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The Temporal and Spatial Effect of Highways on China's Economic Growth*

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Abstract: Infrastructure investment is currently enjoying great popularity among government as a strategy to handle the recent worldwide economic recession. However, the relevant literatures have yet to come to a consistent agreement on how infrastructures, especially that of transportations, impact economic growth. This paper investigates the effects of highway infrastructure on economic growth using spatial regression models estimated from the county data of Guangxi Zhuang Autonomous Region (GXZAR) in China from 1993-2007. The results indicate that relationships between initial highway infrastructure and economic growth can be positive, negative, or negligible. The spatial effects are also inconsistent. Impacts are stronger in near short-term but diminishing over times. We conclude that the highways are a necessary, but not a sufficient condition for economic growth. The highway impact depends on other factors as well. Improving infrastructure alone could not create a continued economic growth.

Key words: growth; spatial; infrastructures; roads; China
JEL codes: O18, R42, R12, R53

1. Introduction

Highway construction is a common-seen policy to stimulate economic development. The newly fiscal-stimulus package announced by Chinese Government in November 2008 includes plans to invest a huge amount of money on transportation infrastructures such as highways and railways. One may cast no doubt on the effect of policies crafted to improve the transportation system because of the common belief that improved transport infrastructures would always result in further development of the region as is the case with most urban areas. However, a clear answer to how the highways impact economic development has not been provided by existing literatures.

The role of highway infrastructures in economic development is usually inquired along with the study of the relationships between economic development and infrastructures. Solow (1957) provides a theoretical model to

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investigate economic development. The model predicts that economies of undeveloped regions grow faster. Barro and Sala-I-Martin (1991) gave empirical evidences for the Solow model. They found that the economies of low income states grow faster than the high income states in the United States of America; they conclude that there exists a convergence among states. Barro and Sala-I-Martin estimate that the speed of convergence is about 2 percent. However, Fujita and Hu (2001) argue that the convergence only happens for regions among the coastal provinces while a divergence exists between coastal provinces and inland provinces in China from 1985 to 1994. The economic convergence is conditional. At macro level across countries, Barro (1991) found evidence supporting convergence from 1960 to 1985. Barro reported that GDP growth rate relates to initial GDP and government expenditure negatively and significantly. However, the relationship between public investment and the growth rate in GDP was found to be insignificant. Barro's result thus implies that investment on transportation infrastructures may not impact economic growth.

Nonetheless, evidence supporting the proposition that the development of transport infrastructures play a role in economic development also exists. Demurger (2001) reported that infrastructures produce an impact on economic growth. Bougheas, Demetriades and Mamuneas (2000) also found that infrastructure (transportation and communication) has a nonlinear relationship with economic growth. Furthermore, Berechman, Ozmen and Ozbay (2006) studied the contribution of highways to economic activities in the difference geographical scales in USA. They found that the contribution of highways declines and the spillover increases when the geographical scale decreases. The effect of highways on economic development can also be examined in terms of economic factors such as input costs and population. Cohen and Paul (2007) estimated the highway impact on the shadow values and input costs and found SAR(R) is more efficient method of estimation compared to SUR. Chi, Voss and Delle (2006) also reported that the construction of highways has an impact on population. A review on the debates in literatures was carried out by Button (1998); this review led to a conclusion that the findings from previous research have not provided a conclusive answer as to the role of transport infrastructure on endogenous growth.

This paper investigates how initial highway condition impacts the economic growth in the later periods. The relationship between the economic growth and the highway is investigated based on the Solow model, assuming the existence of spatial dependent. Spatial models are used to test the hypothesis that the highway densities have an impact on the regional economic growth and the impact varies over different periods. The other hypothesis can be tested by the models is spillover effect of highway infrastructures. The dataset for parameter estimation includes data of 89 counties of Guangxi Zhuang Autonomous Region in China from 1993 to 2007.

The next section of the paper provides the exploratory spatial data analysis (ESDA). The theoretical model and empirical model will be given in section III. In section IV, the estimated results are discussed. The conclusion is made in section V.

2. Data and Spatial Analysis

2.1 Dataset

The dataset is collected from the statistic year-books of Guangxi Zhuang Autonomous Region in 1993-2007. The data of 1995 are not included for the reason of non-availability. The dependent variable is the average GDP growth rates over thirteen periods, which are 1993-1994, 1993-1996…, and 1996-1997, 1996-1998…, 1996-2007. The independent variables are the initial conditions of highway densities and other control variables in 1993 or 1996. The results of the exploratory spatial data analysis (ESDA) of the key variables are provided next.

Table 1 Data Description

Variables	Unit	Mean	Standard Deviation	Minimum	Maximum
Growth Rate 96-97	Percent	11.3391	10.7899	-35.5300	62.5700
Growth Rate 96-98	Percent	2.6278	10.0473	-38.1600	28.1300
Growth Rate 96-99	Percent	3.5343	7.5835	-23.3500	21.7300
Growth Rate 96-00	Percent	3.8189	5.9537	-16.9000	17.7600
Growth Rate 96-01	Percent	4.2772	5.0863	-12.6900	16.3000
Growth Rate 96-02	Percent	4.5630	4.3767	-9.1200	13.9200
Growth Rate 96-03	Percent	4.4724	4.1998	-7.2900	15.6000
Growth Rate 96-04	Percent	5.4800	3.6566	-4.4500	17.3800
Growth Rate 96-05	Percent	6.7091	3.2482	-2.1600	17.3500
Growth Rate 96-06	Percent	7.5530	3.0932	-1.0200	16.4600
Growth Rate 96-07	Percent	8.1091	2.8910	0.9100	17.3400
Highway Density (HWD) in 1996	KM/KM^2	0.1768	0.0723	0.0373	0.4608
Population Density in 1996	$Person/KM^2$	225.2813	212.4247	39.9000	1323.5000
Fix Asset Investemtnt in 1996	Yuan per Capita	716.3206	786.5654	55.5200	4155.3800
Middle-Primary School Student Ratio in 1996	Ratio	0.3859	0.4612	0.1201	4.5446
Health Service in 1996	Beds/1000 Persons	17.8721	15.3173	1.5600	82.3600

2.2 The Spatial Distributions of GDP Growth

Understanding the spatially distributed pattern of GDP growth rates is great helpful for us to build an appropriate model. Before we go into the major steps to analyze the cluster and the spatial dependency, we first investigate the structure of the spatial weight matrix.

A weight matrix has to be chosen before the ESDA. However, no theories are available to specify the structure of the weight matrix. For the purpose of this paper, the economic growth may be influenced by all neighbor regions because they are connected by highways. We consider the queen matrix and the nearest k matrix.

The Moran's I of dependent variable for different periods, using different weight matrixes, are graphed in Figure 1. A pattern can be seen in the Figure 1 is that the magnitudes of Moran's *Is* are declined as the farther neighbor counties are included in the weight matrix. The Moran's *Is* computed from nearest-3 matrix are higher than that from nearest-5, which are in turn larger than that from nearest-7. Similarly, the Moran's *Is* from queen-1 matrix are larger than that from queen-2. Also in Figure 1, the variation of Moran's *Is* over periods are similar regardless of the differences of the weight structures. Interestingly, the Moran's *Is* of nearest-3 are almost the same as queen-1. In this paper, the spatial model will be based the queen-1 neighbor matrixes.

A very important implication of Moran's *I* is to analyze the spatial dependence. Figure 1 indicates that the spatial dependences of the GDP growth rates increase quickly in short term, decline slightly in mid-term, and then climb up in long term. It is reasonable for the spatial dependence of economic growth in long term causing by the interaction among regions. However, the decline in the mid-term is puzzling. This may be explained by that economic activities are immediately stimulated by an improvement of infrastructure and then calm down by rational sense. Next we will investigate the distribution pattern of GDP growth.

The spatial distribution of the average GDP growth rate over 1993-2006 is shown in Figure 2. The higher-growth-rate counties are concentrated in the northeast and west areas. They also distribute along with the railways or the expressways. On the other hand, the lower-growth-rate counties are those in the southeast and the mid-north areas. This can be also seen in Figure 3 by LISA. There is a cluster of high-high growth rate in the west, a cluster low-low growth rate in the southeast.

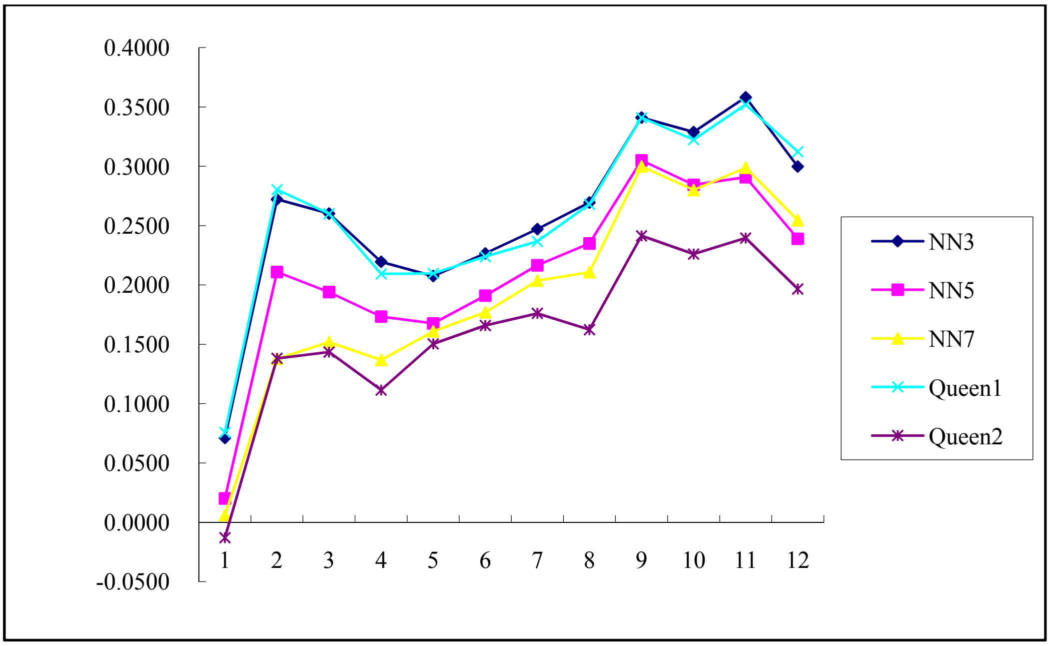

Figure 1 The Moran's I of GDP Growth Rate over Different Periods

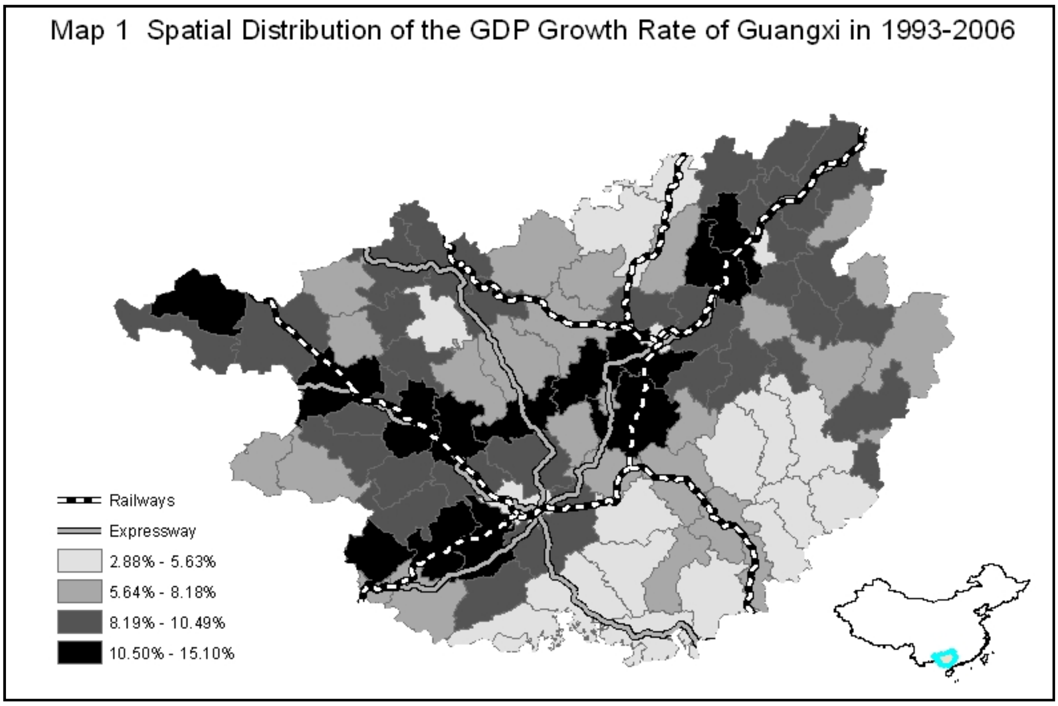

Figure 2 Spatial Distribution of the GDP Growth Rate of Guangxi in 1993-2007

2.3 Highway Density

By comparing Figure 4 and 5, we can see that lower growth rates over 1993-2006 are overlap the higher highway densities in 1993 in the southeast areas.

And a cluster of high-high highway density is in the southeast. The highway densities seem related to GDP growth negatively.

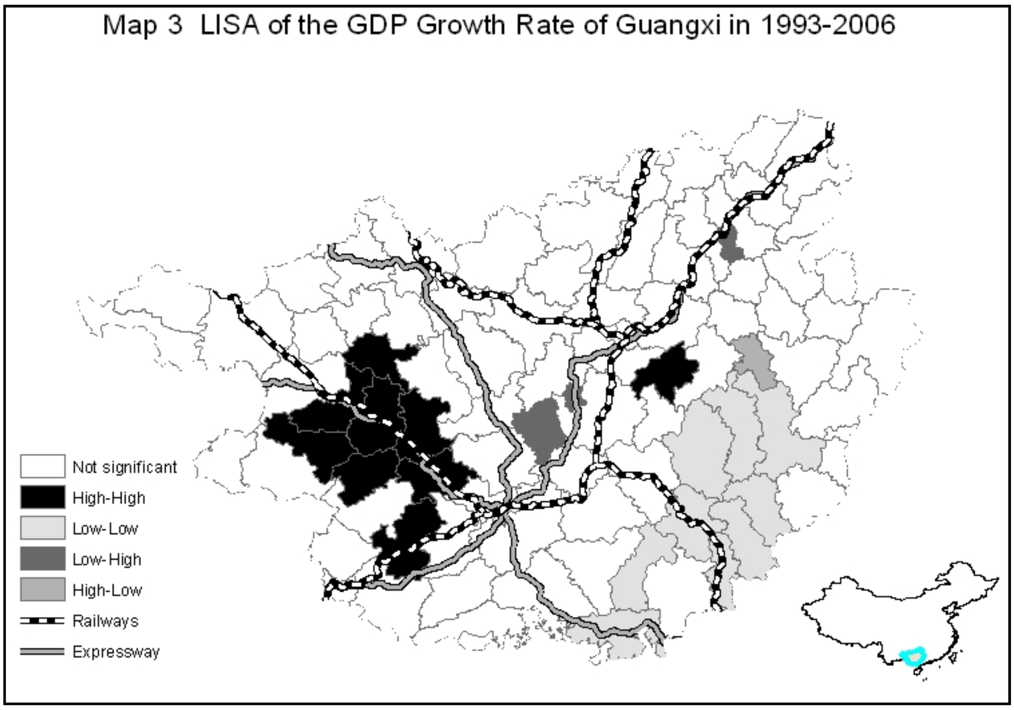

Figure 3 LISA of the GDP Growth Rate of Guangxi in 1993-2006

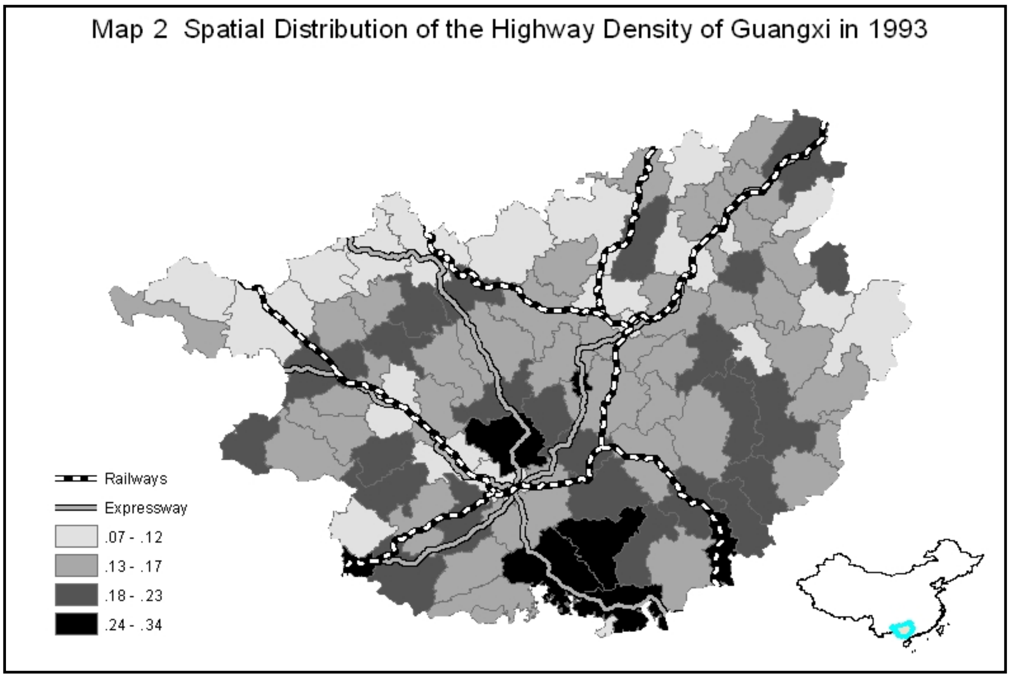

Figure 4 Spatial Distribution of the Highway Density in Guangxi in 1993

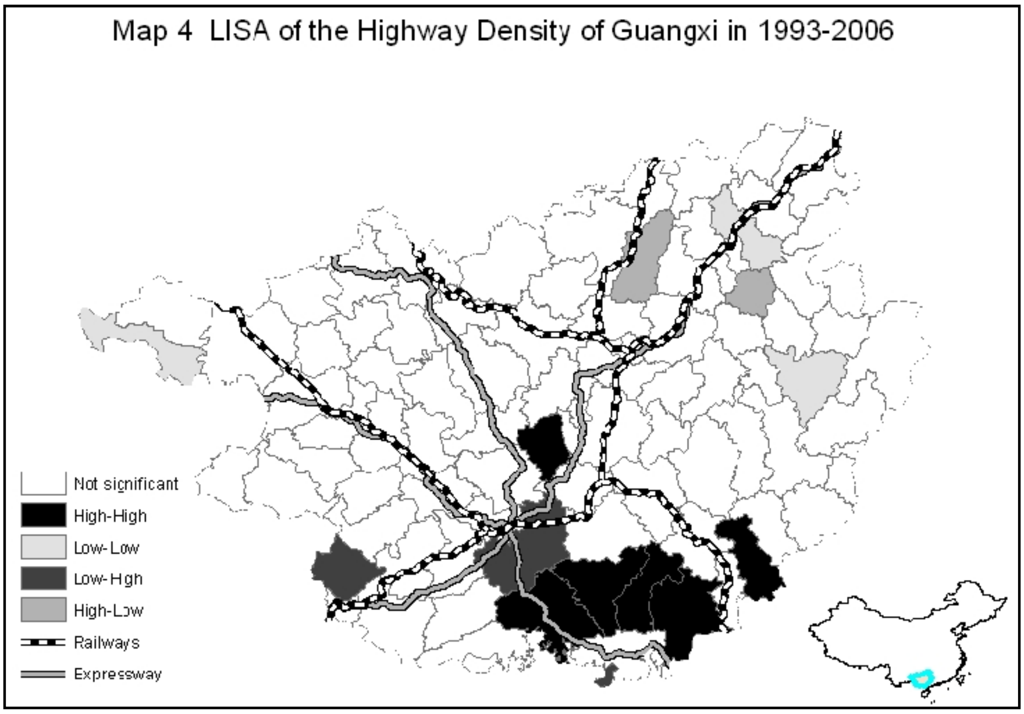

Figure 5 LISA of the Highway Density of Guangxi in 1993-2006

3. Economic Model

3.1 Theoretical Model

Economic factors can be divided by their liquidity into two categories—the liquid and the fixed factors. The liquid factors, such as labor and money, move to the regions or economic sectors of higher economic returns. The fixed factors, such as infrastructures and natural resources, are bound to a region. For a specific region, the economic development is easier to seen variation with the flow of liquid factors. However, the fixed factors are usually monotonic. Therefore, the relationship of infrastructure like highways to economic growth is harder to be identified.

Among the infrastructures, highways are the one that increases monotonically. Unless in an extreme case such as earthquake, the physical amount of highways in a region is never declined. Thus, in certain regions, the highway densities may either remain unchanged or grow. Furthermore, once a highway is constructed, it exists for a long time. Highways may be upgraded or improved so that they continue to serve economic development. Finally, highways are public goods. Though a fee may be required to use certain segments of highways, most of highways are open to public. These features allow highways produce a different impact on economic development.

The impact of highways on economic development can be both temporal and spatial. The time impact of highways is derived from that they serve the economic activities in all times and the impacts usually are through other economic factors. The investment of highway construction is an economic activity, which influences economic development in the same way as other investment such as increase the employment and income. However, after constructed, the physical highways are not an investment but a public good that serves for years. It becomes a necessary environment for economic activities. Only if the improvement of highway condition is realized, the other factors are mobilized into the region and take the advance of the improved highway services. The impact of the highways depends on the performance of the liquid factors after constructed.

In spatial dimension, the impacts of public infrastructures are not confined only in the local regions. The highways facilitate the economic activity such as trade and mobility of economic factors such as technology, labor, and capital by reducing transportation costs. The economic dependency among regions increases. Meanwhile, the economic opportunities created by highways also affect the neighbor regions.

The temporal and spatial lag impacts of highways have to be considered in economic model. Let H represents the quantity of highways in a region or the neighbors. Y is the output. The production function is given in the following form.

$$Y_t = \left[e^{\beta H}\right]^{(s-t-s/t)} f(K, L) \tag{1}$$

Where, β is parameter. t is the time period. s is a constant and the highest effect of highways is obtained at the period $\sqrt{s}$. The term (s-s/t-t) captures the variation of highway effect over times. When t is small, the whole term is negative and the impact of highway is small. When t = s, the term is 1 and the highway has full impact. $f(.)$ is the production function of other non-fixed asset factors K and L and is supposed not vary over time period. Therefore,

$$Y_0 = f(K, L) \tag{2}$$

The function can be rearranged as

$$Y_t / Y_0 = \left[e^{\beta H}\right]^{(s-t-s/t)} \tag{3}$$

Taking log and divided by t of both sides, derive

$$ln(Y_t/Y_0)/t = (s/t - s/t^2 - 1)\beta H \tag{4}$$

The left hand side is the average growth rate. On the right hand side, let $a = (s/t - s/t^2 - 1)\beta$ which is the coefficient of highway. It can be positive or negative and varies along with the time. The null hypothesis for test is

$$H_0: \text{ a=0}$$

If a = 0 is rejected, economic growth is affected by highway construction. Testing the significance of the coefficient for the highway density in the region or the neighbor region equals to test the highway effect and spillover effect. The sign of the coefficient indicates the direction of impact. A positive sign means that economy benefits from the highways construction. In contrast, a negative sign indicates that the economic activities are drained away.

3.2 Empirical Model

The spatial dependence of dependent variable causes bias if empirical model is estimated by OLS. The Moran's Is of GDP growth rates, shown in section II, imply that the existence of spatial dependency is very possible. The major source of spatial dependence is the interaction of neighbor economic activities which is promoted by the improvement of transportation and information infrastructure. This paper focuses on the effect of highways. The spatial effect of highway density is presented by the spatial lag of highway density. However, the highway may be not the only source of the spillover. A spatial lag of the dependent variable is also added into the equation.

$$y_i = a_0 + bwy_i + a_1 H_i + a_2 wH_j + a_3 X_i + e \tag{5}$$

Where, y is the average growth rate of GDP over a period of time. H is the highway density. wy and wH are the weighted growth rate and highway density. i represent the regions and j is the neighbor regions (i≠j). H_j is the average highway density of neighbor regions. e is the error term. a and b are the parameters. X is other control variables included the initial GDP, investment, human capital, and other control variables such as other means of transportations.

4. Estimations and Discussion

The estimated results of empirical models are shown in Table 2. We investigates the impact of Highways based on the initial endowment in 1996 (96 models) because the continuity of the available data. The results are also compared to that based on the initial endowment in 1993 (93 models), 1997 (97 models), and 1999 (99 models). The dependent variables for different models are the average GDP growth rate over different periods. Comparing the results of different models allows us to understand how highways impact the economic growth rate over periods. Furthermore, the models provide us evidences to investigate the spatial effect. Next we will discuss the specification of the spatial models and then the direct effect and spillover effect of highways. At the end, the results of control variables are provided.

4.1 Spatial Model Specification

The results from OLS in table 2 provide evidences to specify the spatial model. The first step is to determine the existence of spatial dependence. The Moran's *I*, LM of the error term, and the LM of lag term are statistics to diagnose for spatial dependence. The Moran's *Is* of the error term in Table 2 indicate the spatial dependences are various but significant over periods. Hypothesizes of independence are rejected for all periods except the last. The Moran's *Is* increase in short term and then reduce as the period become longer. Beside the shortest and longest periods, the LM-lags and LM-errors are significant. This means that both the lag and error terms are the sources for the spatial dependence for the GDP growth rate and then the OLS models are bias. The bias of spatial dependent model should be corrected by an appropriate model.

Table 2 The Estimates of OLS Model

Dependent Variable: Average Annual GDP Growth Rate											
Independent Variables		1996-1997		1996-1998		1996-1999		1996-2000		1996-2001	
CONSTANT	Coeff.	11.7870	*	5.0106		6.1002		7.1852	**	6.8313	**
	Std	6.0902		5.3416		3.9096		3.0978		2.6009	
Initial GDP	Coeff.	-0.0157	***	-0.0212	***	-0.0175	***	-0.0123	***	-0.0110	***
	Std	0.0056		0.0049		0.0036		0.0029		0.0024	
Highway Density (HWD)	Coeff.	42.5835	*	30.9083		20.7945		13.7407		14.0917	
	Std	21.5955		18.9409		13.8633		10.9845		9.2226	
Weighted HWD	Coeff.	-13.2785		-0.5178		-1.2004		-9.0495		-7.2537	
	Std	37.1607		32.5928		23.8554		18.9017		15.8699	
Population Density	Coeff.	-0.0088		-0.0111		-0.0095	*	-0.0074	*	-0.0071	*
	Std	0.0088		0.0077		0.0056		0.0045		0.0037	
Fix Asset Investemtnt	Coeff.	0.01	**	0.01	***	0.01	***	0.01	***	0.01	***
	Std	0.0034		0.0030		0.0022		0.0017		0.0014	
Education	Coeff.	1.1302		0.5535		0.2790		-0.0470		-0.0595	
	Std	2.6265		2.3036		1.6861		1.3360		1.1217	
Health	Coeff.	0.0551		0.1612		0.1712	*	0.1148		0.1057	*
	Std	0.1501		0.1316		0.0963		0.0763		0.0641	

(Table 2 to be continued)

(Table 2 continued)

Railway Dummy	Coeff.	3.2997	0.1847	0.4035	-0.1858	0.2286
	Std	2.4451	2.1446	1.5697	1.2437	1.0442
R-squared		0.1512	0.1716	0.2919	0.2787	0.3033
Likelihood		-330.1850	-318.5110	-290.7370	-270.0210	-254.4610
AIC		678.3700	655.0230	599.4730	558.0420	526.9220
BIC		700.7670	677.4210	621.8710	580.4400	549.3200
Breusch-Pagan		18.1617 ***	12.9880	15.1911 *	13.7416 *	9.2192
Moran's I		0.0851 *	0.2902 ***	0.3283 ***	0.2787 ***	0.2463 ***
LM(lag)		1.0201	20.9321 ***	27.5131 ***	19.7716 ***	16.5228 ***
Robust LM(lag)		0.1908	4.4385 ***	6.2997 ***	4.5974 ***	4.8215 ***
LM(error)		1.43	16.68 ***	21.35 ***	15.39 ***	12.02 ***
Robust LM(error)		0.60	0.19	0.14	0.21	0.32
LM(SARMA)		1.62	21.12 ***	27.65 ***	19.99 ***	16.84 ***

Dependent Variable: Average Annual GDP Growth Rate							
Independent Variables		1996-2002	1996-2003	1996-2004	1996-2005	1996-2006	1996-2007
CONSTANT	Coeff.	6.0876 ***	7.0913 ***	8.5304 ***	9.0787 ***	9.9248 ***	10.6745 ***
	Std	2.1960	2.2114	1.9341	1.7499	1.6584	1.5740
Initial GDP	Coeff.	-0.0097 ***	-0.0095 ***	-0.0080 ***	-0.0068 ***	-0.0063 ***	-0.0054 ***
	Std	0.0020	0.0020	0.0018	0.0016	0.0015	0.0014
Highway Density (HWD)	Coeff.	14.3941 *	9.6929	6.9404	4.2370	4.7910	2.9035
	Std	7.7870	7.8413	6.8582	6.2052	5.8805	5.5813
Weighted HWD	Coeff.	-0.0867	-7.5717	-9.6310	-6.7610	-7.6396	-7.8330
	Std	13.3996	13.4931	11.8013	10.6776	10.1188	9.6041
Population Density	Coeff.	-0.0053 *	-0.0001	0.0005	-0.0002	-0.0014	-0.0019
	Std	0.0032	0.0032	0.0028	0.0025	0.0024	0.0023
Fix Asset Investemtnt	Coeff.	0.01 ***	0.00 **	0.00 **	0.00 **	0.00 **	0.00 **
	Std	0.0012	0.0012	0.0011	0.0010	0.0009	0.0009
Education	Coeff.	-1.7424 *	-0.6596	-0.5281	0.0117	-0.2735	0.0199
	Std	0.9471	0.9537	0.8341	0.7547	0.7152	0.6788
Health	Coeff.	0.0838	0.1379 **	0.1104 **	0.0984 **	0.0997 **	0.0694 *
	Std	0.0541	0.0545	0.0477	0.0431	0.0409	0.0388
Railway Dummy	Coeff.	-0.1115	0.1553	-0.1025	0.4737	0.5816	0.4876
	Std	0.8817	0.8878	0.7765	0.7026	0.6658	0.6319
R-squared		0.3292	0.2614	0.2546	0.2267	0.2342	0.2102
Likelihood		-239.4020	-240.0210	-228.0980	-219.1930	-214.4090	-209.7630
AIC		496.8050	498.0420	474.1960	456.3860	446.8180	437.5250
BIC		519.2020	520.4400	496.5930	478.7830	469.2160	459.9230
Breusch-Pagan		10.2321	12.0656	7.2647	4.3348	4.2706	7.4124
Moran’s I		0.2745 ***	0.2671 ***	0.2211 ***	0.1622 ***	0.1236 **	0.0712
LM(lag)		18.9451 ***	16.7905 ***	12.4101 ***	5.9845 **	4.4225 **	1.6724
Robust LM(lag)		4.0803 **	2.6689 *	2.9361 *	0.7697	1.7692	1.0645
LM(error)		14.93 ***	14.13 ***	9.69 ***	5.21 **	3.03 *	1.00
Robust LM(error)		0.06	0.01	0.21	0.00	0.37	0.40
LM(SARMA)		19.01 ***	16.80 ***	12.62 ***	5.98 *	4.79 *	2.07

Note: * presents significant at 10 percent level; ** presents significant at 5 percent level; *** presents significant at 1 percent level.

Table 3 The Estimates of SARMA Model

Dependent Variable: Average Annual GDP Growth Rate							
Independent Variables		1996-1997	1996-1998	1996-1999	1996-2000	1996-2001	1996-2002
CONSTANT	Coeff.	14.5312 *	5.8883 *	5.0837 **	4.1020 **	3.2064 *	3.5020 **
	Std	8.2673	3.1195	2.5240	1.9991	1.7755	1.6314
Initial GDP	Coeff.	-0.0178 ***	-0.0108 ***	-0.0113 ***	-0.0082 ***	-0.0072 ***	-0.0075 ***
	Std	0.0061	0.0031	0.0025	0.0019	0.0017	0.0015
Highway Density (HWD)	Coeff.	42.0375 **	25.6056	19.6073 *	15.9681 *	15.7332 *	14.4854 **
	Std	19.2827	16.1705	11.2705	9.2325	8.1028	6.4501
Weighted HWD	Coeff.	10.7960	-45.6009 *	-32.5793 *	-28.2996 *	-22.6434 *	-16.8360
	Std	40.1225	24.9083	18.1501	14.5454	12.7743	10.8149
Population Density	Coeff.	-0.0127	0.0052	0.0039	0.0033	0.0021	0.0019
	Std	0.0093	0.0051	0.0042	0.0033	0.0030	0.0026
Fix Asset Investment	Coeff.	0.0083 ***	0.0060 ***	0.0061 ***	0.0049 ***	0.0039 ***	0.0043 ***
	Std	0.0032	0.0020	0.0016	0.0013	0.0011	0.0010
Education	Coeff.	-0.0990	1.5975	0.8993	0.6947	0.6278	-1.1313
	Std	2.3340	1.6391	1.2556	1.0068	0.8848	0.7602
Health	Coeff.	0.1423	0.0037	0.0470	0.0209	0.0331	0.0283
	Std	0.1413	0.0909	0.0711	0.0567	0.0499	0.0430
Railway Dummy	Coeff.	3.3463	-1.1861	-0.8631	-1.0459	-0.6532	-0.7570
	Std	2.5566	1.2692	1.0505	0.8272	0.7291	0.6627
Weighted Growth Rate	Coeff.	-0.4779 ***	0.9607 ***	0.8861 ***	0.9316 ***	0.8842 ***	0.8478 ***
	Std	0.1792	0.0820	0.0912	0.0979	0.1042	0.1159
LAMBDA	Coeff.	0.5361 ***	-0.7029 ***	-0.3960 **	-0.4737 ***	-0.4757 ***	-0.2174 ***
	Std	0.1113	0.1548	0.1648	0.1635	0.1635	0.1645
R-squared		0.2306	0.5494	0.5553	0.5317	0.5064	0.5264
Likelihood		-328.94	-299.90	-271.38	-252.72	-241.07	-224.33
AIC		677.88	619.80	562.76	525.44	502.14	468.66
BIC		702.76	644.69	587.64	550.32	527.03	493.54
Breusch-Pagan Test		14.1694	7.5779	9.0559	5.0045	1.3786	0.9522
Residual Moran's I		0.0055	-0.0423	-0.0213	-0.0274	-0.0273	-0.0092
Likelihood Ratio Test		1.5124	7.2580 ***	1.9090	3.1901 *	2.6957	0.7275

Dependent Variable: Average Annual GDP Growth Rate						
Independent Variables		1996-2003	1996-2004	1996-2005	1996-2006	1996-2007
CONSTANT	Coeff.	2.0396	1.8342	1.7227	2.0981	2.2647
	Std	1.5462	1.3952	1.5592	1.5412	1.6817
Initial GDP	Coeff.	-0.0062	-0.0047 ***	-0.0040 ***	-0.0034 ***	-0.0029 ***
	Std	0.0014	0.0012	0.0012	0.0011	0.0011
Highway Density (HWD)	Coeff.	12.5201 *	10.0902 *	6.5000	6.2097	5.0824
	Std	6.5734	5.9275	5.7288	5.4320	5.3983
Weighted HWD	Coeff.	-14.6724	-13.4611	-8.4287	-9.9807	-8.0850
	Std	10.3593	9.0863	8.8334	8.3245	8.1291
Population Density	Coeff.	0.0040	0.0037 **	0.0024	0.0019	0.0009
	Std	0.0022	0.0019	0.0018	0.0017	0.0016

(Table 3 to be continued)

(Table 3 continued)

Fix Asset Investment	Coeff.	0.0019		0.0015	**	0.0011		0.0008		0.0010	
	Std	0.0009		0.0008		0.0008		0.0007		0.0007	
Education	Coeff.	-0.4112		-0.4114		0.0862		-0.0244		0.1785	
	Std	0.7299		0.6294		0.6188		0.5825		0.5641	
Health	Coeff.	0.0705		0.0441		0.0467		0.0458		0.0253	
	Std	0.0410		0.0354		0.0346		0.0322		0.0308	
Railway Dummy	Coeff.	-0.4774		-0.5321		-0.0283		0.0777		0.0538	
	Std	0.5998		0.4953		0.4924		0.4568		0.4323	
Weighted Growth Rate	Coeff.	0.9433		0.9738	***	0.9068	***	0.8899	***	0.8727	***
	Std	0.1037		0.1016		0.1228		0.1203		0.1309	
LAMBDA	Coeff.	-0.4266		-0.5738	***	-0.5217	***	-0.5761	***	-0.6567	***
	Std	0.1644		0.1606		0.1623		0.1605		0.1572	
R-squared		0.5127		0.5130		0.4115		0.4291		0.3815	
Likelihood		-223.07		-211.98		-209.37		-204.18		-202.59	
AIC		466.14		443.96		438.74		428.36		425.17	
BIC		491.03		468.84		463.63		453.24		450.06	
Breusch-Pagan Test		5.6869		4.7661		5.9182		8.1990		7.5054	
Residual Moran’s I		-0.0162		-0.0242		-0.0300		-0.0364		-0.0462	
Likelihood Ratio Test		2.4763		5.0198	**	3.1120	*	5.0629	**	6.2745	**

Note: * presents significant at 10 percent level; ** presents significant at 5 percent level; *** presents significant at 1 percent level.

The candidate models include the spatial lag, the spatial error and SARMA models. Shown in Tables 2, 3 and Appendix A and B, we find that SARMA model is the appropriate model to investigate the highway impact. The OLS model shows the LM-lags are always larger than the LM-errors except the early period of 1996-1997. This implies the spatial lag models are preferred to the spatial error models. However, the tables in appendix A and B indicate the both spatial lag and spatial error do not completely solve the problem of spatial dependence. Although the Moran’s Indexes of the residuals in these two models are all small and insignificant, the likelihood ratio tests are all significant, showing that the certain degree of spatial dependence still exists. As shown in Table 3, the SARMA models give higher the log-likelihoods and smaller value of AICs and BICs. The likelihood ratio tests show that the SARMA model yield a better results in solving the problem of spatial dependence though not completely. Therefore, this paper investigates the impact of highways based on the estimated results of SARMA model.

4.2 The Highway Effect

The interesting findings are the positive and diminishing effect highway density on the economic growth. As shown in Table 3, all coefficients of highways density are positive and diminishing. Most of coefficients are statistically significant except the periods of two years and longer than eight years. The coefficient of the two-year period is very close to significant criterion of ten percent. With these results, we are able to investigate the highways density impact on the economic growth both in scale and time.

Magnitude of impact is large in the near term and diminishes until dies off. For near next year, the contribution of highways for an average highway density county (0.1768 kilometer per square kilometer) is unbelievable high. However, it declines down to about 91 percent GDP growth rate in the first two year period and then reduces gradually to about 5 percent GDP growth in the period of 1996-2004. The contribution continues to diminish and the impact becomes statistically insignificant in longer periods. These results clearly indicate the pattern of highway impact on GDP growth. Across the space, the higher highway density a region has today, the higher GDP growth rate will be in following short periods. The highways do not have long time impact.

As discussed above, highways are a necessary factor for economic growth. They provide an improved environment for economic activities. Whether not the improved environment improved by highways becomes a real economic growth depends on some other factors. Better transportation condition may draw other investments, the effect of transportation infrastructure depends the investments. Based on this consensus, the results above might hold for every case.

Table 4 shows the coefficients of initial highway density in 93 models, 97 models and 99 models. The results do not support the findings of 96 models. In 93 models, the coefficients are negative and statistically significant after 2003. All coefficients in 97 models are negative and statistically insignificant. In 99 models, the coefficient of the first period is negative and statistically significant. The coefficients of other periods are all statistically insignificant but positive or negative. It is difficult to make an inference for these conflict results. However, two patterns seem observable. The magnitudes of the coefficients are diminishing. The other is the significant coefficients seem continue for a period of times. We suspect this is the consequence of average. That is, the potential of highways only result in economic growth in certain year. Then the significant relationship among the highways and growth rate is spurious.

Table 4 Coefficients of Initial Highway Density in the SARMA Models for Different Periods

Independent variables	HWD 93	Std. Error	Independent variables	HWD 97	Std. Error	Independent variables	HWD 99	Std. Error
Growth rate 93-94	13.0899	18.0784						
Growth rate 93-96	-3.2143	13.8005						
Growth rate 93-97	-6.6700	10.4031						
Growth rate 93-98	-1.9624	8.9936	Growth Rate 97-98	-20.2799	21.6423			
Growth rate 93-99	-2.0605	7.8964	Growth Rate 97-99	-16.2479	12.8933			
Growth rate 93-00	-3.8911	7.2454	Growth Rate 97-00	-13.8937	9.5139	Growth Rate 99-00	-11.3851	5.9535 *
Growth rate 93-01	-2.1240	6.5503	Growth Rate 97-01	-5.4404	8.1986	Growth Rate 99-01	-2.7307	4.7827
Growth rate 93-02	-2.9126	5.8652	Growth Rate 97-02	-2.3217	6.7720	Growth Rate 99-02	3.7628	5.4291
Growth rate 93-03	-9.6869	5.0385 *	Growth Rate 97-03	4.1708	6.4776	Growth Rate 99-03	3.1202	6.2100
Growth rate 93-04	-10.2848	4.6742 **	Growth Rate 97-04	2.4351	5.5987	Growth Rate 99-04	-0.7736	5.2773
Growth rate 93-05	-10.6642	4.2857 **	Growth Rate 97-05	0.4617	5.2145	Growth Rate 99-05	0.0683	5.0727
Growth rate 93-06	-10.6477	4.3003 **	Growth Rate 97-06	-0.3417	4.9897	Growth Rate 99-06	-1.0081	4.9035
Growth rate 93-07	-10.8078	4.3132 **	Growth Rate 97-07	-0.8858	4.8037	Growth Rate 99-07	-2.1555	4.7078

Note: * presents significant at 10 percent level; ** presents significant at 5 percent level; *** presents significant at 1 percent level。

To verify the real impact, the initial highway densities are regressed to the growth rates by years. Results indicate the highway density in 1993 and 1996 only relate significantly to the GDP growth rate of 2003 and of 1997 respectively. This result confirms that highways are a necessary condition for economic growth but not a sufficient condition. Highways construction itself produces a stronger impact on near term economic. This impact may be significant or insignificant. The impact diminishes in times.

4.3 The Spillover of Highway

No strong evidences support the existence of spillover effect. The results of 96 models in Table 2 show the average highway density of neighbor counties have negative and statistically significant coefficients for some periods. However, only the coefficient of the first period of weighted highway density is positive and significant in 94 models in table 5. All coefficients in other models are insignificant and not consistent signs are found.

Table 5 Coefficients of Initial Highway Density in the SARMA Models for Different Periods

Independent Variables	WHWD 93	Std. Error		Independent Variables	WHWD 97	Std. Error	Independent Variables	WHWD 99	Std. Error
Growth rate 93-94	47.3554	28.8569	*						
Growth rate 93-96	31.9421	25.7701							
Growth rate 93-97	24.3043	19.7247							
Growth rate 93-98	18.5120	16.0213		Growth rate 97-98	-12.6812	30.4993			
Growth rate 93-99	13.5871	13.8308		Growth rate 97-99	-6.7444	19.4544			
Growth rate 93-00	9.7394	12.9776		Growth rate 97-00	-2.3241	14.4464	Growth rate 99-00	14.0873	10.1959
Growth rate 93-01	6.5597	11.6164		Growth rate 97-01	-5.1898	12.0782	Growth rate 99-01	2.5424	9.2574
Growth rate 93-02	7.9081	10.6284		Growth rate 97-02	1.6979	10.0012	Growth rate 99-02	12.5917	11.5549
Growth rate 93-03	9.8902	9.0309		Growth rate 97-03	-2.9739	9.5813	Growth rate 99-03	2.0755	10.9970
Growth rate 93-04	5.3324	8.4663		Growth rate 97-04	-2.0349	8.2755	Growth rate 99-04	4.6669	8.9583
Growth rate 93-05	3.2164	7.6848		Growth rate 97-05	-0.8530	7.6231	Growth rate 99-05	2.0209	8.4841
Growth rate 93-06	1.6134	7.7786		Growth rate 97-06	-4.9266	7.2615	Growth rate 99-06	1.4076	7.9185
Growth rate 93-07	2.4209	7.7957		Growth rate 97-07	-1.8443	7.0291	Growth rate 99-07	4.5761	7.4392

Note: * presents significant at 10 percent level; ** presents significant at 5 percent level; *** presents significant at 1 percent level

4.4 The Effect of Other Variables

The results also allow us to investigate effect of other variables. First, as the prediction of Solow model, the initial economic level (GDP) is found to have negative impact on economic growth in long periods. The fix asset investment is also found to require time to have significant impact on economic growth. The coefficients are positive and significant in short term and insignificant in long term. Their magnitudes decrease in times. Both proxy variables for education, measured by the ratio of middle school students to primary school students, and for Health service have positive and statistically insignificant coefficients. The effect of population density is negative and insignificant in both short and long periods. The effect of railway is positive but insignificant.

The coefficients of the dependent lag are positive except the first period, and significant in both long periods. The economic growths in neighbor counties produce positive spillover. Their magnitudes vary in the same pattern as the Moran's I of the dependent variables, implying the term captures the spatial dependence.

5. Conclusion

Spatial dependences of economic growth are found in county-level data of Guangxi Zhuang Autonomous Region in China. The OLS estimator is bias in the estimation of highway impact. SARMA models are used to correct the bias. The empirical results show that the effects of the highways on economic growth are inconsistent. The signs and the significances of the coefficients vary with times and the initial conditions. That is, the impact of initial highway densities can be positive or negative and can be significant or insignificant. No strong evidences indicate the existence of highway spillover effect. However, the magnitudes of the highway impacts and spillover effects are all large in short term and diminishing in time. These results are determined by the property of highways as a public good.

Highways are a public infrastructure that increases monotonically while economic growth can fluctuate. The impact of highways can be two folds. The construction of highways is a part of investment so it can produce a sort term impact on economic growth. The sort term impacts are direct and stronger. Then direct impact will die out in times. On the other hand, the service provided by the highways is a necessary condition but not a sufficient condition for economic growth. Therefore, the impact of highways is obtained through the performances of other factors. The spatial effects from highways in neighbor regions could not be directly and are long term. Similar to the highways inside the region, the spillover effect of neighbor highways are derived from the performances of other economic factors. The signs of the impact cannot be deterministic and depend on the movement direction of other economic factors.

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Appendix A The Estimates of Spatial Lag Model

Independent Variables		1996-1997	1996-1998	1996-1999	1996-2000	1996-2001	1996-2002
CONSTANT	Coeff.	10.5756 *	5.3016	4.5537	4.9769 *	4.7444 **	4.4511 **
	Std	5.8664	4.5378	3.1733	2.6623	2.3083	1.8982
Initial GDP	Coeff.	-0.0157 ***	-0.0166 ***	-0.0129 ***	-0.0095 ***	-0.0089 ***	-0.0078 ***
	Std	0.0054	0.0043	0.0030	0.0025	0.0021	0.0018
Highway Density (HWD)	Coeff.	43.3157 **	29.3142 *	17.6161	12.7354	13.1513 *	13.0414 **
	Std	20.3336	16.0452	11.1239	9.1793	7.8812	6.5598
Weighted HWD	Coeff.	-16.0472	-18.4878	-11.7520	-13.2725	-11.2405	-7.5334
	Std	35.2358	27.7087	19.1687	15.8022	13.5743	11.3627
Population Density	Coeff.	-0.0078	-0.0033	-0.0023	-0.0027	-0.0031	-0.0022
	Std	0.0083	0.0066	0.0046	0.0038	0.0033	0.0027
Fix Asset Investment	Coeff.	0.0079 **	0.0096	0.0072 ***	0.0061 ***	0.0054 ***	0.0048 ***
	Std	0.0032	0.0025	0.0018	0.0015	0.0013	0.0010
Education	Coeff.	1.0396	0.0945	-0.0997	-0.2870	-0.0355	-1.5741 **
	Std	2.4730	1.9511	1.3522	1.1166	0.9586	0.7971
Health	Coeff.	0.0557	0.0795	0.0956	0.0603	0.0597	0.0462
	Std	0.1419	0.1125	0.0783	0.0645	0.0555	0.0461

(Appendix A to be continued)

(Appendix A continued)

Railway Dummy	Coeff.	3.0714	-0.8677	-0.4242	-0.7966	-0.2446	-0.4395
	Std	2.3167	1.8178	1.2612	1.0397	0.8942	0.7423
Weighted Growth Rate	Coeff.	0.1331	0.4545	0.5467 ***	0.4990 ***	0.4545 ***	0.4822 ***
	Std	0.1436	0.1135	0.1000	0.1075	0.1112	0.1072
R-squared		0.1629	0.3990	0.4933	0.4396	0.4340	0.4716
Likelihood		-329.73	-310.63	-279.11	-261.44	-247.37	-231.24
AIC		679.47	641.25	578.22	542.88	514.74	482.48
BIC		704.36	666.14	603.11	567.76	539.62	507.36
Breusch-Pagan		15.0642 *	5.2562	2.9448	1.6697	1.1800	1.3702
Residual Moran's I		0.0161	0.0020	0.0205	0.0125	0.0061	0.0220
Likelihood Ratio Test		0.9012	15.7718 ***	23.2547 ***	17.1652 ***	14.1873 ***	16.3279 ***

Independent Variables		1996-2003	1996-2004	1996-2005	1996-2006	1996-2007
CONSTANT	Coeff.	4.8372 **	5.8318 ***	6.5981 ***	7.5670	8.9699 ***
	Std	2.0006	1.8918	1.9097	1.9472	2.0199
Initial GDP	Coeff.	-0.0076 ***	-0.0066 ***	-0.0060 ***	-0.0056	-0.0051 ***
	Std	0.0018	0.0016	0.0015	0.0015	0.0014
Highway Density (HWD)	Coeff.	9.6804	7.3471	4.9997	5.2842	3.3745
	Std	6.6978	6.0090	5.6487	5.4119	5.2309
Weighted HWD	Coeff.	-11.1410	-11.2780	-7.3515	-7.9480	-7.4559
	Std	11.5253	10.3402	9.7241	9.3200	9.0181
Population Density	Coeff.	0.0016	0.0015	0.0005	-0.0007	-0.0015
	Std	0.0027	0.0024	0.0023	0.0022	0.0021
Fix Asset Investment	Coeff.	0.0024 **	0.0022 **	0.0017 *	0.0016	0.0019 **
	Std	0.0011	0.0009	0.0009	0.0009	0.0008
Education	Coeff.	-0.4621	-0.3622	0.1412	-0.1628	0.0964
	Std	0.8145	0.7308	0.6870	0.6582	0.6360
Health	Coeff.	0.1047 **	0.0829 **	0.0838 **	0.0884	0.0630 *
	Std	0.0472	0.0423	0.0397	0.0381	0.0367
Railway Dummy	Coeff.	-0.1002	-0.2468	0.3702	0.4497	0.4180
	Std	0.7587	0.6805	0.6414	0.6145	0.5937
Weighted Growth Rate	Coeff.	0.4589 ***	0.4097 ***	0.3092 **	0.2661	0.1740
	Std	0.1114	0.1178	0.1275	0.1313	0.1392
R-squared		0.4007	0.3634	0.2871	0.2785	0.2287
Likelihood		-232.92	-222.79	-216.51	-212.44	-208.99
AIC		485.84	465.58	453.03	444.89	437.99
BIC		510.73	490.47	477.91	469.78	462.87
Breusch-Pagan		8.9333	5.0156	4.1907	3.7088	6.4619
Residual Moran's I		0.0251	0.0119	0.0221	0.0027	-0.0031
Likelihood Ratio Test		14.1999 ***	10.6112 ***	5.3598 **	3.9294 **	1.5378

Appendix B The Estimates of Spatial Error Model

Independent Variables		1996-1997	1996-1998	1996-1999	1996-2000	1996-2001	1996-2002
CONSTANT	Coeff.	11.5200 *	8.4372	7.0115	7.7305 **	7.2286 **	6.2358 **
	Std	6.3095	6.6359	5.1404	3.9316	3.2143	2.7587
	T-value	1.8258	1.2715	1.3640	1.9662	2.2489	2.2604
	P-value	0.0679	0.2036	0.1726	0.0493	0.0245	0.0238
Initial GDP	Coeff.	-0.0174 ***	-0.0194 ***	-0.0153 ***	-0.0110 ***	-0.0101 ***	-0.0094 ***
	Std	0.0056	0.0048	0.0034	0.0028	0.0024	0.0020
	T-value	-3.1162	-4.0726	-4.5533	-3.9908	-4.2826	-4.7372
	P-value	0.0018	0.0000	0.0000	0.0001	0.0000	0.0000
Highway Density (HWD)	Coeff.	43.4417 **	27.2831 *	16.4674	10.9182	11.3997	13.2945 **
	Std	19.7885	15.5054	10.9753	8.9935	7.7061	6.4115
	T-value	2.1953	1.7596	1.5004	1.2140	1.4793	2.0735
	P-value	0.0281	0.0785	0.1335	0.2247	0.1391	0.0381
Weighted HWD	Coeff.	-9.5756	-18.4871	-6.5133	-11.1801	-9.3973	-2.1523
	Std	35.9540	32.5660	24.0995	19.0916	15.9763	13.5024
	T-value	-0.2663	-0.5677	-0.2703	-0.5856	-0.5882	-0.1594
	P-value	0.7900	0.5703	0.7870	0.5581	0.5564	0.8734
Population Density	Coeff.	-0.0083	-0.0020	-0.0018	-0.0031	-0.0030	-0.0024
	Std	0.0087	0.0074	0.0052	0.0043	0.0037	0.0031
	T-value	-0.9639	-0.2687	-0.3536	-0.7187	-0.8281	-0.7853
	P-value	0.3351	0.7882	0.7237	0.4723	0.4076	0.4323
Fix Asset Investment	Coeff.	0.0084 ***	0.0101 ***	0.0076 ***	0.0065 ***	0.0057 ***	0.0051 ***
	Std	0.0032	0.0026	0.0018	0.0015	0.0013	0.0011
	T-value	2.5983	3.8927	4.2138	4.3402	4.4599	4.7575
	P-value	0.0094	0.0001	0.0000	0.0000	0.0000	0.0000
Education	Coeff.	0.9844	-0.5531	-0.6206	-0.7694	-0.1518	-1.3829 *
	Std	2.4529	1.8690	1.2841	1.0774	0.9350	0.7717
	T-value	0.4013	-0.2960	-0.4833	-0.7141	-0.1624	-1.7922
	P-value	0.6882	0.7673	0.6289	0.4752	0.8710	0.0731
Health	Coeff.	0.0814	0.1115	0.1250	0.0851	0.0747	0.0692
	Std	0.1430	0.1142	0.0795	0.0660	0.0569	0.0472
	T-value	0.5690	0.9765	1.5726	1.2880	1.3132	1.4671
	P-value	0.5693	0.3288	0.1158	0.1977	0.1891	0.1424
Railway Dummy	Coeff.	3.3105	-1.4041	-0.5990	-1.1301	-0.3546	-0.4898
	Std	2.4293	2.0698	1.4552	1.2003	1.0277	0.8559
	T-value	1.3628	-0.6784	-0.4116	-0.9416	-0.3451	-0.5722
	P-value	0.1730	0.4975	0.6806	0.3464	0.7300	0.5672
LAMBDA	Coeff.	0.1838	0.5485 ***	0.6429 ***	0.5714 ***	0.5202 ***	0.5543 ***
	Std	0.1474	0.1096	0.0955	0.1064	0.1134	0.1088
	T-value	1.2466	5.0048	6.7346	5.3725	4.5862	5.0958
	P-value	0.2125	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared		0.1705	0.4210	0.5124	0.4499	0.4370	0.4793
Likelihood		-329.48	-310.11	-278.93	-261.58	-247.90	-231.50
AIC		676.96	638.22	575.87	541.17	513.79	481.01
BIC		699.36	660.61	598.26	563.56	536.19	503.40
Breusch-Pagan		14.6886 *	3.4710	1.1061	0.3349		1.1524
Residual Moran's I		-0.0028	-0.0014	0.0148	0.0116	0.0098	0.0202
Likelihood Ratio Test		1.4098	16.8063 ***	23.6073 ***	16.8761 ***	13.1286 ***	15.7986 ***
Independent Variables		1996-2003	1996-2004	1996-2005	1996-2006	1996-2007	
CONSTANT	Coeff.	7.6181 *	8.7502 ***	9.1405 ***	10.0006 ***	10.6288 ***	
	Std	2.7406	2.3147	1.9848	1.8150	1.6239	
	T-value	2.7797	3.7803	4.6053	5.5099	6.5453	
	P-value	0.0054	0.0002	0.0000	0.0000	0.0000	

(Appendix B to be continued)

(Appendix B continued)

Initial GDP	Coeff.	-0.0088 ***	-0.0073 ***	-0.0066 ***	-0.0060 ***	-0.0054 ***
	Std	0.0020	0.0018	0.0016	0.0015	0.0014
	T-value	-4.4020	-4.1027	-4.0280	-3.8878	-3.7531
	P-value	0.0000	0.0000	0.0001	0.0001	0.0002
Highway Density (HWD)	Coeff.	8.9306	6.5396	4.7274	4.8370	3.0953
	Std	6.5016	5.8341	5.4504	5.2635	5.1293
	T-value	1.3736	1.1209	0.8673	0.9190	0.6035
	P-value	0.1696	0.2623	0.3858	0.3581	0.5462
Weighted HWD	Coeff.	-12.3896	-12.8815	-8.9063	-9.1969	-8.0111
	Std	13.5511	11.7929	10.5541	9.9242	9.2890
	T-value	-0.9143	-1.0923	-0.8439	-0.9267	-0.8624
	P-value	0.3606	0.2747	0.3987	0.3541	0.3885
Population Density	Coeff.	0.0017	0.0014	0.0005	-0.0007	-0.0017
	Std	0.0031	0.0028	0.0025	0.0024	0.0022
	T-value	0.5486	0.5136	0.2071	-0.3115	-0.7698
	P-value	0.5833	0.6076	0.8360	0.7554	0.4414
Fix Asset Investment	Coeff.	0.0026 **	0.0023 **	0.0018 **	0.0017 *	0.0020
	Std	0.0011	0.0010	0.0009	0.0009	0.0008
	T-value	2.3621	2.3441	1.9611	1.9205	2.3791
	P-value	0.0182	0.0191	0.0499	0.0548	0.0174
Education	Coeff.	-0.2069	-0.1739	0.3207	-0.0448	0.1516
	Std	0.7868	0.7154	0.6757	0.6541	0.6354
	T-value	-0.2630	-0.2432	0.4746	-0.0685	0.2386
	P-value	0.7925	0.8079	0.6351	0.9454	0.8114
Health	Coeff.	0.1182 **	0.0927 **	0.0909 **	0.0961 **	0.0688 *
	Std	0.0480	0.0432	0.0403	0.0386	0.0370
	T-value	2.4639	2.1440	2.2584	2.4879	1.8582
	P-value	0.0137	0.0320	0.0239	0.0128	0.0631
Railway Dummy	Coeff.	-0.1435	-0.3011	0.4548	0.4619	0.4415
	Std	0.8675	0.7739	0.7087	0.6710	0.6272
	T-value	-0.1655	-0.3890	0.6417	0.6883	0.7039
	P-value	0.8686	0.6973	0.5211	0.4913	0.4815
LAMBDA	Coeff.	0.5318 ***	0.4634 ***	0.3603 ***	0.2905 **	0.1737
	Std	0.1119	0.1206	0.1321	0.1388	0.1481
	T-value	4.7544	3.8422	2.7282	2.0935	1.1725
	P-value	0.0000	0.0001	0.0064	0.0363	0.2410
R-squared		0.4142	0.3676	0.2944	0.2760	0.2251
Likelihood		-232.77	-223.03	-216.42	-212.73	-209.20
AIC		483.54	464.06	450.84	443.47	436.40
BIC		505.94	486.45	473.24	465.86	458.80
Breusch-Pagan		6.3767	3.6987	3.7877	3.4728	6.6370
Residual Moran's I		0.0207	0.0171	0.0187	0.0129	0.0091
Likelihood Ratio Test		14.5037 ***	10.1405 ***	5.5478 **	3.3506 *	1.1221