. We assume that the intensity of the relation between cities depends on the distance between them. The literature suggests various alternative weighting methods. The most widely used methods rely on contiguity and distance between localities, but differ in the functional form used. As recommended by Anselin and Bera (1998) and Keller (2002), the elements of the matrix have to be exogenous,[17] otherwise the empirical model becomes highly non-linear. We choose a spatial weighting matrix W that depends exclusively on the geographical distance d_{ij} between cities i and j since the exogeneity of distance is absolutely unambiguous. Distance-based weights are defined as follows:

$$w^*_{ij} = 0, \quad \text{if } i = j$$

$$w^*_{ij} = 1/d^2_{ij}, \quad \text{if } d_{ij} \leq 1{,}624$$

$$w^*_{ij} = 0, \quad \text{if } d_{ij} > 1{,}624$$

$$w_{ij} = w^*_{ij} \Big/ \sum_j w^*_{ij},$$

where w^*_{ij} is an element of the unstandardised weight matrix and w_{ij} is an element of the standardised weight matrix. d_{ij} is the distance in kilometres between cities i and j. The distance 1,624 km is the cut-off parameter above which interactions are assumed to be negligible. This distance has been chosen so that each

[17] This condition is a prerequisite for the introduction of spatial econometrics.

city interacts with at least one other Chinese city. This cut-off parameter is important since there must be a limit to the range of spatial dependence allowed by the spatial weights matrix (Abreu et al., 2005). This is due to the asymptotical feature required to obtain consistent estimates for the parameters of the model. We use the inverse squared distance in order to reflect a gravity relation. The matrix is row-standardised so that each row sums to one and each weight may be interpreted as the province's share in the total spatial effect of the country.

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