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Contents

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SUMMARY

This paper provides a case study of whether foreign direct investment (FDI) promotes economic growth when accounting for spatial dependence. 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 positive impact on economic growth is characterized by a substitution or a complementary pattern across Chinese cities, i.e. whether economic growth is fostered by FDI received locally as well as FDI received in surrounding localities.

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

However, empirical studies have so far produced inconclusive results regarding spillovers. 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.

An important empirical literature exists on openness to trade, or to FDI, and economic growth. This literature has been criticized for having failed to consider the possible reverse causation between openness and growth. 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, 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 is completely neglected even though it is an important force in the process of convergence and ignoring it could result in serious misspecification. 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. A per capita income growth model is estimated, relying on dynamic panel Generalized Method of Moments estimations that control for endogeneity, variable omission and spatial dependence problems. The question is whether FDI inflows in one locality promote growth in this locality and/or in the surrounding localities.

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 increase in the local FDI rate raises income per capita in the same proportion than a one standard deviation increase in the FDI rate in the surrounding localities, i.e. by around 5%. 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 increase in real GDP per capita in the surroundings could increase local income by around 10%.

[1]We would like to thank two anonymous referees for their comments. We are also grateful to Agnès Bénassy-Quéré for her corrections and suggestions.

ABSTRACT

We study the impact of FDI on growth performance. We rely on a data set of Chinese cities between 1990 and 2002 to investigate the effects of FDI in the traditional growth regression framework using the GMM estimator for dynamic panels. Our growth model incorporates an explicit consideration of spatial dependence effects in the form of spatially lagged income and FDI. Our results reveal that Chinese cities take advantage not only of FDI flows received locally but also of FDI flows received by their neighbors.

JEL classification: E1, O1, O5, R1.
Keywords: Growth, Regional convergence, Economic geography, Foreign Direct Investment, China.

L'INVESTISSEMENT DIRECT À L'ÉTRANGER EN CHINE: EXTERNALITÉS ET IMPACT SUR LA CROISSANCE.

RÉSUMÉ

Nous étudions l'impact des investissements directs étrangers (IDE) sur la croissance économique en Chine en tenant compte des effets de la dépendance spatiale. Nous avons recours à une base de données infranationales à l'intérieur de la Chine pour estimer une équation de croissance en panel dynamique. Nous prenons explicitement en compte le fait que les villes chinoises peuvent tirer profit non seulement des IDE reçus localement mais aussi de ceux reçus dans les localités environnantes. Nous déterminons si les IDE sont caractérisés par une relation de complémentarité ou de substitution entre les villes chinoises.

En lien avec les avantages attendus des IDE, de nombreux pays en développement et en transition ont cherché à favoriser l'implantation d'investisseurs étrangers. Les gouvernements attendent des IDE qu'ils apportent des transferts de technologie, une amélioration de la gestion et du marketing et ainsi qu'ils encouragent les gains de productivité et de compétitivité des industries nationales. L'attraction des IDE est devenue une priorité pour les pays désireux de rattraper l'avance technologique des pays développés.

Les études empiriques s'intéressant au lien entre IDE et croissance ont pourtant souvent obtenu des résultats non concluants. Les difficultés associées à la distinction entre les différents effets en jeu ainsi que le manque de données ont limité la capacité des chercheurs à fonder un consensus sur l'existence d'externalités positives des IDE. Une littérature empirique importante existe sur les liens entre ouverture commerciale, IDE et croissance économique. Cette littérature a néanmoins été critiquée pour sa non prise en compte de la possible causalité inverse entre l'ouverture et la croissance. Une autre limite de ces études est que l'hétérogénéité en termes de systèmes légaux et autres institutions pourrait avoir un effet à la fois sur les IDE et sur la croissance, ce dernier pouvant être incorrectement attribué aux IDE. Enfin, ces études considèrent traditionnellement chaque région ou pays comme une entité isolée. Le rôle de la dépendance spatiale est ainsi ignoré alors qu'il constitue une force importante du processus de convergence et que sa non prise en compte produit un problème de spécification.

Cette étude explore les variations régionales à l'intérieur d'un pays unique (la Chine). Un modèle de croissance du revenu par tête est estimé par la méthode des moments généralisés en panel dynamique qui résout les problèmes d'endogéneité, d'omission de variables et de dépendance spatiale.

Nos résultats indiquent que les relations spatiales entre les villes chinoises comptent. Les estimations suggèrent que la croissance économique des villes répond positivement aux IDE reçus localement ainsi qu'à ceux obtenus par les villes environnantes.

RÉSUMÉ COURT

Cette étude réexamine la question de l'impact des IDE sur la performance de croissance. Nous exploitons une base de données de villes chinoises entre 1990 et 2002 pour étudier les effets des IDE dans le cadre traditionnel de régression de la croissance en utilisant l'estimateur GMM pour les panels dynamiques. Notre modèle de croissance incorpore des effets de dépendance spatiale sous la forme de termes de revenu et d'IDE spatialement décalés. Nos résultats revèlent que les villes chinoises tirent profit non seulement de leur propre ouverture aux IDE mais également des flux d'IDE reçus par leurs voisins.

Classification *JEL* : E1, O1, O5, R1.
Mots Clefs : Croissance, Convergence Régionale, Economie géographique, Investissements Directs Etrangers, Chine.

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 characterized 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" (p. 37). 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 Smarzynska, 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 regressions (Agosin and Mayer, 2000; Bosworth and Collins, 2000; Carkovic and Levine, 2002; Edison et al., 2002). This literature has been criticized 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

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dependence[4] 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, institutions changes follow a similar pattern across the country[5]. A per capita income growth model is estimated, relying on dynamic panel Generalized 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 aggregate 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 (fifty per cent) increase in real GDP per capita in the surroundings could increase local income per capita by around ten per cent. 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 analyzes 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.

[4]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 neighboring localities.

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

2 FDI impact and spillovers in China

2.1 FDI trends and policies

Since economic reforms launching in 1979, China has received a large part of international direct investment flows.[6] 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 fourteen coastal cities across ten provinces were opened, and FDI levels really started to take off. The realized value of inward FDI to China reached US$3.49 billion in 1990. This kind of preferential regimes policies resulted in an overwhelming concentration of FDI in the east. The expected spillover effects from coastal to inland provinces failed to materialize. 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 more nation-wide 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.

2.2 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 3 percent- with about 80 percent of the benefits coming from increased productivity (Tseng and Zebregs, 2002).

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

2.2.1 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.[7] 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 (3% 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) emphasizes the role of foreign investment enterprises (FIEs) in the modification of China's industrial structure, the diversification of labour intensive products 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% greater than that of directly 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 emphasized 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 leading

[7] 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.

to balance-of-payment deficits as a result of rising equity repayment obligations.

2.2.2 Spillover channels

Several channels of spillovers are identified in the literature (see Görg and Greenaway (2004) for a complete description of these channels):[8]

- 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). Incoming MNEs are expected to foster competition. This new competition compels them to adapt their technology and production processes. By reducing X-inefficiency, greater competition improves productivity.

- Exports spillovers are an additional source of productivity gain. Domestic firms learn from multinationals to implement an exporting strategy (Görg and Greenaway, 2004; Aitken et al., 1997). 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 labor in the host country. Hence they invest in technological know-how transfer or staff training. As a result, labor turnover from MNEs to local firms can generate productivity improvement by means of complementary workers or by stealing 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; Javorcik Smarzynska, 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 FIEs, the more likely and the more frequently their employees interact with each other, and the more frequently labor moves between these two firms. This spatial link may also be important for vertical spillovers between firms and their

[8]However, these transmission channels are constrained by the technology gap between local and foreign firms (Javorcik Smarzynska, 2002; Blömstrom, Globerman and Kokko, 1999). The scope of positive FDI spillovers is all the greater the smaller the technology gap between foreign and local firms.

local suppliers, which often are located close to one another. It is furthermore well recognized 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 organization of economic activity in space. As expressed in Tobler's (1979) 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; Rey and Montouri, 1999). These spatial aspects are especially important to account for since ignoring them could result in serious misspecification (Abreu et al., 2005).

2.3 Evidence on spillovers in China

Empirical evidence is still limited on FDI spillovers in China, but generally confirms that there are positive FDI spillovers (Tong and Hu, 2003; Hu and Jefferson, 2001). 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 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, Clegg and Wang (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.

While the above-mentioned papers suggest spillover effects from FDI, to our knowledge, only three papers use spatial econometric techniques to examine FDI activity although ignoring them could result in serious misspecification. They focus on FDI motivations and the geographic pattern of FDI location while correcting for third-country effects (Blonigen et al., 2004; Egger et al., 2006). Coughlin and Segev (2000) explain US FDI across Chinese provinces while accounting for the positive spatial correlation between local FDI and that received in alternative regions. These authors argue that it accounts for agglomeration economies. To our knowledge, no empirical work has directly tested the presence of FDI spillovers on economic growth between Chinese cities applying appropriate econometric techniques.

Labor and goods mobility constitute two straightforward channels through which spillovers from FDI would occur between cities. The labor mobility mechanism, through the movement of skilled workers from foreign firms to domestic firms, helps transfering advanced technology and management skills. Djankov and Hoekman (2000) and Görg and Strobl (2005) present evidence demonstrating the existence of labor mobility effect in the Czech republic and Ghana, respectively. In the case of China, Hale and Long (2006) find empirical evidence that the labor market channel facilitates FDI spillovers in Chinese cities. Labor 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 the society as a whole. Between 1990 and 1995, 13 million people (out of a recorded total of 33 million of migrants) engaged in a urban-urban migration either within the same province (9.6 million) or between two separate provinces (2.2 million)(Poncet, 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 mean of embedded technology transmission. Reform advances especially in terms of output rationalization and price liberalization 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

3.1 Data

The data set 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 data set covers 180 cities spread over the entire territory except for the provinces of Qinghai and Tibet. In order to explain the data set clearly, it is useful to provide a brief description of the Chinese administrative structure (see Figure A-1 in Appendix). The entire country is divided into 27 provinces plus four province-status "super-cities" – Beijing, Chongqing, Shanghai and Tianjin.[9] In each province (or supercity), the population is further divided into prefecture level cities and lower level cities and rural counties. Our data set consists of information on the urban part of those prefecture level cities.[10] 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 A-1 in the appendix A lists the various cities by province covered by the data set. Figures A-2 and A-3 (in Appendix A) show the geographic pattern in 2002 of

[9]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 data set does not include Hong Kong SAR, Macau SAR and Taiwan Province of China.

[10]In other words, the data does 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 over-estimate the impact of FDI on growth.

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 the Xinjiang province, only two cities in 2002 have this level of power, against 12 in the Hubei province. Moreover these cities are more recent and are thus characterized 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 comparable level of GDP per capita. The average GDP per capita in current terms in 2002 is 18,177 yuans. 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 (see Section 2). Numerous cities in the interior provinces are shown to have a ratio of FDI over GDP above three per cent.

3.2 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 data set 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 inward FDI rate in order to determine its influence on growth. Our strategy follows Easterly and Levine (1998)'s strategy.

$$\begin{aligned}\ln y_{i,t} = \alpha_0 \ln y_{i,t-T} + \alpha_1 \ln s_{K_{it}} + \alpha_2 \ln s_{H_{it}} + \alpha_3 \ln(n_{it} + g + \delta) \\ + \alpha_4 \ln FDI_{it} + \eta_i + \gamma_t + \epsilon_{it}\end{aligned} \tag{1}$$

where the dependent variable, $y_{i,t}$, 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 the 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}.

3.3 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 city 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 liberalize 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).

3.3.1 Spatial dependence

Spatial dependence can take two forms.[11] The first form is spatial autocorrelation, which describes how a city's income per capita can be affected by a shock to income per capita in surrounding cities: shocks in neighboring 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: $y = \rho Wy + \beta X + \epsilon$, where y is a n element vector of observations on the dependent variable, W is a $n \times n$ spatial weighting matrix, X is a $n \times k$ 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 neighboring 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.

3.3.2 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 B-1 (in the Ap-

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

pendix 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 the Appendix C. We verified that our results were robust to the use of alternative weight matrices.[12]

We further rely on the Moran's 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).[13] 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 weighted averages of these regressors. Weights, as discussed above, are based on distances between cities i and j:

$$\begin{aligned}\ln y_{i,t} = {} & \alpha_0 \ln y_{i,t-T} + \alpha_1 \ln s_{K_{it}} + \alpha_2 \ln s_{H_{it}} + \alpha_3 \ln(n_{it} + g + \delta) \\ & + \alpha_4 \ln FDI_{it} + \alpha_5 \ln Wy_{it} + \alpha_6 \ln WFDI_{it} + \eta_i + \gamma_t + \epsilon_{it}\end{aligned} \tag{2}$$

The last two control variables, $\ln Wy_{it}$ and $\ln WFDI_{it}$ are defined in line with our efforts to account for spatial dependence within China. We introduce the spatially lagged[14] dependent variable (income per capita) and the spatially lagged FDI rate which are computed and based on the exogenous spatial weight matrix W.[15]

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.

[12] 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 upon request, remain virtually unchanged.

[13] 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.

[14] 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 $WX_i = \sum_{j \neq i}(X_j w_{ij})$, 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.

[15] 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.

Our results will be informative 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 neighboring 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.

3.3.3 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 Generalized Method of Moments (GMM) estimator. However, if other explanatory variables than the serially lagged variable 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 appears to be the best estimator as it corrects for the potential endogeneity of all explanatory variables[16]. We adopt the Generalized 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[17].

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 economic growth framework).

Caselli et al. (1996) and Bond et al. (2001) 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 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 esti-

[16]Another drawback of the Maximum Likelihood method is that it does not control for the presence of measurement errors.

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

mator, however, which takes into account the unobserved location specific effects, produces on the opposite, a downward bias with the extent of attenuation increasing when exogenous covariates are added (Nickell, 1981).

4 Empirical estimation results

4.1 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 analyzes the sample analog of the moment conditions used in the estimation process. The figures reported in the result tables for the Hansen test are the Chi^2 values for the null hypothesis of a valid specification.
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 overidentifying restrictions does not indicate a serious problem with the validity of the instruments. Failure to reject the null hypothesis of no second order serial correlation attested by the test statistics insignificance provides further support to the model.

4.2 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 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 breakdown of our twelve 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[18], with standard errors that are not only asymptotically robust to heteroskedasticity but have also been found to be more reliable for finite sample inference (Blundell and Bond, 1998).[19]

Table 1: OLS

Between est.	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)***
Phys. cap. investment	-0.007 (0.058)	0.026 (0.059)	0.022 (0.061)	0.038 (0.061)
Human cap. investment	0.030 (0.029)	0.060 (0.029)**	0.061 (0.031)*	0.073 (0.030)**
Pop. 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)**
Spat. lagged Income per capita		0.366 (0.106)***		0.294 (0.107)***
Spat. 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)
Obs. Nb.	175	175	175	175
R-squared	0.71	0.73	0.72	0.74

Heteroskedastic consistent standard errors in parentheses,
with ***, ** and * denoting the significance at 1, 5 and 10% level.

Regression results are presented first based on a restricted specification. Spatially lagged FDI and income are then added to the model.

[18]Estimations are computed with the xtabond2 stata command provided by Roodman D. (2005).

[19]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.

As expected, 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 recognized 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 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. A positive coefficient is coherent with a complementarity pattern while a negative one would support a substitution relation between local and neighboring income. All estimators clearly provide evidence in favor 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 spatial FDI variable is introduced). These estimates yield a higher speed of convergence than those of Weeks and Yudong (2003) study on China's growth for the 1978-1997 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 neighboring cities. We also find 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 B-4 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 twice that of FDI since our results indicate that a one standard deviation (fifty percent) increase in aggregate real GDP per capita in the surroundings could increase local income by around ten per cent. 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 aggregate FDI rate in the surrounding localities, i.e. by around five 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 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 estimator, it has 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 upwards the estimated annual β-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 neighboring 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 raises 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.

Table 2: Estimations pooling, panel and GMM

	Pooling			Within			System GMM				
	1	2	3	4	5	6	7	8	9	10	11
Initial	0.94	0.91	0.91	0.18	0.17	0.17	0.97	0.87	0.78	0.868	0.787
income	(0.02)***	(0.02)***	(0.03)***	(0.05)***	(0.06)***	(0.06)***	(0.06)***	(0.04)***	(0.06)***	(0.04)***	(0.05)***
Phys.	-0.01	0.01	0.01	-0.06	-0.07	-0.07	0.12	0.07	0.20	0.07	0.12
cap. in.	(0.01)	(0.01)	(0.01)	(0.06)	(0.06)	(0.06)	(0.06)*	(0.03)**	(0.06)***	(0.03)*	(0.04)***
Human	0.02	0.03	0.03	0.13	0.13	0.13	0.09	0.05	0.07	0.06	0.04
cap. inv.	(0.01)*	(0.01)***	(0.01)***	(0.02)***	(0.03)***	(0.03)***	(0.05)*	(0.03)*	(0.03)**	(0.02)**	(0.02)*
Pop	-0.09	-0.09	-0.08	-0.02	-0.03	-0.03	-0.24	-0.20	-0.20	-0.18	-0.13
+g+δ	(0.03)***	(0.02)***	(0.02)***	(0.02)	(0.02)	(0.02)	(0.04)***	(0.04)***	(0.03)***	(0.03)***	(0.06)**
FDI	0.04	0.03	0.02	0.01	0.02	0.02		0.05	0.03	0.02	0.02
	(0.01)***	(0.01)**	(0.01)**	(0.01)**	(0.01)**	(0.01)**		(0.03)**	(0.01)*	(0.01)*	(0.01)*
Spat. lag.		0.15	0.15		0.58	0.58				0.62	0.21
Income		(0.03)***	(0.03)***		(0.10)***	(0.10)***				(0.09)***	(0.10)**
Spat. lag.			-0.02			-0.01			0.063		0.11)
FDI			(0.02)			(0.03)			(0.04)*		(0.04)**
Cons.	0.38	-0.13	-0.48	3.28	0.65	0.63	-1.13	-0.06	-3.22	0.13	-0.35
	(0.12)***	(0.15)*	(0.21)**	(0.41)***	(0.64)	(0.57)	(0.43)***	(0.38)	(0.54)***	(0.31)	(0.59)
Hansen							12.28	40.01	21.80	51.00	38.82
AR(1)							-5.67***	-5.25***	-5.30***	-5.19***	-5.35***
AR(2)							-1.08	-1.01	-1.47	-1.42	-1.45
Obs.	709	709	709	709	709	709	704	704	704	704	704
R^2	0.91	0.91	0.91	0.96	0.96	0.96					

Heteroskedastic consistent standard errors in parentheses,with ***, ** and * denoting the significance at 1, 5 and 10% level.

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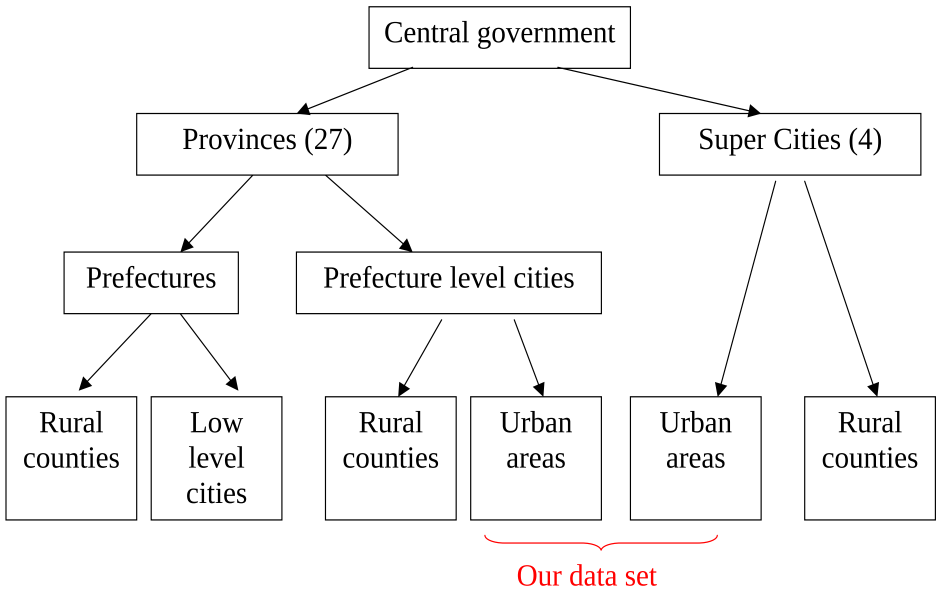
APPENDIX A

Figure 1: Administrative Structure in China



APPENDIX A Table A-1: 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				

Figure 2 : Spatial distribution of FDI to GDP rate (2002)

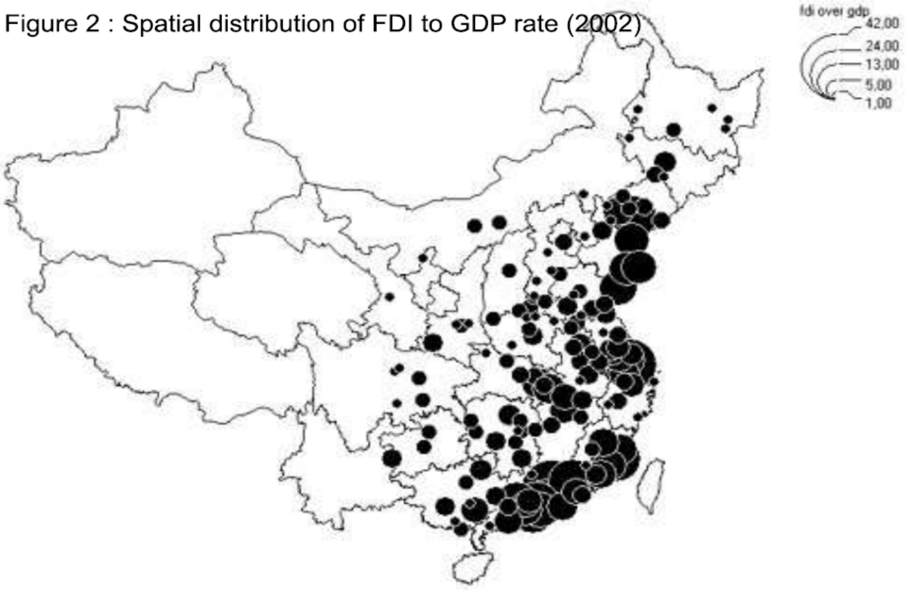


Figure 3 : Spatial distribution of GDP per capita (2002)

APPENDIX B

Table B-1: Spatial dependance 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 B-2: 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
Spat. lag. per cap. Income	81.43	37.40	18.67	276.48
Spat. lag. FDI/ GDP	0.05	0.04	0.00	0.30
Population growth+g+δ	0.03	0.04	-0.03	0.29

Table B-3: Correlation matrix

	Inc. per capita	Initial inc. per cap.	Human cap inv	FDI GDP	Phys. cap. inv.	Pop growth	Spat. lag. FDI
Initial Income	0.94*	1					
Hum. cap. inv.	0.44*	0.45*	1				
FDI over GDP	0.44*	0.27*	0.22*	1			
Phys. cap. inv.	0.39*	0.47*	0.32*	-0.12*	1		
Pop. +g+δ	0.19*	0.29*	0.17*	0.17*	0.01	1	
Spat. lagged FDI	0.41*	0.19*	-0.04	0.66*	-0.26*	0.17*	1
Spat. lagged Inc.	0.65*	0.59*	0.21*	0.50*	0.52*	0.11*	0.63*

Table B-4: Impact of one standard deviation increase
over mean of explanatory variables on income per capita statistics

Variable	Minimum	Maximum
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[20], 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:
$w_{ij}^* = 0$, if $i = j$
$w_{ij}^* = 1/d_{ij}^2$, if $d_{ij} \leq 1624$
$w_{ij}^* = 0$, if $d_{ij} > 1624$
and $w_{ij} = w_{ij}^* / \sum_j w_{ij}^*$
where w_{ij}^* is an element of the unstandardized weight matrix and w_{ij} is an element of the standardized weight matrix. d_{ij} is the distance in kilometers between cities i and j. The distance 1624 km is the cut-off parameter above which interactions are assumed to be negligible. This distance has been chosen so that each 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-standardized 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.

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

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