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Do Large Agglomerations Lead to Economic Growth? Evidence from Urban India

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DO LARGE AGGLOMERATIONS LEAD TO ECONOMIC GROWTH? EVIDENCE FROM URBAN INDIA

Sabyasachi Tripathi*

Abstract

The cities and towns of India constitute the world's second largest urban system besides contributing over 50 per cent of the country's Gross Domestic Product (GDP). This phenomenon has been neglected by the existing studies and writings on urban India. By considering 59 large cities in India and employing new economic geography models, this paper investigates the relevant state- and city-specific determinants of urban agglomeration. In addition, the spatial interactions between cities and the effect of urban agglomeration on India's urban economic growth are estimated. The empirical results show that agglomeration economies are policy-induced as well as market-determined and offer evidence of the strong positive effect of agglomeration on urban economic growth and support for the non-linearity of the Core-Periphery (CP) model in India's urban system.

Key Words: Urban Agglomeration, Urban Economic Growth, New Economic Geography, India.

JEL Classification: O18, R11, R12

1. Introduction

In the past large cities were found mainly in the industrialized nations. However, today many of the world's largest cities are found in the developing countries. As per *World Urbanization Prospects: 2009 Revision,* the number of cities with population in excess of one million in the United States of America (or India) was 12 (or 5) in 1950. It increased to 42 (or 46) in 2010 and was projected to reach 48 (or 59) by 2025. In an attempt to find the relevant factors responsible for the concentration of economic activities in cities, the link between urban agglomeration and urban economic growth was studied by Krugman (1991) and Fujita *et al.* (1999). It was done within the framework of New Economic Geography (NEG) with the productivity differential leading to a shift of resources from agriculture or hinterland region to an urban sector or core region. Compared to earlier location theories, a general equilibrium framework with imperfect competition is new in NEG.

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The population size and the number of urban centres in India are growing rapidly even as their geographical boundaries are expanding. In this context, as Narayana (2009) points out, there is a growing concentration of urban population in metropolitan areas (cities with a million-plus population) compared to non-metropolitan areas in India. The growth in population is attributable to various factors such as natural growth, rural-to-urban migration, expansion of city boundaries and reclassification of rural areas as urban. At the beginning of the Twentieth Century, for instance, there was only one city with a population of more than a million, namely, Kolkata (then known as Calcutta with a population of 1.5 million). In 1991, there were 23 cities with million-plus population accounting for about 33 per cent of the total urban population. However, by 2001, the number of million-plus cities increased to 35 (supporting about 38 per cent of the total urban population). Further, in 2001, there were six mega cities (with population over five million) in India, namely, Kolkata, Mumbai, Delhi, Chennai, Bangalore and Hyderabad.

The Indian urban economy too is growing and making a sizeable contribution to the country's national income. For instance, the share of urban economy in the total net domestic product (NDP) increased from 37.65 per cent in 1970-71 to 52.02 per cent in 2004-05 and accounted for about 6.2 per cent growth rate of urban NDP from 1970-71 to 2004-05 at constant prices (1999-00). Within urban NDP, the share of the industrial and service sectors was about 27 per cent and 72 per cent respectively in 2004-05 at constant (1999-00) prices.

The major explanation of urban agglomeration and its effect on economic growth has been studied in the NEG theory since the pioneering work of Krugman (1991). The NEG models involve a tension between the "centripetal" forces (pure external economics, variety of market scale effects and knowledge spillovers) that tend to pull population and the production process towards agglomerations and the "centrifugal" forces (congestion and pollution, urban land rents, higher transportation costs and competition) that tend to break up such agglomerations (Overman and Ioannides 2001, Tabuchi 1998). While formalizing the interplay of agglomeration and dispersion forces, the CP model explains the formation of dynamic urban system and finds a "∽"-shaped curve between the distance of a regional center and a local market potential in a single-core urban system (Partridge *et al* 2009, Fujita *et al* 1999). This curve shows that as the relative distance to a central city increases, the market potential declines first, later rises and then declines again. But CP models mostly remain difficult to manipulate analytically making the model consistent with data as most of the results derived in the literature are based on numerical simulation (Fujita and Mori 1997, Fujita *et al* 1999a) and the nonlinear nature of geographical phenomena (Fujita and Krugman 2004).

Black and Henderson's (1999) studies established that that population growth was faster in cities that are closer to a coast and cities with bigger initial populations, though this effect weakens as neighbouring population masses become larger. Dobkins and Ioannides (2000), Ioannides and Overman (2004), using the US metropolitan data for 1900-1990, provide evidence that the distance from the nearest higher-tier city is not always a significant determinant of size and growth and that there is no evidence of persistent non-linear effects of either size or distance on urban growth. Chen *et al* (2011) estimate the impact of spatial interactions in China's urban system on urban economic growth over the period 1990-2006. Their results verify the non-linearity of the CP Model of urban system and find presence of agglomeration shadow in Chinese urban economies.

In the context of identifying relevant factors behind urban agglomeration, Da Mata *et al* (2005) observe that increases in rural population supply, improvements in inter-regional transport connectivity and educational attainment of the labour force have a strong impact on city growth in Brazil. Ades and Glaeser (1995) find that, as predicted by Krugman and Elizondo (1996), countries with high shares of trade in GDP or low tariff barriers (even holding trade levels constant), rarely have population concentrated in a single city, but remain skeptical as to the existence of a direct casual link. The cross-country analysis shows the negative impact of the development of transportation networks and the positive impact of capital city dummy, non-urbanized population of a country, urbanized population outside the main city, real GDP per capita, share of the labour force outside of agriculture and the concentration of power in the hands of a small cadre of agents living in the capital city of a country. This is positively related to urban primacy in the main city of a country. Henderson (1986), Wheaton and Shishido (1981) show that across a small sample of countries, increased government expenditure, including non-federalist governments, leads to urban concentration. Further, Henderson (2010) finds that the level of urbanization and income per capita are highly correlated [R^2 =0.57].

Many studies have found a link between urban agglomeration and economic growth. Brülhart and Sbergami (2009) found that the agglomeration process boosted the growth of GDP only up to a certain level of economic development. Fujita and Thisse (2002) found that "growth and agglomeration go hand-in-hand," whereas a review paper by Baldwin and Martin (2004) emphasized on the result that given localized spillovers "spatial agglomeration is conducive to growth". Ades and Glaeser (1995) examined economic growth across a cross-section of American cities and found that income and population growth moved together and the growth of both were positively related. Henderson (2003) found that urban primacy (the share of a country's largest city) was advantageous to growth in low-income countries. On the other hand, Au and Henderson (2006) estimated the net urban agglomeration economies for Chinese cities and found that current government policy for city population agglomeration is bad for the country. Wheaton and Shishido (1981) and Rosen and Resnick (1980) observed that urban concentration first increased and then decreased in respect of a country's per capita GDP. In the case of developing countries, Henderson (2005) also found a positive effect of urban agglomeration on city productivity and growth.

Among the Indian studies, Sridhar (2010) estimated the determinants of city growth and output both at the district and city levels and found that factors like proximity to a large city and the process of moving from agriculture to manufacturing determines the size of a city. In 1986, Mills and Becker used a national sample of large Indian cities and then a sample of cities in the large Indian state of Madhya Pradesh to establish that a large initial population discouraged further growth of cities with an initial population below one million. They also found that cities grew faster in higher income states than in lower income states. Finally, they argued that the farther the cities are from the nearest Class I city (with a population of more than 100,000), the faster they grow. The study by Narayana (2009) showed the dispersion of metropolitan population though there is growing concentration of urban population in metropolitan areas compared to non-metropolitan areas. Furthermore, some studies on

India (Lall and Mengistae 2005, Lall and Rodrigo 2001, Lall *et al* 2004, Chakravorty and Lall 2007) focus on industrialization-related urban agglomeration and urban economic development through the framework of NEG models.

Given the above review of studies, the determinants of urban agglomeration and its impact on urban economic growth and empirical research on "non-linearity" of CP model to explain the urban system are the key researchable issues in the Indian context. These issues form the key focus and objective of this paper. To our knowledge, this paper is a beginning to analyze the impact of urban agglomeration on India's urban economic growth using the sub-national (i.e., state and urban) level data.

The paper is organized as follows. In the next section, we explain the model and its econometric specification for the empirical analysis. Sections 3 and 4 outline the measurement of variables with data sources and a short description of the data used for the analysis, respectively. Section 5 highlights the details of estimated results followed by a summary of major conclusions and implications in Section 6.

2. Empirical Framework

For the empirical analysis of the determinants of urban agglomeration and spatial interaction among cities on economic growth, we employ the commonly used reduced form estimation procedure (Dobkins and Ioannides 2000, Brülhart and Koenig 2006). Based on the economic growth model of Barro (2000), the cross-section OLS regression method is used as the basic reduced-form CP model for measuring India's urban economic growth. The potential endogeneity problem of OLS estimation is not a main concern here as all the explanatory variables are either exogenous geographic factors or initial values of those control variables. To estimate the relevant state- and city-specific determinants of urban agglomeration and its effect on urban economic growth, the following multiple regression OLS technique in the form of recursive econometric model is used.

2.1. Recursive equation model

The basic model for estimation of the determinants of urban agglomeration is stated as follows:

$$UA = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 + a_8X_8 + a_9X_9 + a_{10}X_{10} + a_{11}X_{11} + a_{12}X_{12} + u_1 \quad \text{-- (1)}$$

where UA stands for population of urban agglomeration, X_1 refers to market size effect, X_2 for distance from a bigger city, X_3 for degree of state trade openness, X_4 refers to transportation cost, X_5 for city vehicle density, X_6 refers to city proximity to natural ways of communication, X_7 for environmental effect, X_8 refers to size of a state, X_9 for state industrial development, X_{10} refers to state urbanization level, X_{11} for political power and political stability and X_{12} refers to government policy for urban agglomeration. Equation (1) is a linear regression model and estimated by OLS. The stochastic error term u_1 satisfies the Classical Linear Regression Model (CLRM) assumptions. Predicted signs of the coefficients are the following: $\alpha_1>0$, $\alpha_2<0$, $\alpha_3<0$, $\alpha_4<0$, $\alpha_5<0$, $\alpha_6>0$, $\alpha_7>0$, $\alpha_8<0$, $\alpha_9>0$, $\alpha_{10}>0$, $\alpha_{11}>0$, and $\alpha_{12}>0$.

To capture the positive effect of First Nature Geography (FNG) on urban agglomeration, we consider the following two variables: 1) city environmental effect because it may have positive influence on the concentration of population in a large city by way of encouraging in-migration of population with favourable climatic conditions (Sridhar 2010). 2) The proximity to natural ways of communication because it encourages development of the large hubs of international trade by absorbing the potential initial advantages of the benefits from easy access to international and domestic market [Krugman 1993].

NEG models [mainly Second Nature Geography (SNG)] explain urban agglomeration by considering the relevant positive and negative factors. Positive factors include the size of the market because a bigger market encourages firms to produce a wider variety of goods (due to advantage of increasing returns at firm level and pooled labour market) that can be consumed by the city dwellers. On the other hand, negative factors include the following variables: First, distance from a bigger city because bigger cities become primary magnets of economic activity and longer distance to a bigger city indicates lower market potential. Second: degree of state trade openness because when a country trades less with rest of the world the domestic transaction becomes more important and these transactions can in general be conducted more cheaply over shorter distances. This process is reversed when more countries trade with the rest of the world (or have more liberalized trade norms), as theoretically predicted by Krugman and Elizondo (1996) and elaborated by Brülhart and Sbergami (2009). Third: high government expenditure on transportation because high internal transport costs provide incentive for the concentration of economic activity (Ades and Glaeser 1995). Fourth: higher vehicle density because it captures the external diseconomies.

Among the other variables, we expect the following to have a positive effect on large city populations. The first is political power because proximity to power widens the scope of political influence, encourages the government to transfer resources to the capital city and attract migrants in the process. Furthermore, rent-seekers coming to the capital may also contribute to the growth of the city's population (Ades and Glaeser 1995). Second is the higher government expenditure on various projects (or better quality of public services) because it attracts more workers and firms to the city. Third is the industrial development (or economic development) because more workers are absorbed and the production process is concentrated mainly in the large city. Fourth is the higher level of urbanization of a state because it is associated with higher population concentration in a large city. On the other hand, large city urban concentration declines with the increase in the state's land area (or geographic size) because we assume that there is a positive link between the bigger state size, dispersion of state resources and formation of more cities (Henderson 2003). Finally, we predict that political instability has a negative effect on agglomeration because it creates an unfriendly environment for the city dwellers.

Given the estimated model in (1) the following equation estimates the determinants of urban economic growth:

?? ? ?? ? ?? ??? ? ???? ? ???? ? ???? ? ???? ? ???? ? u_2 ------------------------------------ (2)

where UG stands for urban economic growth, ?? refers to predicted values of the dependent variable (i.e., urban agglomeration) of Equation (1), Z_1 stands for city density (or growth rate of city density), Z_2 refers to special interaction among cities, Z_3 refers to size of a city, Z_4 stands for effect of human capital accumulation, and Z_5 stands for initial level of per capita real city output. Equation (2) is a linear cross-section regression model, which is estimated using OLS technique and u_2 is a well-behaved error term. Predicted sign of the coefficients are the following: $b_1>0$, $b_2>0$, $b_4>0$, $b_5>0$, and $b_6<0$ ($b_6>0$) if the economy experiences (or does not experience) conditional convergence. However, following the prediction of CP model, distance to a bigger city has a negative effect (i.e., $b_s<0$) on city economic growth whereas square and cubes of distances have positive (i.e., $b_s>0$) and negative effects (i.e., $b_s<0$).

Following the NEG models, we expect India's large city urban agglomeration to have a strong positive effect on urban economic growth because the bigger cities have higher productivity, wages and capital per worker (i.e., higher economies of agglomeration) and bigger efficiency benefits (Duraton 2008) as empirically supported by the World Bank (2004) research work and elaborated in Narayana's (2009) study. In addition, major factors behind the existence of urban increasing returns, include sharing (e.g., local infrastructure), matching (e.g., employers and employees), and learning (e.g., new technologies) (Duraton and Puga 2004).

Among the other factors we expect distance to large city to have a negative effect on city economic growth and squares and cubes of distances have positive and negative effects, respectively, as the CP model of NEG theory (Fujita *et al* 1999) shows that with the distance to a large city increasing, the market potential declines first, and later rises, then declines again. The theory finds the "∽"- shaped correlation between distance to a large city and economic activities. Further, education (capture the initial economic growth effect) has a positive effect on city's economic growth (Barro 2000), as the accumulation of human capital can create a pool of skilled labour force by attracting firms and residents. Following economic growth literature, we also expect initial income to have an effect on the conditional convergence of the city's income growth rate. Finally, economic growth may benefit from the size of the city so we expect a positive effect of higher urban economic growth in larger cities. Equations (1) and (2) together constitute the recursive equation system for estimation of determinants of large city agglomeration and its impact on urban economic growth.

3. Measurement of variables and data sources

Appendix Table 1 presents the name of the cities used in the analysis. Appendix Table 2 summarizes the descriptions, measurements, and data sources of all the variables used in the estimation of recursive econometric model of Equations (1) and (2).

4. Description of data

Appendix Table 3 gives the means, standard deviations, minimum, and maximum values for the variables that we use in our regression estimations. Most importantly, standard deviations (measures the variability of the variables) are found higher for state government expenditure on transport, city wise sanctioned cost under JNNURM and total number of primary and upper primary district enrollment, which indicate that the data points for these variables are spread out over a large range of values.

Appendix Tables 4 and 5 show the raw correlation of the variables. In Appendix Table 4, the values of the correlation coefficient (r^2) show that large city population is positively associated with the percentage of urban population residing in each urban agglomeration (i.e., r^2 is 0.92), sanctioned cost under JNNURM (i.e., r^2 is 0.71), population coverage per primary school (i.e., r^2 is 0.49), and state-level urban population (i.e., r^2 is 0.42). On the other hand, large city population agglomeration is negatively correlated with distance to state capital city (i.e., r^2 is 0.34), city wise total road length per 1,000 population (i.e., r^2 is 0.26), and distance to large city (i.e., r^2 is 0.18). Moreover, Appendix Table 5 shows that the city output growth rate is positively associated with total number of primary and upper primary enrollment, district literacy rate, initial level of per capita DDP, and growth rate of city density. In contrast, city output growth rate is negatively correlated with distance to large city, distance state capital city, and distance to sea port city. Due to existence of multicollinearity problem in the raw data, we considered the following two remedies: First, we chose an appropriate model specification by dropping the high collinear variables. Second, we transformed the equation in to its logarithmic form.

Key proxy variables in the estimation include the following: (a) City district literacy rate to capture the human capital accumulation, as literate people generally have a higher socio-economic status by enjoying better health status and employment prospects. (b) Total number of primary and upper primary enrollment as a second proxy variable of human capital accumulation, because high rate of enrollment in school made faster growth in per capita income through rapid improvement in productivity (Bils and Klenow 2000). (c) Driving (or road/railway) distance is used for approximating the spatial interactions between cities as in Hanson (1998 and 2005). (d) Non-primary DDP as a proxy of city output because NEG theories emphasize the agglomeration of manufacture and service sectors (Krugman 1991 and used in Sridhar 2010 for Indian case).[1] (e) Due to lack of estimates of GSDP at market prices, GSDP at factor cost in current prices is used. (f) Crime rate is used as a proxy for political instability as it indicates the law and order situation in a state. (g) State-wise length of rail network per lakh population is used as a proxy for state transportation cost because it measures the internal transport costs (Krugman 1991). (h) Temperature differences are used as a proxy for environmental effect as in Haurin (1980) and Sridhar (2010). (i) Population coverage per primary school and total road length per 1,000 population are used as proxies for government expenditure for urban agglomeration, following the certain studies (Sridhar, 2010). (j) Percentage of population living in each urban agglomeration and percentage share of district urban population of surrounding city districts are used as proxies for city market size because they show higher percentage with higher population in the main city. (k) Vehicle density is used as a proxy for congestion because it contributes to low density development and often reduces transit use. (f) Population size is used as a measure of urban size as it captures both geographical and economic size of urban areas (Narayana 2009).

5. Results of estimation

5.1. Determinants of urban agglomeration

Table 1 presents the results of size models of the determinants of urban agglomeration based on Equation (1) by employing the OLS method. Log of city population and growth rate of city population are used as dependent variables in the estimation. The models which are estimated are not only different in specifications but also by number of observations. Regression (1) shows the estimates of the full model which includes all variables for maximum number of available observations. Regression (2) to (6) report results for a parsimonious model, excluding controls that are not found to be statistically significant or matched with the expected sign of the regression parameters. More specifically, due to paucity of data, we ran Regressions (2) to (6) and have presented the results of the best fitted models in terms of predicted signs, significance level of the variables and goodness of fit of the regressions, according to available different number of observations of the variables. All the regressions report OLS results with robust standard errors (to correct heteroskedasticity) in parentheses with taking care (or absence) of multicollinearity problem.

Regression (2) includes the set of controls of the best fitted model for maximum number of available observations. The regression explains 88 per cent of the total variation in the dependent variable. In Regression (2), among the proxy variables of government policy for urban agglomeration, we find that city cost sectioned under JNNURM has a positive and statistically significant effect on urban agglomeration which is line with our working hypothesis. In particular, a 10 per cent increase in expenditure through JNNURM is associated with 1.4 per cent increase in large city population and supports the positive effect of government policy on urban agglomeration. In contrast, the second proxy variable (or city wise total road length per 1,000 population) for measuring the government policy for urban agglomeration does not show the expected relationship. In addition, we find that the coefficient of state capital dummy is positive but not significant.

The results also show that the percentage of urban population residing in each urban agglomeration (market control variable) is positive and significant. The findings support our expected hypothesis and show that a 10 per cent increase in urban population residing in each urban agglomeration increases concentration of large city population by 4.7 per cent. On the other hand, the percentage of district urban population in the surrounding city districts (which shows higher percentage with higher population of the main city) explains the negative and significant effect (at 5 per cent level) on large city population agglomeration. The result runs counter to the expected hypothesis and indicates that over-concentration of city population has a negative effect on further urban agglomeration.

The estimated coefficient of the state trade openness variable is positively and significantly related to the large city population agglomeration, which runs against the predicted hypothesis. An increase of 10 per cent in the share of trade in GSDP leads to 9.3 per cent increase in the population agglomeration. This finding concludes that the degree of state trade liberalization is not enough to curb the population agglomeration of the large city. The results also show that the distance to a large city (or distance to state capital city) has a negative (as predicted) and insignificant effect on city population concentration. Among the three variables used to capture the role of FNG for explaining urban agglomeration, dummy of cities located on river banks has a positive (expected) and significant (at 1 per cent level) effect on urban agglomeration. The coefficient of sea port city dummy has a positive and statistically insignificant impact on the concentration of city population.

The coefficient of temperature differences shows a positive value which implies that extreme weather conditions encourage urban agglomeration. However, the relationship between temperature differences and urban agglomeration does not seem to be stronger as the coefficient is not statistically significant. The finding suggests that temperature differences (as expected impact was negative) do not play an important role in explaining India's urban agglomeration.

Regression (3) reports estimates with a parsimonious set of controls. As usual, the cross section agglomeration regression performs well, explaining up to 79 per cent of sample variance in the population agglomeration of the large cities. The state-level urbanization variable (state-wise percentage of urban population) is positive and significant at 5 per cent. The coefficient 0.013 indicates that with a 10 per cent increase in state urban population, large city population increases by 0.1 per cent. This result suggests that higher level of state urbanization mainly depends on the concentration of population in the large cities. We also find a negative and significant effect (as expected) of state land area (state size) on concentration of city population. The value of the coefficient suggests that with a 10 per cent increase in size of the state, city population agglomeration decreases by 1.7 per cent. The regression results show that, as expected, state-wise percentage of workers in non-agriculture has a positive and significant effect on population agglomeration. On the other hand, transport cost control variable and state government capital expenditure on transport (or state- wise length of rail network) takes on negative coefficients that are in line with our working hypothesis. However, surprisingly both the coefficients in Regression (3) are not statistically significant. The results also report that the significance level of city sanctioned cost under JNNURM (or dummy of the cities located in the bank of river) improved from 10 per cent (or 5 per cent) in Regression (2) to 1 per cent in

Table 1: Economic Determinants of large city population agglomeration:Estimates of log linear regression model

	Dependent variables:					
	Log of large city population in 2005					Growth rate of city population
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	8.80*** (2.84)	6.92*** (0.237)	7.48*** (1.22)	10.19*** (1.39)	-0.236 (2.59)	0.037** (0.017)
Distance to state capital city	-0.035 (0.038)	-0.024 (0.032)	-0.034 (0.039)	-0.001** (0.0005)	-0.001** (0.0004)	
Share of trade in GSDP	0.916 (1.07)	0.929* (0.551)		3.24*** (0.666)	2.41** (0.811)	0.03 (0.021)
City-wise sanctioned cost under JNNURM	0.138 (0.095)	0.143* (0.085)	0.445*** (0.077)			-0.001 (0.002)
Distance to large city	0.001 (1.19)	-0.017 (0.106)		-0.006*** (0.002)	-0.006*** (0.002)	
State capital dummy	0.018 (0.152)	0.025 (0.139)		0.718*** (0.234)	0.579** (0.235)	0.004 (0.003)
City-wise total road length per 1000 population	-0.049 (0.068)	-0.049 (0.069)	-0.086 (0.078)	-0.3*** (0.086)		-0.002** (0.001)
State-wise percentage of workers in non-agriculture	-0.007 (0.009)		0.014* (0.008)		0.036*** (0.012)	
Log of population coverage per primary school	-0.079 (0.085)			-0.163 (0.13)	-0.177* (0.096)	-0.061 (0.224)
Dummy of the cities located in bank of river	0.202 (0.125)	0.234** (0.112)	0.398*** (0.129)			0.002 (0.003)
percentage of state- level urban population	0.001 (0.009)		0.013** (0.006)			-0.015* (0.009)
State govt. capital expenditure on transport	0.03 (0.067)		-0.041 (0.062)	-0.049 (0.072)		-0.001 (0.001)
Sea port city dummy	0.092 (0.229)	0.105 (0.226)		0.229 (0.183)		0.001 (0.004)
Parentage share of district urban population of surrounding city district	-0.011* (0.005)	-0.009** (0.004)				
Log of per capita real NSDP	-0.039 (0.216)				0.719*** (0.182)	
Percentage of urban population residing in each urban agglomeration	0.499*** (0.047)	0.477*** (0.041)				
Log of state land area	-0.023 (0.086)		-0.167* (0.083)			
City temperature differences	0.005 (0.004)	0.003 (0.004)				-0.003 (0.012)
State-wise rail network per lakh population			-0.012 (0.028)	-0.123** (0.046)		
City crime rate				-0.024 (0.043)	-0.007 (0.035)	
City vehicle density (VD)					-0.002** (0.0008)	
No. of Observation	59	59	58	34	23	52
R^2	0.89	0.88	0.79	0.86	0.90	0.16
? ?	0.85	0.86	0.76	0.79	0.84	-0.03

Note: Figures in parentheses represent robust standard errors. ***, ** and * indicate statistical significance at 1%, 5%, and 10% level, respectively. Source: Estimated using equation (1).

Regression (3). However, the coefficient of the distance to state capital city (or city-wise road length per 1,000 population) again remains statistically insignificant. In Regression (4), we add city crime rate (capture the city political instability) and third proxy measurement of government policy for urban agglomeration (i.e., log of population coverage per primary school) to our earlier regression. Both the coefficients of the variables are negative which match with the expected sign condition, even though, the result is not significant. On the other hand, the positive and statistically significant coefficient of state capital dummy indicates that large cities are 72 per cent larger if they also happen to be state capital cities. This may mean that power attracts population or indicate that state capitals are located in larger cities. The variance inflation factor (VIF) test indicates that result does not suffer from any multicollinearity effect as the VIF value for state capital dummy is 3.48 in this context. Distance to large city (or distance to state capital city) has a negative (as predicted) and significant effect on concentration of city population and indicates that proximity to large cities makes cities larger as well, implying the existence of market and scale economies. The VIF value is 1.52 (or 2.65) for the coefficient of distance to large city (or distance to state capital city) which indicates no problem of multicollinearity. However, the significant and negative sign of city-wise total road length per 1,000 population coefficient does not show the expected relationship as it runs against our expected sign. The VIF value for this coefficient is 2.20 suggesting free of any multicollinearity effect. The coefficient of state wise length of rail network is negative and significant which implies that with a 10 per cent increase in state wise length of rail network the concentration of population in a large city decreases by almost 1.2 per cent. The VIF value for the coefficient of state wise length of rail network is 2.28. Moreover, the results also show that significance level of the state trade openness variable increased from 10 per cent in Regression (2) to 1 per cent in this regression. The VIF value (i.e., 2.50) of the coefficient of state trade openness variable does not show any multicollinearity effect.

In contrast, the coefficient of the state government capital expenditure on transport (or sea port city dummy) does not show any improvement from the earlier regression results in terms of level of significance. Regression (5) includes a state-level industrial proxy variable: state per capita income. The positive and significant coefficient of state per capita income variable indicates that the level of industrial development of a state increases the population agglomeration of a large city. A 10 per cent increase in state per capita income increases large city population by 7.2 per cent. As expected, the coefficient of city vehicle density (control for city external diseconomies) is negative and significant at 5 per cent. This implies that higher congestion and pollution lead to lower urban agglomeration. The positive and significant (at 1 per cent) coefficient of the state share of workers engaged in all non-agricultural activity (capture the proportion of population that is not conditioned to natural resources) implies that the large cities require some economic development through industrialization. On the other hand, public services such as population coverage per primary school show a negative and significant relationship implying that population coverage by primary schools (a large number of persons per school) discourages cities from becoming larger. The result strongly suggests that India's agglomeration economies are policy induced. The estimates of Regression (5) also provide consistent results for the other variables that include distance to state capital city and distance to large city, as the coefficients of these variables are significant and go with our expected signs. However, the coefficients of share of trade in GSDP and state capital city dummy lose significance level from 10 per cent to 5 per cent from Regression (4). In addition, again the coefficient of city crime rate shows the negative and an insignificant effect on urban agglomeration.

In Regression (6), city population growth rate has been used as a proxy for urban agglomeration because this specification gives us the best fitted predicted values of the dependent variable which is used as an independent variable in Equation (2) for capturing the positive effect of urban agglomeration on urban economic growth endogenously, suggesting that the changes in level of agglomeration directly effect on the changes of urban economic growth.[2] The Regression (6) explains only 16 per cent of the total variation in the dependent variable. The results show that the level of state urbanization (or city-wise total road length per 1,000 population) has a negative and significant effect on city population growth. The coefficient indicates that a 10 per cent increase in state level urbanization (or city-wise total road length per 1,000 population) is associated with a reduction of 0.2 (or 0.02) per cent in large city population growth rate. We also find that state trade openness, state capital dummy, dummy of the cities located in bank of river and sea port city dummy have a positive (as expected) effect on growth rate of city population. However, surprisingly none of the variables is found to be statistically significant. In addition, the coefficients of the population coverage per primary school, city wise temperature differences, and state government expenditure on transport show the negative and insignificant effect on growth rate of city population.

5.2. Determinants of urban economic growth

In Regression (7), we present the results with controlling entire variables along with agglomeration variable (predicted values of agglomeration variable of Regression (6) used in Equation (2). Though we find agglomeration effect has a positive and significant effect on city economic growth but most of the other variables do not match with our expected sign and show the lower level of significant (or insignificant) effect.

Therefore, we run Regressions (8) to (12) excluding controls that are not plausible in terms of expected signs and level of significance of the variables. In Regression (8), we only measure the effect of agglomeration on urban economic growth without controlling any other variables, while in Regression (9) we capture the effects of linear form of distance variables on urban economic growth. Finally, we run Regressions (10) to (12) separately for three proxy measurements of the distance variable in the form, which is predicted in the CP model of NEG theory. As the raw data shows that prominently a '∽ "-shaped curve relationship exists between the distance to the state capital city and distance to large city with urban economic growth, we add square and cube terms in Regressions (11) and (12) for these two distance variables, respectively. In contrary, the raw data does not show any strong nonlinear relationship between distance to a sea port city and urban economic growth. Therefore, we consider only linear term of this distance variable in Regression (10). Table 2 summarizes the estimates of the Regressions from (7) to (12) based on Equation (2). We also perform Durbin–Wu–Hausman endogeneity test the potential endogeneity problem. However, the large *p*-values for Regressions (7) to (12) indicate that OLS is consistent. In addition, Regressions (7) to (12) are estimated separately, as we did not find any positive contemporaneous correlation (i.e., correlation between error terms of

Regression (6) and Regressions (7) to (12)). Therefore, Equations (1) and (2) do not form the system of equations.

Table 2: Economic determinants of urban economic growth: Estimates of log linear model

	Dependent variable: Growth rate of non-primary per capita DDP (or city output) from 2001 to 2005					
	(7)	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Constant	0.055 (0.114)	-0.023 (0.027)	0.001 (0.025)	-0.04 (0.083)	-0.09 (0.085	0.031 (0.024)
Predicted values of the dependent variable (??) of Model 6.	2.71* (1.34)	2.64** (0.982)	2.49*** (0.884)	2.55** (1.15)	2.69** (1.07)	2.79*** (0.838)
Distance to a sea port city	-0.007 (0.006)		-0.002*** (0.001)	-0.002** (0.001)		
Distance to a sea port city square	0.036 (0.086)					
Distance to a sea port city cube	-0.005 (0.03)					
Distance to the state capital city	-2.17* (1.12)		-0.128 (0.172)		-0.021** (0.01)	
Distance to the state capital city square	0.632 (0.422)				0.681* (0.361)	
Distance to the state capital city cube	-0.456 (0.356)				-0.509* (0.294)	
Distance to a large city	0.015 (0.055)		-0.009 (0.007)			-0.068* (0.039)
Distance to a large city square	0.002 (0.007)					0.011* (0.006)
Distance to a large city cube	-0.002 (0.003)					-0.004* (0.002)
Growth of city density	0.023 (0.019)				0.027** (0.012)	0.019* (0.011)
Total number of primary enrollment	-0.012 (0.047)				0.029 (0.027)	
Total number of upper primary enrollment	0.03 (0.069)					0.043 (0.042)
City district literacy rate	-0.001 (0.001)				0.0002 (0.0005)	
Per capita net district domestic product 2001	-0.031 (0.093)				-0.052 (0.085)	
Mega city dummy	0.001 (0.025)			0.003 (0.018)		
Log of City density 2005	-0.002 (0.008)			0.003 (0.007)	0.005 (0.006)	
No. of Observations	52	52	52	52	52	52
R^2	0.42	0.11	0.27	0.25	0.28	0.24
? ?	0.12	0.09	0.20	0.19	0.12	0.14
Durbin–Wu–Hausman endogeneity test	0.01 (0.904)	0.20 (0.659)	0.01 (0.918)	1.46 (0.234)	0.82 (0.37)	0.00 (0.98)

Note: Figures in parentheses represent robust standard errors. ***, ** and * indicate statistical significance at 1%, 5%, and 10% level respectively. P-values for the null hypotheses of the endogeneity test are reported in the parentheses at the end of the table.

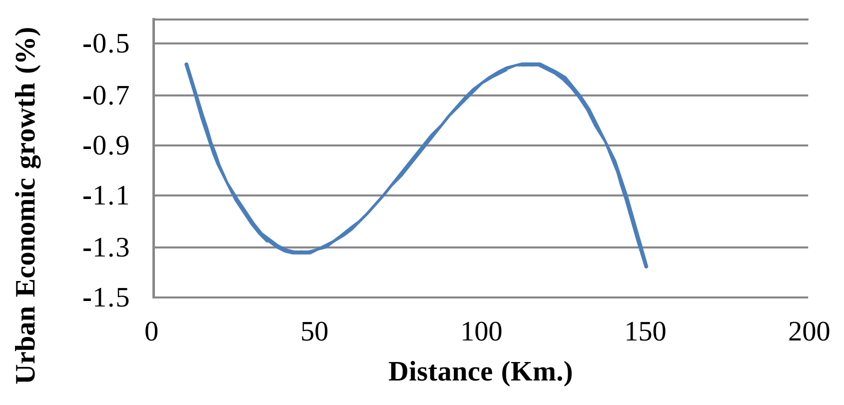
Source: Estimated using Equation (2).

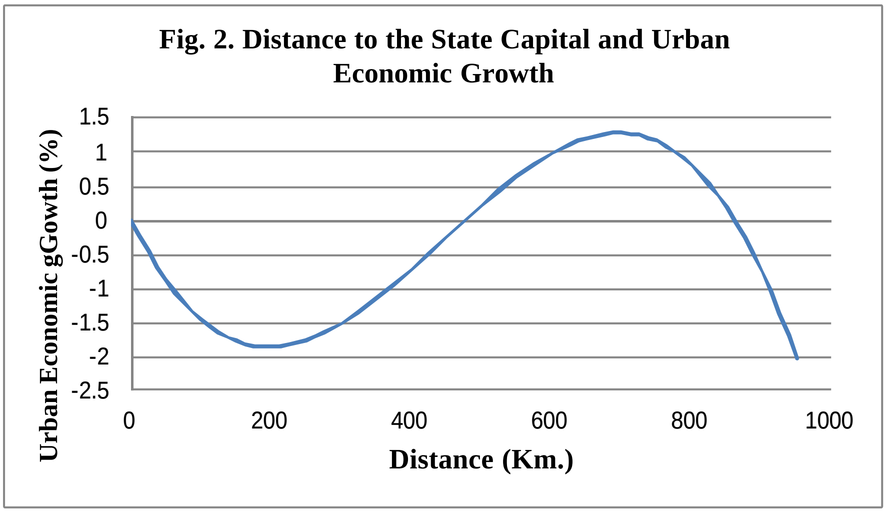
The result of Regression (8) shows that the agglomeration (controlled in endogenously) variable has a positive and significant effect on urban economic growth. This positive impact of agglomeration on growth matches with our main working hypothesis. In particular a 10 per cent increase in urban agglomeration increases urban economic growth by 26 per cent. In Regression (9), the coefficients of the linear item of distance to a large city, distance to state capital city and distance to a major ports are negative, which implies that urban economic growth decreases away from a large city (or state capital city) and major ports. However, the coefficient of distance from a major sea port city is the only variable (among the three variables) which is significant at 1 per cent level. Results of the Regression (10) show that the coefficient of distance to a sea port city is negative and statistically significant which again indicates that urban economic growth decreases away fom major ports. The value of VIF 1.84 indicates there is no multicollinearity effect on the coefficient of distance to a sea port city. In Regressions (11) and (12), the coefficients of the distance to the nearest large city (or state capital city) and its square and cube are all significant and all present the expected signs which offer evidence of the non-linearity pattern of India's urban system.

Most importantly, the growth rate of city density (capture the internal population agglomeration) has a positive and significant effect on urban economic growth. The result of Regression (11) shows that a 10 per cent increase in growth of city density is associated with 0.3 per cent increase in city output. The results clearly suggest that in India, large city urban agglomeration (controlled endogenously or exogenously) leads to urban economic growth.[3] However, the coefficient of city density has a positive but insignificant effect on urban economic growth.

Based on the estimated results to approximate the exact distance in which urban economic growth is positive (or negative) as predicted in the CP model, we simulate the correlation between distances to large cities (or state capital cities) and urban economic growth. In Figures 1 and 2, the horizontal axis represents the distance (kilometres) away from large cities (or state capital city), and the vertical axis is the urban economic growth rate (percentage). Two figures show the CP pattern of India's urban system and support the theoretical prediction of NEG models.

Fig.1. Distance to Large City and Urban Economic Growth





Source: Based on estimated results of regression (12) Source: Based on estimated results of regression (11)

Figures 1 and 2 suggest that while a city is located away from a large city (or state capital city), within 40 km (or 200 km) but closer to a large market, it has potential for higher economic growth rate. When distance is long enough, more than 110 km from a large city (or 700 km from the state capital city), the city suffers low market potential and poor economic growth rate.

Regression (11) suggests that the total number of primary enrollment (or city literacy rate) has a positive effect on city economic growth. In addition, Regression (12) shows that the total number of upper primary enrollment also has a positive effect on city economic growth. The results support the prediction about the positive effect of human capital accumulation on city economic growth rate. But the values of estimated coefficients are not significant. Regression (11) shows that the per capita net non-primary DDP (controlled to observe whether the Indian economy is experiencing conditional convergence at the city level) has an insignificant negative impact on India's urban economic growth and no significant change in conditional convergence. Regression (10) further examines the role of bigger city size (i.e., over size of city captured by mega city dummy) on urban economic growth and finds the insignificant positive effect of mega city dummy urban economic growth.

The positive effect of capital city, per capita GSDP and level of urbanization on urban concentration support the findings of Ades and Glaeser (1995). The positive effect of government expenditure through various projects on urban concentration supports the finding of Henderson (1986), Wheaton and Shishido (1981). The positive effect of trade openness on urban concentration supports Brülhart and Sbergami (2009), Duranton (2008) and Fujita and Mori (1996) and differs from Krugman and Elizondo (1996). The negative effect of transport cost on urban agglomeration supports the findings of Krugman (1991), Ades and Glaeser (1995). The positive effect of industrial development on population concentration supports the finding of Murphy *et al* (1989), Ades and Glaeser (1995). The positive effect of market size on urban agglomeration supports Krugman (1991) while the negative effect of land area on urban concentration supports Henderson (2003). The positive effect of difference in city temperature on urban population concentration supports Sridhar (2010). The role of population coverage per primary school on urban concentration differs from Sridhar (2010) while the effect of road length per 1,000 population supports. The impact of distance from large on urban agglomeration supports Sridhar (2010) and Krugman (1991). The negative effect of external diseconomies on urban agglomeration supports Krugman (1991). The importance of sea port on agglomeration differs from the result of Chen *et al* (2011). The role of river on urban concentration differs from Cali (2007) and supports (Krugman 1993). The positive effect of urban agglomeration on urban economic growth supports the prediction of Krugman (1991), Brülhart and Sbergami (2009), Henderson (2003, 2005) and Fujita and Thisse (2002). The result of the CP model supports Fujita and Mori (1997), Fujita *et al* (1999), and Chen *et al* (2011). Finally, the positive effect of human capital accumulation on urban economic growth supports Sridhar (2010).

6. Conclusions and implications

This paper has attempted to identify at the sub-national level (i.e., state and urban levels) determinants of large urban agglomerations across 59 large cities in India and measure the effect of urban agglomeration (considering urban agglomeration exogenously and endogenously) on urban economic growth, using the NEG approach pioneered by Krugman (1991).

To identify the relevant determinants of urban agglomeration, the study focuses on the factors included in the First Nature Geography, Second Nature Geography and some other important factors that may affect urban agglomeration by constructing several proxy variables.

The estimated results show that the market size control variable, dummy cities located on the banks of a river, degree of state trade openness, per capita income of a state, percentage of state urban population, percentage of workers engaged in non-agricultural activity of a state, state capital dummy, and city sanctioned cost under JNNURM positively and significantly (or robustly) affect the large city urban agglomeration that is measured by city population (or growth rate of city population). On the other hand, distance from the bigger cities, state government expenditure on transport, city vehicle density, size of the state, city population coverage per primary school, and city road length per thousand population negatively and significantly (or robustly) affect population agglomeration of the large cities. However, other variables that do not have a strong (or significant) effect on urban agglomeration include city crime rate, city temperature differences, dummy of the sea port city.

In relation to urban economic growth, we find the significant (or robust) and positive effect of urban agglomeration on urban economic growth by considering the agglomeration variables endogenously (or exogenously) in our basic recursive econometrics model. This paper is also a small beginning to verify the spatial pattern of India's urban system following the CP Model. The results verify the "∽"-shaped non-linear correlation between the geographical distance to a large city (100,000 or greater population or state capital city) and urban economic growth, which is consistent with the CP Model of urban system in the NEG theory. Moreover, we find that the initial economic growth factors (level of human capital accumulation or initial level of per capita income) play an important role in India's urban economic growth.

These findings imply that in India, agglomeration economics are policy-induced (for example, the government's urban development programme, JNNURM) and market-determined. Recent research shows that Class I (with a population above 100,000) towns have been experiencing the lowest population growth compared to other cities. This study is also an attempt to shed light on this phenomenon by identifying relevant factors that tend to influence urban agglomeration negatively (or positively).

Our regression results suggest that the predictions made in NEG theoretical models are much more relevant (or successful) in explaining urban agglomeration and its effect on urban economic growth than any other predictions made in existing theories (including predictions of the First Nature Geography models).

Our results should be taken as suggestive at best. As we have taken many proxy variables and as there are no limits to use of proxy variables, variable definitions and econometric model specification, further scientific examination is needed.

Finally, we suggest the government take responsibility in generating data on urban India for a better analysis and appropriate policy decisions. However, over different periods of time, the effect of urban agglomeration on urban economic growth, the historical aspect (Krugman 1991) for urban agglomeration and the contribution of the size of cities on urban economic growth are topics for future research.

Notes

[1] The limitation of non-primary DDP is that in cities where the UA forms a small part of the district, the non- primary output shows a poor measure of its value-added/economic growth.

[2] To capture urban agglomeration effect in the form of our basic recursive model, we also used (results are not reported here) city population and its log form, city density and its growth rate, and level of city output as the dependent variables of Equation (1). However, we obtained most satisfactory results in terms of positive effect of urban agglomeration on growth, expected signs of the variables and their significant levels in the case of growth rate of city population, which has been reported here.

[3] Other variables, which did not show the satisfactory results in terms of capturing positive effect of urban agglomeration on urban economic growth by considering exogenous to the model, include city population and its growth rate, and city density square (results are not reported here).

References

Ades, A F and E L Glaeser (1995). Trade and Circuses: Explaining Urban Giants. *Quarterly Journal of Economics*, 110: 195-227.

Au, C-C and J V Henderson (2006). Are Chinese Cities too Small?. *Review of Economic Studies*, 73: 549-76.

Baldwin, R E and P Martin (2004). Agglomeration and Regional Growth. In Henderson, J V, J-F Thisse (eds), *Handbook of Regional and Urban Economics, vol.4: Cities and Geography*. North-Holland: Elsevier.

Barro, R J (2000). Inequality and Growth in a Panel of Countries. *Journal of Economic Growth*, 5: 5-32.

Bils, M and P J Klenow (2000). Does Schooling Cause Growth?. American Economic Review 90, 1160-1183.

Black, D and J V Henderson (1999). Spatial Evolution of Population and Industry in the United States. *American Economic Review*, 89: 321-27.

Brülhart, M and P Koenig (2006). New Economic Geography meets Comecon. *Economics of Transition*, 14 (2): 245–67.

Brülhart, M and F Sbergami (2009). Agglomeration and Growth: Cross-country Evidence. *Journal of Urban Economics*, 65: 48-63.

Cali, M (2007). Urbanization, Inequality, and Economic Growth: Evidence from Indian States. Background paper, World Development Report 2009, World Bank.

Chakravorty, S and S V Lall (2007). *Made in India: The Economic Geography and Political Economy of Industrialization*. New Delhi: Oxford University Press.

Chen, Z, M Lu and Z Xu (2011). A Core-Periphery Model of Urban Economic Growth: Empirical Evidence using Chinese City-Level Data, 1990-2006. *Global COE Hi-Stat Discussion Paper Series gd11-206*. Institute of Economic Research, Hitotsubashi University.

Da Mata, D, U Deichmann, J V Henderson, S V Lall, and H G Wang (2005). Determinants of City Growth in Brazil. *Journal of Urban Economics*, 62: 252-72.

Dobkins, L H and Y M Ioannides (2000). Dynamic Evolution of the Size Distribution of US Cities. In Huriot, J M and J M Thisse (eds), *Economics of Cities*. Cambridge: Cambridge University Press, pp. 217-60.

Duranton, G (2008). Viewpoint: From Cities to Productivity and Growth in Developing Countries. *Canadian Journal of Economics*, 41: 689-736.

Duranton, G and D Puga (2001). Micro-foundation of Urban Agglomeration Economies. In Henderson, J V and J-F Thisse (eds), *Handbook of Regional and Urban Economics, Volume 4: Cities and Geography*. North Holland: Elsevier, pp. 2063-117.

Fujita, M and T Mori (1996). The Role of Ports in the Making of Major Cities: Self-agglomeration and Hub-effect. *Journal of Development Economics*, 49: 93-120.

———— (1997). Structural Stability and Evolution of Urban Systems. *Regional Science and Urban Economics*, 27: 399-442.

Fujita, M, P Krugman and A J Venables (1999). *The Spatial Economy: Cities, Regions and International Trade*. Cambridge, MA: MIT Press.

Fujita, M, P Krugman, and T Mori (1999a). On the Evolution of Hierarchical Urban Systems. *European Economic Review*, 43: 209-51.

Fujita, M and J-F Thisse (2002). *Economics of Agglomeration: Cities, Industrial Location and Regional Growth*. Cambridge: Cambridge University Press.

Fujita, M and P Krugman (2004). The New Economic Geography: Past, Present and the Future. *Regional Science*, 83: 139-64.

Hanson, G H (1998). Regional Adjustment to Trade Liberalization. *Regional Science and Urban Economics*, 28: 419-44.

———— (2005). Market Potential, Increasing Returns and Geographic Concentration. *Journal of International Economics*, 67: 1-24.

Henderson, J V (1986). Urbanization in a Developing Country: City Size and Population Composition. *Journal of Development Economics*, 22: 269-93.

———— (2003). The Urbanization Process and Economic Growth: The So-what Question. *Journal of Economic Growth*, 8: 47-71.

———— (2005). Urbanization and Growth. In Aghion, P, and S N Durlauf (eds), *Handbook of Economic Growth, Volume 1B*. North Holland: Amsterdam, pp. 1543-94.

———— (2010). Cities and Development. *Journal of Regional Science*, 50: 515-40.

Haurin, D R (1980). The Regional Distribution of Population, Migration and Climate. *Quarterly Journal of Economics*, 95: 294–308.

Indiastat.com (2011). http://www.indiastat.com/economy/8/stats.aspx.

Ioannides, Y M and H G Overman (2004). Spatial Evolution of the US Urban System. *Journal of Economic Geography*, 4: 131-56.

Krugman, P (1991). Increasing Returns and Economic Geography. *Journal of Political Economy*, 99: 483-99.

———— (1993). First Nature, Second Nature and Metropolitan Location. *Journal of Regional Science*, 33: 129-44.

Krugman, P and R L Elizondo (1996). Trade Policy and Third World Metropolis. *Journal of Development Economics*, 49: 137-50.

Lall, S and C Rodrigo (2001). Perspective on the Sources of Heterogeneity in Indian Industry. *World Development*, 29: 2127-43.

Lall, S V, Z Shalizi and U Deichmann (2004). Agglomeration Economies and Productivity in Indian Industry. *Journal of Development Economics*, 73: 643-73.

Lall, S V, T Mengistae (2005). Business Environment, Clustering and Industry Location: Evidence from Indian Cities. *Policy Research Working Paper Series 3675*. World Bank.

Mills, E S, C M Becker (1986). Studies in Indian Urban Development. New York: Oxford University Press for the World Bank.

Murphy, K M, A Shleifer and R W Vishny (1989). Industrialization and Big Push. *Journal of Political Economy*, 97: 1003-26.

Narayana, M R (2009). Size Distribution of Metropolitan Areas: Evidence and Implications for India. *The Journal of Applied Economic Research*, 3: 243-64.

Overman, H G, and Y M Ioannides (2001). Cross-sectional Evolution of the US City Size Distribution. *Journal of Urban Economics*, 49: 543-66.

Partridge, M D, D S Rickman, K Ali and M R Olfert (2009). Do New Economic Geography Agglomeration Shadows underlie Current Population Dynamics across the Urban Hierarchy? *Regional Science*, 88: 445-66.

Reddy, B S and P Balachandra (2010). Dynamics of Urban Mobility: A Comparative Analysis of Mega Cities of India. *IGIDR Working Paper 23*. Mumbai: Indira Gandhi Institute of Development Research. http://www.igidr.ac.in/pdf/publication/WP-2010-023.

Rosen, K T and M Resnick (1980). The Size Distribution of Cities: An Examination of the Pareto Law and Primacy. *Journal of Urban Economics* 8: 165-86.

Sridhar, K S (2010). Determinants of City Growth and Output in India. *Review of Urban and Regional Development Studies*, 22: 22-38.

Tabuchi, T (1998). Urban Agglomeration and Dispersion: A Synthesis of Alonso and Krugman. *Journal of Unban Economics*, 44: 333-51.

Wheaton, W C and H Shishido (1981). Urban Concentration, Agglomeration Economies and the Level of Economic Development. *Economic Development and Cultural Change*, 30: 17-30.

World Bank (2004). *India: Investment Climate and Manufacturing Industry*. Washington: World Bank.

Appendix Table 1: Name of cities used in regression analysis

Agra (Agra), Ahmadabad (Ahmadabad)*, Aligarh (Aligarh), Allahabad (Allahabad), Amritsar (Amritsar), Asansol (Barddhaman), Aurangabad (Aurangabad), Bangalore (Bangalore Urban), Bareilly (Bareilly), Bhiwandi (Thane), Bhopal (Bhopal), Bhubaneswar (Khordha), Chandigarh@, Chennai (Chennai). Coimbatore (Coimbatore), Delhi@, Dhanbad (Dhanbad), Durg-Bhilainagar (Durg), Guwahati (Kamrup), Gwalior (Gwalior), Hubli-Dharwad (Dharward), Hyderabad (Hyderabad), Indore (Indore), Jabalpur (Jabalpur), Jaipur (Jaipur), Jalandhar (Jalandhar), Jammu (Jammu)*, Jamshedpur (Purbi-Singhbhum), Jodhpur (Jodhpur), Kanpur (Kanpur Nagar), Kochi (Eranakulam), Kolkata (Kolkata), Kota (Kota), Kozhikode (Kozhikode), Lucknow (Lucknow), Ludhiana (Ludhina), Madurai (Madurai), Meerut (Meerut), Moradabad (Moradabad), Mumbai (Mumbai), Mysore (Mysore), Nagpur (Nagpur), Nashik (Nashik), Patna (Patna), Pune (Pune), Raipur (Raipur), Rajkot (Rajkot)*, Ranchi (Ranchi), Salem (Salem), Solapur (Solapur), Srinagar (Srinagar)*, Surat (Surat)*, Thiruvananthapuram (Thiruvananthapuram), Tiruchirappalli (Tiruchirappalli), Tiruppur (Coimbatore)**, Vadodara (Vadodara)*, Varanasi (Varanasi), Vijayawada (Krishna), Visakhapatnam (Visakhapatnam).

Note: Name in the first bracket indicates the name of the district in which the city is located.

* Cities are not used to find out the determinants of urban economic growth due to unavailability of DDP data of these city districts.

** Coimbatore and Tiruppur cities belong to Coimbatore district, for that reason Coimbatore City is considered a representative of Coimbatore district.

@ Delhi and Chandigarh were considered a whole proxy of a city district.

Appendix Table 2: Measurements and data sources of the variables

Variables descriptions	Measurement	Data Source(s)
Dependent variables:		
Large city population	59 urban agglomerations with 750,000 or more inhabitants in 2005.	UN, World Urbanization Prospects, 2009 Revision.
Growth of large city population	Growth rate of city population over the period 2000 to 2005.	UN, World Urbanization Prospects, 2009 Revision.
City output and its growth	Non-primary district domestic product (DDP) is measured the city output and growth rate of DDP over the period 2000-01 to 2004-05 at 1999-2000 constant prices is a measure of urban economic growth.	Directorate of Economics and Statistics (DES), various State Governments, Government of India (GOI).
Independent variables:		
State trade openness	Ratio of state export value to the value of Gross State Domestic Product (GSDP) at current prices in 2005-06.	www.indiastat.com (2011) and DES, various state Government.
Level of industrialization of a state	Percentage share of non-agriculture labor force in a state in 2005.	The Ministry of Statistics and Programme Implementation, GOI, 2005.
Highest concentration of political power of a state	Dummy of the state capital city. Dummy variable: = 1, if state capital; 0, otherwise.	http://en.wikipedia.org/wiki/List_of_state_and_union_territory capitals_in_India. Dated on 23 May, 2010.
State transportation cost	Two measures: (a) State government capital expenditure on transport in 2005-06. (b) State wise length of rail network (as on 31.03.2009) per lakh population.	State Finance: A study of Budgets of 2006-07, RBI and www.indiastat.com (2011).
Government policy on urban agglomeration	Three measures: (a) City wise sanctioned cost under JNNURM (Jawaharlal Nehru National Urban Renewal Mission) in 2005, generated by allocating project cost to each city in proportion of their share in total population. (b) City wise total road length per 1000 population for 2001. (c) City wise population coverage per primary school for 2001.	Annual Urban Report of India 2009, and Town Directory, Census of India 2001, GOI.
Market size	Two measures: (a) The percentage share of (Urban population/Total population) urban population of the surrounding districts of cities, except the city district (i.e., the district to which the sample city is located) in 2001. (b) Percentage share of urban population residing in each urban agglomeration in 2005.	General Population Table, Census of India 2001, GOI and UN, World Urbanization Prospects, 2009 Revision.
Level of urbanization of a state	The percentage share of state wise urban population to total population in 2001.	Statistical Abstract of India 2007, GOI.
Income of a state	State wise per capita Net State Domestic Product (NSDP) at constant prices (1999-2000 as the base year) in 2005-06.	Central Statistical Organization (CSO), GOI.
Distance to a nearest bigger city	Distance to the nearest large city (with 100,000 or more population). Or distance to the state capital city.	Town Directory, Census of India 2001. GOI.
City environmental effect	City wise temperature difference (in degrees centigrade)	Town Directory, Census of India 2001. GOI.

Contd...

Variables descriptions	Measurement	Data Source(s)
City geographical factors (or proximity to natural ways of communication)	Dummy variable: = 1, if sea port city and cities located on the banks of a navigable river; 0, otherwise.	http://en.wikipedia.org/wiki/List_of_Indian_cities_on_rivers; http://en.wikipedia.org/wiki/Category: Port_cities_in_India. Dated on May 2, 2010.
City political instability	Proxied by city crime rate in 2005.	Indian Penal Code (IPC), GOI.
City external diseconomies	City wise vehicle density, a proxy in terms of transfer congestion and pollution.	The data base generated by Reddy and Balachandra (2010).
Spatial interaction within regional urban system	Road distance to the nearest large city (with 100,000 or more population) or distance to state capital in 2001.	Town Directory, Census of India 2001, GOI.
Spatial interaction among national urban system	Proxied by shortest rail distance to nearest major sea port city.	Department of Indian Railways, GOI. Web address: www.indianrail.gov.in, dated on 12 December, 2010.
City population agglomeration	Two measures: (a) City density in 2005. (b) Growth rate of city density over the period 2000 to 2005.	UN, World Urbanization Prospects, 2009 Revision and Town Directory, Census of India 2001, GOI.
Initial state of economic growth factor	Two measures: (a) The effect of education which is proxied by total number of primary (Grades I-IV) and upper primary (Grades VI-VIII) enrollment in 2005-06 of the city district and the city district literacy rate in 2001. (b) Initial level of per capita non primary DDP in 2001.	District Information System of Education: District Report Cards published by National University of Educational Planning and Administration, New Delhi, Census of India 2001. Directorate of Economics and Statistics (DES), 2001, GOI.
Bigger city size	Dummy variable: = 1, if mega city or 0, otherwise.	Town Directory, Census of India 2001, GOI.

Source: Author's compilation

Appendix Table 3: Description of the data

Variables	Obs.	Mean	Std. Dev.	Min	Max
Percentage share of urban population of surrounding city district (PSD)	59	26.03	12.01	6.49	60.54
State land area in thousand sq km (SLA)	59	191.36	99.362	0.11	342.24
Share of trade in GSDP (STDP)	59	0.13	0.11	0.005	0.32
State government capital expenditure on transport, Rs in million (CET)	59	977.56	885.44	0	2613.42
State capital dummy (SCD)	59	0.29	0.46	0	1
State-wise percentage share of non-agricultural workers (SWNA)	59	89.93	6.58	77.2	99.7
Per capita real NSDP in thousand Rs (SNSDP)	59	20.97	9.98	6.48	65.23
State-wise rail network per lakh population in route km (SRNW)	58	6.54	2.16	1.32	10.52
State-wise percentage share of urban Population (SUP)	59	31.58	14.64	10.46	93.18
City population in 2005 in million (POP2005)	59	2.49	3.78	0.68	19.49
Percentage share of urban population residing in each urban agglomeration (UPRUA)	59	0.77	1.16	0.2	6
Total road length per 1,000 population in km (TRL)	59	0.92	0.77	0.05	4024
Distance to a large city in km (DLC)	59	45.89	44.5	0	186
City-wise sanctioned cost under JNNURM Rs in million, (CJJURM)	59	781.46	1236.43	0	7604.91
City-wise temperature difference in degrees centigrade (TD)	59	22.34	11.16	7.13	43.4
Distance to the state capital city in km (DSC)	59	216.81	200.05	0	855
Sea port city dummy (SPCD)	59	0.07	0.25	0	1
Dummy of the cities located on river bank (CLBR)	59	0.39	0.49	0	1
City-wise crime rate (RC)	34	316.24	164.46	71.1	766.1
City-wise population coverage per primary school in thousands (PSCH)	59	5.39	5.92	0.4	43.33
City-wise vehicle density (VD)	23	276.04	105.94	64	532
Distance to a sea port city in km (DPC)	52	744.42	551.02	0	1821
Growth rate of city population (GCP)	52	0.028	0.01	0.009	0.044
Total no. of primary enrollment in thousands (TPE)	52	288.43	141.59	61.38	643.15
Total upper primary enrollment in thousands (TUPE)	52	197.74	98.44	56.19	489.9
Mega city dummy (MCD)	52	0.12	0.32	0	1
District literacy rate in percentage (DLR)	52	72.67	9.93	44.75	93.2
Per capita net DDP 2001 in thousand Rs (DDP01)	52	17.36	9.22	0.79	51.97
City density in 2005 in thousands (CD)	52	15.09	13.26	3.54	76.7
Growth rate of city density (GCD)	52	0.21	0.27	0.04	1.44
Growth of per capita net DDP (GRY)	52	0.05	0.03	0.001	0.13

Source: Author's Computation

Table 4: Correlation Coefficient of determinants of urban agglomeration variables

	POP-2005	DSC	STDP	CJJU-RM	DLC	SCD	TRL	SWNA	PSCH	CLBR	SUP	CET	PSD	SPCD	SN-SDP	UP-RUA	SLA	TD
POP2005	1																	
DSC	-0.34	1																
STDP	0.27	0.18	1															
CJJURM	0.71	-0.31	0.3	1														
DLC	-0.18	-0.06	0.14	-0.13	1													
SCD	0.44	-0.58	-0.29	0.44	-0.01	1												
TRL	-0.26	-0.17	-0.3	-0.16	0.03	-0.06	1											
SWNA	0.08	-0.16	-0.4	-0.15	0.21	0.2	-0.03	1										
PSCH	0.49	-0.29	-0.01	-0.02	-0.07	0.29	-0.03	0.27	1									
CLBR	0.24	-0.11	0.1	0.21	-0.01	-0.05	0.01	-0.13	0.13	1								
SUP	0.42	0.03	0.52	0.1	-0.06	0.09	-0.23	-0.05	0.59	0.04	1							
CET	-0.06	0.25	-0.02	-0.04	-0.01	-0.25	-0.15	0.06	-0.05	0.23	-0.07	1						
PSD	0.4	-0.03	0.58	0.33	-0.13	-0.01	-0.32	-0.22	0.08	-0.13	0.58	0.02	1					
SPCD	0.33	0.02	0.08	0.52	-0.19	0.13	0.19	-0.25	-0.02	-0.08	0.06	-0.08	0.26	1				
SNSDP	0.31	-0.029	0.46	0.1	-0.11	0.09	-0.05	-0.22	0.46	-0.05	0.91	-0.32	0.56	0.13	1			
UPRUA	0.92	-0.34	0.27	0.71	-0.19	0.44	-0.25	0.07	0.49	0.24	0.42	-0.06	0.4	0.33	0.31	1		
SLA	-0.08	0.27	0.29	0.15	0.39	-0.16	-0.2	0.02	-0.45	0.13	-0.24	0.16	-0.08	-0.01	-0.34	-0.09	1	
TD	-0.17	-0.13	-0.31	-0.18	0.06	0.04	0.08	0.23	0.09	-0.11	-0.08	-0.27	-0.29	-0.13	-0.02	-0.17	-0.18	1

Note: See Appendix Table 3 for variable definitions. The correlation coefficients are based on 59 observations.

Source: Author's Calculation

Table 5: Correlation Coefficient of determinants of urban economic growth variables

	DPC	DSC	DLC	GCD	TUPE	TPE	DLR	DDP01	MCD	CD	GRY
DPC	1										
DSC	-0.03	1									
DLC	0.2	-0.04	1								
GCD	-0.24	-0.19	-0.3	1							
TUPE	-0.08	-0.23	0.14	0.15	1						
TPE	-0.02	-0.26	0.1	-0.08	0.75	1					
DLR	-0.41	-0.24	-0.14	0.17	0.1	-0.03	1				
DDP01	-0.12	-0.28	-0.19	0.2	0.25	0.15	0.59	1			
MCD	-0.19	-0.37	-0.24	0.22	-0.02	-0.05	0.37	0.49	1		
CD	-0.29	-0.25	-0.37	0.53	-0.02	-0.09	0.22	0.38	0.69	1	
GRY	-0.41	-0.11	-0.12	0.21	0.26	0.16	0.16	0.11	0.09	0.08	1

Note: See Appendix Table 3 for variable definitions.

The correlation coefficients are based on 52 observations.

Source: Author's Calculation

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