UC Santa Cruz

Mapping Global Inequalities

Title

Regional Income Inequality in Post-1978 China: A Kaldorian Spatial Econometric
Approach

Permalink

https://escholarship.org/uc/item/2xh9w2qp

Author

Jeon, Yongbok

Publication Date

2007-12-10

Regional Income Inequality in Post-1978 China

: A Kaldorian Spatial Econometric Approach

Prepared for

Mapping Global Inequalities Conference

Center for Global, International

And Regional Studies

University of California

Santa Cruz

December 13-14, 2007

Yongbok Jeon

Department of Economics

University of Utah

jeon@economics.utah.edu

Regional Income Inequality in Post-1978 China
: A Kaldorian Spatial Econometric Approach

Yongbok Jeon

Department of Economics

University of Utah

Abstract: The conventional approaches to the regional income inequality in China including growth accounting, regional convergence regression analysis, and ad-hoc regression econometrics, are far from satisfaction. The purpose of this study is twofold. First, utilizing spatial econometric techniques with regional data set, it empirically tests the spatial dependence among the Chinese regions and the validity of the hypothesis of industry as the engine of economic growth. It is shown that the hypothesis hold in the Chinese regions, implying the validity of a demand-oriented approach to Chinese regional growth. It also finds that regional dependence is very weak among the Chinese provinces, which is in sharp contrast to previous studies on other regions like the EU and US states. The second objective of the present study is to draw implications for a regional policy to stimulate regional economic growth. It is argued that the finding of this study of the characteristic of autarky (spatial independence) reflects the importance of regional policies conducted by local governments in the regional development. For example, the active roles of local governments in economic development consequently resulted in reduction of disparity of regional income during the 1980s. In contrast, after 1992 when neo-liberalist policies represented by privatization and local governments' abandonment of industrial policy were pursued, the regional income inequality started getting worse until the present. This study suggests that the restoration of regional policies is a crucial part to reduce the increasing regional income inequality in China.

JEL Classification: O18, O53, R58

1. Introduction

The rapid growth of the Chinese economy has been accompanied by widening disparity of regional incomes among Chinese regions. In fact, the regional income inequality in China had been reduced over the 1980s, but the trend rebounded after 1992 when China started its neo-liberal policies (Yu and Wei, 2003).

The growing empirical literature on regional economic growth in China could be classified into three groups. The first group of studies is engaged in the regional growth accounting practices (e.g., Ezaki and Sun, 1999; Fleisher and Chen, 1997; Liu and Yoon, 2000; Wu, 2000) that estimate regional total factor productivity (TFP) by either the national income accounts or econometric models. These studies argue that the regional disparities of technical progress which is measured by TFP explain the different economic performances across Chinese provinces. They show that the rapid economic growth of east coastal provinces has benefited much from a high level of TFP, while the inland provinces have suffered from lower TFP. These empirical findings imply that the uneven regional distribution of technological progress is the major source of regional income inequality in China. However, it does not go without criticisms. First, in a methodological perspective, the notion of TFP is not so convincing in practice unless the relationship between factor shares (or income distribution) and technological progress is clarified at the empirical level (Felipe and McCombie, 2003; Jeon, 2007). Second, in the TFP literature, it is hard to find any explanation of the different TFP itself among regions. This may mean that the technological progress is presumed to be exogenously given.

The second group of studies, which has taken center stage in empirical research on regional economic growth, discusses the sources of regional income inequality in China in the context of "convergence debates". Building on the (augmented) Solow model and following pioneering empirical application of Barro and Sala-I-Martin (1991; 1992) and Mankiw et al. (1992), they regress the growth rates of regional per capita GDP over the sample period on the initial level of regional per capita GDP plus variables that could affect the steady-state rate of growth such as investment and human capital (e.g., Chen and Fleisher, 1996; Gundlach, 1997; Yao and Weeks, 2003), in which the models are estimated either by cross section or panel data to incorporate regional heterogeneity. These empirical studies find the tendency for per capita production to (conditionally) converge across China's regions. The convergence of regional income across the Chinese provinces may imply that the regional inequality would be explained by the disparity of steady-state growth rate among them. Although the econometric techniques used for these studies may be so advanced and sophisticated as in the convergence literature in general, it is

1

hard to believe that technical progress is exogenous and even across all regions and economies. As is well known, the (augmented) Solow model focuses on the transitional growth dynamics of one economy or one region toward its steady-state income path. However, it is by the assumption of the same steady-state growth rates and income levels across economies or regions that empirical studies on the regional economic growth have transferred the convergence within an economy or a region to the convergence across economies or regions. Furthermore, this is the case even for the panel data analysis in which regional heterogeneity is considered.

The last group of research may be called an ad-hoc regression approach in which regional per capita (log) income level is regressed on a vector of variables. The specification of the regression equation in this type of study is not derived from some growth theory. Instead, the explanatory variables are selected in an ad-hoc manner. These equations usually include the variables which are popular in growth literature such as the initial level of GDP and others depending on the research interests. For example, Bao et al. (2002) incorporates some geographic variables into their regression equation and finds that geographic effects on the regional GDP growth are significant, while Yu and Wei (2003) finds strong associations between the growth of regional per capita GDP and geographical location, FDI, and (negatively) share of SOEs (see also, Fleisher and Chen, 1997; Chen and Feng, 2000; Demurger, 2001; Lin and Liu, 2000; Ying, 2003, for numerous factors). Although they have found "statistically" significant explanatory variables, its ad-hoc manner of variable selection makes it hard to interpret the econometric results. Furthermore, Levine and Renelt (1992) demonstrates that those empirical results are extremely sensitive to minor alternations in the explanatory variables.

In addition to the shortcomings of the conventional approaches above, one can find a common ground on which the conventional approaches are based: they are exclusively supply-oriented approaches in which the roles of demand side are ignored. In general, in explaining differences in rates of economic growth among economies or regions and factors that constrain their economic growths, two viewpoints have contested each other. On the one hand, the mainstream neoclassical view to which all approaches above belong has taken supply-oriented approach in which differences in economic performance among countries or regions are explained exclusively by exogenously determined technological progress and inputs of factors of production. On the other hand, Kaldorian tradition, which is one tradition of the demand-oriented approaches[1], has questioned the very presumption of exogeneity of factors of production and technical progress. In this viewpoint, supply of factors of production and

---

[1] For a comprehensive discussion on various traditions of demand-oriented approach and associated issues, see McCombie & Thirlwall (1994) and Setterfield (2002).

technological progress are driven by demand, instead of determined exogenously by the outside economy. This does not mean that the supply conditions do not matter. On the contrary, what the demand-side approach attempts to do is to make the supposedly exogenous factors in the supply side be endogenous to demand. If the exports to other economies or regions, for instance, were to be determined by such factors of production in the supply side as the growth of labor forces and technical progress, this should be through interaction with the conditions in the demand side that might well have an influence on conditions in the supply side.

Formulating the effect of demand factors at work in economic growth, Kaldor put forward a series of laws for economic growth in the late 1960s (Kaldor, 1966; 1967; 1968). Since then, his followers have intensively developed more accurate theoretical underpinnings and extensively accumulated empirical results supporting them. They are especially relevant to regional economic development, because the mechanisms that were identified have important implications for the appropriate role of public policies in stimulating the economic growth of lagging regions.

Although numerous studies have empirically tested Kaldor's laws, only a few have been carried out at a regional level with regional data within an economy. McCombie and de Ridder (1984) and McCombie(1985) were the first two studies testing Verdoorn's law (Kaldor's second law) with regional data for the United State. They found substantial increasing returns to scale in the United State. However, these studies do not take into account spatial effects which might lead to biased estimates and inefficient tests when OLS is applied. In contrast, Bernat(1996) is the first and only study which uses US states' data in a spatial econometric perspective. He found substantial spatial dependence between the continental 48 states as well as evidence for Kaldor's laws. In terms of spatial econometrics, Fingleton and McCombie(1998) tests Verdoorn's law in the EU regions and finds evidence for increasing returns to scale in the region. Pons-Novell and Viladecans-Marsal (1999) applies spatial econometric models to all Kaldor's laws in the European Regions, finding supportive evidences. To the author's knowledge, there are only two case studies for China testing Kaldor's hypotheses. Using a panel data set that consists of Chinese provinces, Hansen and Zhang(1996) and Jeon(2006) find the evidences that all three of Kaldor's laws hold. However, these two studies are at national level, and do not take into account the regional or spatial dependences.

The purpose of this study is twofold. First, using regional data set and utilizing spatial econometric techniques, it empirically tests the validity of Kaldor's laws. It is shown that Kaldor's laws hold in the Chinese regions, implying the validity of a demand-oriented approach

to Chinese regional growth. It also finds that regional dependence is weak among the Chinese provinces, which are in sharp contrast to previous studies on other regions like the EU and US states. The second objective of the present study is to draw implications for a regional policy to stimulate regional economic growth. The findings that the regional growth in China was demand–led and that Chinese regions spatially depend very little on each other may imply the importance of regional policies conducted by local governments in China. At the first stage of reform during the 1980s when Chinese local governments were responsible for their region's economic development, they were able to promote local economic growth by stimulating regional industries which played a key role in the economic development during this time period. Regarding the regional income inequality, the active roles of local governments in economic development consequently resulted in reduction of disparity of regional income during this period. In contrast, after 1992 when neo-liberalist policies represented by privatization and local governments' abandonment of industrial policy were pursued, the regional income inequality started getting worse until the present. Therefore, this study imply the importance of regional industrial policy by local governments to reduce regional disparities.

The present study is organized as follows. Section 2 briefly discuss Kaldor's laws along with their implications and suggests their test specifications. Using regional data set, section 3 estimates the spatial regression models of Kaldor's law specified in section 2. Section 3 concludes by discussing policy implications of the empirical findings.

2. Kaldor's Economic Growth Law[2]

The first law often called "the engine of growth hypothesis" maintains that the growth of GDP is positively associated with the growth of the manufacturing sector of the economy. Formally,

$$q_{GDP} = a_1 + a_2 q_m, \ a_2 > 0 \tag{1}$$

where q_{GDP} and q_m are the growth of GDP and of manufacturing, respectively, and $a_i \ (i = 1, \ 2)$ are regression coefficients. Note that the strong association between GDP growth and expansion of manufacturing is not simply because the manufacturing sector takes an increasingly bigger proportion in an economy as economic development proceeds, which might be called a "share effect". To avoid this share effect, an alternative specification is suggested as:

---

[2] This section draws heavily on Jeon(2006)

$$q_{GDP} = a_3 + a_4(q_m - q_{nm}) \tag{2}$$

where, q_{nm} indicates the rate of growth of non-manufacturing output. A positive sign of the coefficient of the growth of manufacturing implies that fast growth of GDP is associated with excess rate of growth of manufacturing over growth rate of GDP. Alternatively, we may examine the role of manufacturing industry in a equation that incorporate all industries as the regressors. That is,

$$q_{GDP} = a_5 + a_6 q_{primary} + a_7 q_m + a_8 q_{tertiary} \tag{3}$$

This study will utilize equation (1) through (3) as the test specifications for the first law.

If the differences of the rates of economic growth between countries are by and large accounted for by differences of productivity of the economies,[3] there should be some identifiable mechanisms through which fast growing manufacturing sector produces higher productivity of an economy as a whole. Kaldor and his followers have suggested two transmission channels, which consists of the next two laws.

The second law that have been referred to as "Verdoorn's Law" states that in the manufacturing sector, the growth of productivity is positively associated with the growth of production, which is specified as

$$p_m = b_1 + b_2 q_m \tag{4}$$

where p_m is the growth rate of labor productivity in manufacturing, and $b_i\,(i = 1,\,2)$ are regression coefficients. To avoid a possibility of a spurious correlation emerging from definitional identity for the labor productivity $p_m = q_m - e_m$, another specification is preferred.

$$e_m = c_1 + c_2 q_m \tag{5}$$

---

[3] This may require the assumption of a constant participation rate of labor force. The assumption could be justified by the stylized fact of a co-movement of disparity in per capita income and labor productivity. Therefore, it may be safe to focus on regional inequality in labor productivity as being the major factor accounting for the regional inequality in per capita GDP. In other words, the factors and sources that explain vicissitude of regional labor productivity differences could also account for that of regional income disparities.

where e_m is the growth of labor employment in manufacturing, and $c_1 = -b_1$ and $c_2 = 1 - b_2$. A c_2 in equation (5) less than unity is interpreted as the existence of substantial dynamic increasing returns to scale. In general, the sufficient condition for there to be increasing returns to scale is $c_2 = 1 - b_2 < 1$.

The sources of increasing returns to scale are explained in two ways. First, it is suggested that the Verdoorn Law be seen as a technical progress function that is combined with investment and the increase in capital stock (Bairam, 1987; Dixon & Thirlwall, 1975; McCombie, 1982). In contrast to the notion of the exogenous technological progress in the conventional approaches, it is assumed that technical progress only takes place through accumulation of capital (Kaldor, 1957). Therefore, there is no need to include a variable for capital stock in a test specification.[4] Second, the technical progress relies much more on dynamic, rather than static, relations between output and productivity. The relationship between changes of output and productivity is dynamic, since it is concerned with technical changes that are brought about by induced technical progress, learning by doing, external economies in production, etc. (McCombie & Thirlwall, 1994, p.174; Young, 1928).

It is extremely important to note that the growth of output plays the key role as the ultimate driving force leading to fast growth of productivity, that is, the causality runs from the demand to productivity, but not the other way round. This is because, first, according to the notion of dual economy which can be applicable even to advanced economies, there cannot be a supply-side constraint such as labor shortage (Cornwall, 1976, 1977; Kaldor, 1975). Second, the exogeneity of technological progress and productivity as in the conventional approaches are not reconcilable with the notion of dynamic increasing returns which is obviously pervasive in manufacturing. Therefore, the correct specification for the measurement of returns to scale should be equation (5) that has been derived in such a way to incorporate mainly the dynamic aspects of increasing returns while not relying on any type of an alleged aggregate production function.

Kaldor's third law maintains that the growth of productivity of an economy as a whole is

---

[4] Many authors testing the Verdoorn's law argue that a variable for capital stock should be included in order to capture the contribution of capital accumulation to productivity growth (*inter alias*, Bairam, 1987; Leon-Ledesma, 2000; McCombie, 1983; McCombie & de Ridder, 1983, 1984; Wolfe, 1968), the rationale for which is the belief that faster capital accumulation may have positive effects on the labor productivity. However, to include the capital variable in the specification for a test of Verdoorn's law is not consistent with the implicit criticism of neoclassical notion of technological progress. For the derivation of the Verdoorn's law in this vein instead of from a neoclassical aggregate production function, see Dixon & Thirlwall(1975) and Targetti (1992).

positively connected with the growth of output in the manufacturing sector through the labor transfers to the manufacturing sector from the other sectors including agriculture and service. Extending and generalizing the notion of dualism, demand-led growth approaches have identified two main channels through which the positive effects of labor transfers to the manufacturing sector on the overall productivity are supposed to work (Cripps & Tarling, 1973; Kaldor, 1968; Thirlwall, 1983). First, the productivity of the manufacturing will increase as it absorbs more of labors to produces more of goods; as the production of manufacturing increase, as seen in the above it is likely to result in a higher productivity through the Verdoorn effect. Second, the productivity outside the manufacturing will also increase because evicting the surplus labor prevailing in them will improve the productivity of the remainder of the labor forces.

In practice, it is hard to test directly the relationship between the labor transfer and the growth of productivity of the economy because it is very difficult to measure productivity growth in many activities outside manufacturing. There are two mutually complementary specifications for the test of the third law.

$$q_{GDP} = d_5 + d_6 e_m + d_7 e_{nm}, \ d_6 > 0, \ d_7 < 0 \tag{6}$$

$$p_{GDP} = d_8 + d_9 q_m + d_{10} e_{nm}, \ d_9 > 0, \ d_{10} < 0 \tag{7}$$

where e_m is the growth rates of employment in manufacturing, e_{nm} is the growth rate of employment outside manufacturing and q_{GDP} and p_{GDP} denote the growth rate of output and productivity, respectively, of an economy. Equation (6) may better represent the spirit of the third law. However, it would be worthwhile to note that specification (7) is sometimes preferred because, first, "most of the variation in productivity growth which is not associated with movements in employment is concentrated in the manufacturing sector and is therefore correlated with the growth of industrial output" (Cripps & Tarling, 1973) and, second, the growth of manufacturing output is a net increment in resources, but not just a reallocation of resources from one use to another, in the sense that they would otherwise have been *de facto* unused (Thirlwall, 1983, Targetti, 1992). The present study will estimate both specifications of (6) and (7).

3. Empirical Results

Data and Methodology

The target time period of the present study is between 1979 when the packet of reform and open

policies was launched and 2004. Instead of a time series data set, we use a regional cross-section data set which was built by averaging each variable for the sample period. The observations represent 29 Chinese provinces and municipalities. For the purpose of the study, the averaged regional cross-section data set is preferred to other data set in that the use of averaged data over the sample period could wipe out the cyclical effects and better reveal the long-term relationships between variables under consideration.

According to the development of spatial econometrics, the presence of spatial autocorrelation could have important adverse consequences to the standard parameter estimations by OLS and their inferences (Anselin and Griffith, 1988; Anselin, 1988). Spatial autocorrelation in the econometric models can take two forms. The first form of the spatial autocorrelation is called spatial lag model and formulated as in equation (8):

$$y = \rho W y + X \beta + \varepsilon \tag{8}$$

where y is a vector of n observations (regions) on the dependent variable, W is a $n \times n$ spatial weight matrix, X is a vector of explanatory variables, β is a coefficient vector, ρ is the spatial autoregressive coefficient, and ε is a vector of error terms which conform to the standard assumption of white noise. Note that the spatial dependence in this model is similar to having a lagged dependent variable as an explanatory variable. If the model (8) is the correct model, but it is to be estimated without the spatial autoregressive term, the estimated vector of coefficient β should be biased and all inferences based on the omitted variable model are invalid. It is important to understand that the spatial autoregressive coefficient ρ captures the magnitude of effect that dependent variables of neighboring regions make on the dependent variable of one region. In other words, it measures the degree of the substantive dependence of one region's dependent variable upon the dependent variable of the surrounding regions, which may derive from a variety of spill-over effects such as technology diffusion and transfers of factors of production. Therefore, the existence of the spatial lag dependence indicates a structural spatial dependence among regions (Rey and Montouri, 1999)

The second form of spatial autocorrelation is the spatial error model and expressed as equation (9):

$$\begin{aligned} y &= X \beta + \varepsilon \\ \varepsilon &= \lambda W \varepsilon + \xi \end{aligned} \tag{9}$$

where λ is the autoregressive parameter and ξ is a vector of white noise error terms. Compared with model (8), model (9) indicates that spatial dependence is embodied in the error terms. If the spatial autocorrelation in model (9) is ignored and estimated by OLS, the OLS coefficient of β may still be unbiased, but the parameter estimation is inefficient and the associated inferences may be misleading. Note that, in contrast to the structural dependence in the spatial lag model, the spatial error autocorrelation may result from a nuisance such as a mismatch between economic boundaries and administrative boundaries based on which data are collected and organized. In other words, the existence of spatial autocorrelation in error terms may not have significant implications as much as the spatial lag dependence with regard to regional policy implications.

In the rest of this section, we estimate the specifications for Kaldor's laws with a first-order contiguity spatial weight matrix[5]. To consider the possible spatial autocorrelation, we first estimate the models by OLS and calculate Moran's I statistics to test spatial dependence. Although the Moran's I test is probably the most popular test for a spatial autocorrelation, it does not provide any additional information about the form of spatial dependence, spatial lag or spatial error. To distinguish between two patterns of spatial dependence, we utilize Lagrange multiplier tests, using LM(error) for a spatial error model and LM(lag) for spatial lag model (Anselin, 1988). When Moran's I is significant and a form of spatial dependence is identified, we re-estimate that spatial econometric model by maximum likelihood (ML) principle. Finally, likelihood ratio (LR) is used to test for the spatial autoregressive coefficient for either spatial lag or spatial error. In addition, we report some diagnostic test results such as Jarque-Bera normality test and (spatial) Breusch-Pagan heteroscedasticity test. The former is especially important in the sense that the maximum likelihood estimation of the spatial econometric models is based on the assumption of normal error terms.

Empirical Results

[Table 1] Kaldor's First Law

Equation	(1)		(2)	(3)		
	OLS	S-Error	OLS	OLS	S-Error	S-Lag
constant	3.215	2.986	10.099	-0.122	0.043	-0.062

---

[5] There is no obvious criterion for the best weight matrix. Although the study reports only the estimation results drawn with contiguity weight matrix, the author experimented with squared and simple distance inverse weight matrices as well as distance band weight matrices with various critical bands. But, the experiments show very similar patterns to those reported here, except for the case of an extremely large distance band weight matrix. However, this case is not usual in economic terms.

	(1)	(2)	(3)	(4)	(5)	(6)
	(0.000)	(0.000)	(0.000)	(0.845)	(0.934)	(0.950)
q_primary				0.097	0.069	0.095
				(0.156)	(0.260)	(0.161)
q_m	0.662	0.692		0.397	0.469	0.397
	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
q_tertiary				0.422	0.366	0.423
				(0.000)	(0.000)	(0.000)
(q_m)-(q_nm)			0.144			
			(0.088)			
Lambda (error)		0.550			0.533	
		(0.002)			(0.003)	
LR (error)		5.862			3.606	
		(0.015)			(0.058)	
Rho (lag)						-0.006
						(0.940)
LR (lag)						0.006
						(0.938)
AIC	57.812	51.949	106.112	28.765	25.158	30.759
LIK	-26.906	-23.975	-51.056	-10.382	-8.579	-10.379
Jarque-Bera	0.681		1.412	2.241		
	(0.711)		(0.494)	(0.326)		
Breusch-Pagan	2.871	2.305	0.010	0.086	0.533	0.081
	(0.090)	(0.129)	(0.919)	(0.993)	(0.912)	(0.994)
Moran's I	3.024		0.949	2.222		
	(0.002)		(0.342)	(0.026)		
LM (error)	5.827		0.374	2.013		2.356
	(0.016)		(0.541)	(0.156)		(0.125)
LM (lag)	1.070	0.493	0.566	0.007	0.980	
	(0.301)	(0.482)	(0.452)	(0.936)	(0.322)	

[Table 1] reports the estimations of the specifications for Kaldor's first law which posits that industry is the engine of economic growth. When equation (1) is estimated by OLS in the second column, the nulls of normality and homoscedasticity are not rejected at the conventional significant level. However, Moran's I test indicates the possibility of spatial dependence. The consequent LM tests, which identify the type of spatial autocorrelation, indicate a spatial error

model, implying inefficiency of OLS estimation. In the next column with the heading of S-error, a spatial error model is estimated by means of ML principle. It shows the improvement of estimation efficiency in terms of AIC and LIK, both of which, in contrast to the value of R-squared, are comparable to those for OLS. The LR test for the coefficient of spatial error verifies the existence of spatial autocorrelation in the error terms, while the LM(lag) test at the bottom of the table shows that there is no spatial lag on error terms left. The estimated coefficient of 0.692 means that the growth rate of GDP for a region with a growth rate of the secondary industry higher by 1 percentage point than its overall average across regions has grown faster by 0.692 percentage points than the average growth rate of GDP across regions in China, which may imply the significant role of the secondary industry in the growth of regional GDP. Note also that the absence of spatial lag autocorrelation points out the absence of spatial dependence of the regional economic growth.

Taking into account the possibility of a spurious relation between the two variables, equation (2) and (3) are also estimated. When equation (2) is estimated by OLS, there is no abnormality in terms of normality and homoscedasticity as well as spatial autocorrelation. The estimation result shows that regional economic growth measured by the growth rate of regional GDP is associated positively, if only moderately, with the difference between the growth rate of secondary industrial output and that of non-secondary output (p-value=0.088). That is, if one region's secondary industry grows faster than the other industries and the difference is higher than the average difference across regions by 1 percentage point, that region's GDP grows faster by 0.144 percentage points than the average GDP growth rate across regions, which may be taken as evidence for Kaldor's first law. When equation (3), in which the regional GDP growth rate is regressed on all three industrial output growth rates, is estimated by OLS, Moran's I test implies spatial autocorrelation, but two LM tests do not. In order to consider any possibility, we estimate both spatial lag and spatial error models. In the two spatial models, no evidence for spatial dependence is found, as LR tests for the spatial autocorrelation coefficients do not reject the null. Furthermore, the values of AIC and LIK for the spatial lag model turned out even worse than those for OLS estimation. Looking at the coefficients, all three of the estimated equations indicate that the coefficient for primary industry is not significant, while those for secondary and tertiary industry are highly significant.

From these empirical findings, we can draw two conclusions. First, the overall results imply that the secondary industry has played a significant role in regional economic development in the regions of China. Although the coefficient for tertiary industry in equation (3) is significant, the causality should run from growth of the regional GDP to growth of tertiary industry, since the

latter is induced by the growing demand for services as the regional economies grow. Second, we find very weak spatial dependence of the growth of regional GDP among the Chinese regions. This may show characteristics of autarky in the Chinese regions, which may in turn reflect the important role of local governments in regional development.

[Table 2] Verdoorn's Law

	OLS
constant	-3.632
	(0.022864)
q_m	0.678
	(0.000)
R-sqr.	0.452
AIC	110.811
LIK	-53.405
Jarque-Bera	4.133
	(0.127)
Breusch-Pagan	0.609
	(0.435)
Moran's I	-0.132
	(0.895)
LM (error)	0.182
	(0.670)
LM (lag)	0.751
	(0.386)

Using equation (5), [Table 2] reports the estimation of Kaldor's second law (or Verdoorn's law) in which the growth rate of secondary employment is regressed on the growth rate of secondary industrial output. We first estimate equation (5) by OLS and then conduct the normality and homoscedasticity tests. As is shown in [Table 2], no abnormality is found. Furthermore, the tests for spatial dependence find no symptom of spatial autocorrelation. Therefore, the OLS estimation results could be taken without a reference to spatial econometric models.

The estimated coefficient has the right sign and is highly significant. And, the implied Verdoorn's coefficient of 0.322(=1-0.678) means increasing returns to scale in the secondary industry of the Chinese regions. That is, regarding regional economic growth in China, a region with growth of output in secondary industry higher by 1 percentage point than the average

enjoyed greater productivity growth by 0.322 percentage points, relative to other regions.

This finding may well imply the leading role that secondary industry has played in regional development. Furthermore, it should be noted that, as is noted in the theoretical discussions, the productivity growth is demand-driven in the sense that increases in demand for industrial goods lead to faster growth of output, which in turn results in higher productivity. As is discussed further in the following, it is worth noting the absence of regional dependence in productivity growth across the Chinese regions.

Finally, [Table 3] estimates two equations, (6) and (7), for Kaldor's third law. When equation (6) is estimated by OLS, there is a symptom of spatial autocorrelation. Since consequent LM tests indicate neither spatial lag model nor spatial error model, both are estimated. The spatial error coefficient, but not the spatial lag coefficient, is moderately significant in terms of the LR test. But, the spatial error model estimation does not alter the results by OLS much in terms of size, sign and inferences. In both estimations, it is shown that the growth rate of regional productivity is associated positively with the growth rate of the secondary industrial output, and negatively with growth of employment in non-secondary industry, as the theory predicts.

In addition, the estimation of equation (7) by OLS does not reveal any abnormality with regard to homoscedasticity, normality, and spatial autocorrelation. It shows that the growth rate of the regional GDP is correlated positively with the growth rate of industrial employment and negatively with that of non-industrial employment, which is also predicted by the third law.

[Table 3] Kaldor's Third Law

Dependent	p_GDP			q_GDP
	OLS	S-Error	S-Lag	OLS
constant	4.853	3.939	4.022	10.080
	(0.000)	(0.000)	(0.005)	(0.000)
e_m				0.349
				(0.005)
e_nm	-0.940	-0.821	-0.913	-0.610
	(0.000)	(0.000)	(0.000)	(0.044)
q_m	0.481	0.554	0.486	
	(0.000)	(0.000)	(0.000)	
Lambda (error)		0.457		
		(0.019)		
LR (error)		2.871		
		(0.090)		
Rho (lag)			0.090	
			(0.500)	
LR (lag)			0.486	
			(0.244)	
R-sqr.	0.775	0.845	0.463	0.366
AIC	72.738	69.867	111.973	98.071
LIK	-33.369	-31.933	-52.986	-46.035
Jarque-Bera	2.559			0.594
	(0.278)			(0.743)
Breusch-Pagan	5.507	6.074	5.197	2.834
	(0.064)	(0.048)	(0.074)	(0.242)
Moran's I	2.034			-0.587
	(0.042)			(0.557)
LM (error)	2.148		1.357	0.810
	(0.143)		(0.486)	(0.368)
LM (lag)	0.546	0.528		0.231
	(0.460)	(0.467)		(0.631)

4. IMPLICATIONS AND CONCLUTIONS

4.1 The Role of Secondary Industry

According to the empirical evidence, the process of economic development in the Chinese regions between 1979 and 2004 can be best described as follows. The expansion of secondary industry has played a key role in growth of regional GDP in two ways. First, it was the secondary industry that achieves appreciable increasing returns to scale which are assumed to be spread over the entire economy in the Chinese regions.

The second reason for the secondary industry to play a key role in the overall economic growth in the Chinese regions is explained by labor reallocation between industries. When surplus labor forces are assumed, transferences of surplus labor into secondary industry with higher productivity might well result in higher overall productivity of an economy as a whole, since the growth of industrial output is a net increment in resources, but not just a reallocation of resources from one use to another in the sense that they would otherwise have been *de facto* unused (Thirlwall, 1983; Targetti, 1992). In the Chinese context, the most important reallocation of labor forces from agriculture to secondary industry took place within rural areas, but not among them.

4.2 The Role of Local Governments

One of the most significant findings in the present study is the absence of spatial autocorrelations for the dependent variables in the various models. This is verified further by examining spatial autocorrelations of all variables involved.

[Table 4] Spatial Autocorrelations

	Moran's I Test		Geary's C Test	
	I	p-value	C	p-value
q_GDP	0.086	0.318	0.872	0.341
q_m	0.106	0.248	0.806	0.147
q_nm	-0.074	0.753	1.201	0.133
q_m – q_nm	-0.069	0.788	1.135	0.313
e_primary	-0.067	0.800	0.913	0.518
e_m	0.265	0.014	0.698	0.024
e_nm	0.074	0.368	0.868	0.325
p_GDP	0.091	0.301	0.861	0.299
p_m	-0.213	0.148	1.250	0.062

[Table 4] reports the test results for spatial autocorrelation by Moran's I and Geary's C. It shows that all variables involved in the previous models are not spatially dependent across the Chinese regions, except for the growth rate of employment in secondary industry.

This finding of spatial independence may have conceivable implications for the importance of the roles that Chinese local governments have played in the regional development processes. As is well known, the rapid expansion of industrial output in China during the reform period was mainly due to the meteoric growth of rural industry represented by so called township-village enterprises (TVEs). Between 1978 and the mid-1990s, it is TVEs that were the most dynamic part of the Chinese economy. On the one hand, TVEs value-added, which accounted for less than 6% of GDP in 1978, increased to 26% of GDP in 1996, notwithstanding the fact that GDP itself was growing very rapidly during this period. On the other hand, the employment of TVEs grew from 28.27 million in 1978 to reach 135.08 million in 1996. After a sharp drop between 1997 and 1998, it resumed absorbing labor and reached its peak of 138.66 million in 2004 (China Statistical Yearbook 2005). Considering the fact that the agricultural employment declined very rapidly, from 70.5% of total employment in 1978 to 50.5% in 1996, one would plausibly infer that the transfer of labor from primary to secondary industry and its productivity benefits were created within Chinese regions.

It is crucial to understand that the Chinese local governments actually run the business of TVEs from their establishment to their management (Oi, 1999; Unger, 2000). Although the conventional approaches have treated them as being a private sector, they were actually collective firms which were owned by the public locally and managed by public offices. They did not work like a private enterprise responding sensitively to its own profit opportunity. For example, the major source of capital for TVEs was local branches of state-owned banks which loaned to them upon request of local government offices, and the local governments' decision was made by public needs in the regions such as employment and regional economic development, but not by private profit motivations. It has also been noticed by many field studies that local governments even acted as a long-run regional planner, establishing a long-term development plan and adjusting long-run industrial structures through rationing financial resources, which is much similar to the role played by the Ministry of International Trade and Industry (MITI) in Japan during its economic development. Furthermore, the Chinese local governments supported industrial development in their areas by providing massive infrastructure, which might not have been built if tasks had been left to the private sector or market processes.

Recalling the importance of secondary industry in regional economic growth, the autarky of the regional economies in China could be explained mainly by the fact that regional economic development in the Chinese provinces has owed much to the active role of local government in promoting local secondary industry. This may also explain the pattern of regional income inequality after 1990: that is, the growing regional income inequality may be due to the retreat of local governments from regional economic development.

Finally, the findings of this study imply that the economic growth in China was demand-led growth. During the 1980s, the Chinese local governments were able to promote local industry under the circumstances of growing income levels which in turn resulted in greater purchasing power for Chinese households. This may be evidenced by the fact that the TVEs were producing manufactured goods: increases in demand for manufactured goods pulled the production of industry which in turn, on the one hand, raised its productivity via Verdoorn's Law, the gains of which should spread over the entire economy; on the other hand, the lift of manufacturing production induced by increase in demand for manufactured goods set off labor transfer from agriculture to manufacturing, increasing labor productivity of the overall economy.

This also shed new light on the importance of economic policy in that the increase in income of households, the source of effective demand during the 1980s, was supported mainly by government policies. For example, the sustained household consumption in the early period of reform could be explained as follows. First, the reform period has witnessed a sustained increase in prices of agricultural goods. Indeed, at the first of the reform in 1979, the average of prices for the quota and above increased by 22.1% and thereafter by 1989, prices of agricultural products grew on an annual average of 8.9%. Furthermore, reflecting the effect of the decision by the state to shift the intersectoral terms of trade in favor of agriculture in 1979, the agricultural terms of trade, as compared to industrial products, improved from 1:1 in 1978 to 1:1.71 in 1989, which might have increased rural household income leading to consumption demand. The second source of the increase in rural incomes was the considerable spurt of agricultural outputs, which was again the direct result of government efforts in improving farm technologies including high-yielding modern varieties, constructing irrigation systems and providing more chemical fertilizer. Third, as seen above, the rapid growth of TVEs in rural areas, which was initiated and managed by the local governments, provides rural households with another source of income by working in industry for a higher wage than that of agriculture workers.

REFERENCES

Anselin L. (1988), *Spatial Econometrics: Methods and models*, Dordrecht: Kluewer Academic Publishers

Anselin, L. and Griffith, D.A. (1988), "Do spatial effects really matter?", *Papers in Regional Science*, **65**, pp.11-34

Bairam, E.I. (1987), 'The Verdoorn Law, Returns to Scale and Industrial Growth: A Review of the Literature', *Australian Economic Papers*, 26, 20-42

Bao, S., Chang, G., Sachs, J., and Woo, W. (2002), "Geographic Factors and China's Regional Development under Market Reforms: 1979-1998", *China Economic Review*, 13, pp.89-111

Barro, R.J. and Sala-I-Martin, X. (1991), "Convergence Across States and Regions", *Brookings Papers on Economic Activity*, 1, pp.107-82

Barro, R.J. and Sala-I-Martin, X. (1992), "Convergence", *Journal of Political Economy*, 100, pp.223-51

Bernat, G. Andrew, Jr. (1996), "Does Manufacturing Matter? A Spatial Econometric View of Kaldor's Laws," *Journal of Regional Science*, 36, pp.463–477

Chen, B. and Feng, Y. (2000), "Determinants of Economic Growth in China: Private Enterprise, Education and Openness", *China Economic Review*, 11, pp.1-15

Chen, J. and Fleisher, B.M. (1996), "Regional Income Inequality and Economic Growth in China", *Journal of Comparative Economics,* 22, pp.141-64

Cornwall, J. (1976), 'Diffusion, Convergence and Kaldor's Laws', *Economic Journal*, 86(342), pp.307-14

Cornwall, J. (1977), *Modern Capitalism: Its Growth and Transformation*, London: Martin Robertson

Cripps, T.F. & Tarling, R.J. (1973), *Growth in Advanced Capitalist Economies, 1950-1970*, Cambridge: Cambridge University Press

Demurger, S. (2001), "Infrastructure Development and Economic Growth: An Explanation for Regional Disparities in China?", *Journal of Comparative Economics*, 29, pp.95-117

Dixon, R. & Thirlwall, A. P. (1975), 'A Model of Regional Growth Rate Differences on Kaldorian Lines', *Oxford Economic Papers*, 27, 201-214

Ezaki, M. & Sun, L. (1999) "Growth Accounting in China for National, Regional, and Provincial Economies: 1981-1995", *Asian Economic Journal*, 13(1), pp. 39-71

Felipe, J. & McCombie, J.S.L. (2003), 'Some Methodological Problems with the Neoclassical Analysis of the East Asian Miracle', *Cambridge Journal of Economics*, 27(5), pp.695-721

Fingleton, B and McCombie, J.S.L. (1998), "Increasing Returns and Economic Growth: Some Evidence for Manufacturing from the European Union Regions: A Correction," *Oxford Economic Papers*, 50, pp.89-105

Fleisher, B.M. and Chen, J. (1997), "The Coast and Non-Coast Income Gap, Productivity and Regional Policy in China", *Journal of Comparative Economics,* 25, pp.220-36

Gundlach, E. (1997), "Regional Convergence of Output per Worker in China: A Neoclassical Interpretation", *Asian Economic Journal,* 11, pp.423-42

Hansen, J.D. & Zhang, J. (1996) 'A Kaldorian Approach to Regional Economic Growth in China', *Applied Economics*, 28(June), pp.679-85

Jeon, Y.B. (2006), "Manufacturing, Increasing Returns and Economic Development in China, 1979-2004: A Kaldorian Approach", *Department of Economics Working Paper,* 2006-06, University of Utah

Jeon, Y.B. (2007), "Total Factor Productivity and Income Distribution: A Critical Review", *Department of Economics Working Paper,* 2007-04, University of Utah

Kaldor, N. (1957), 'A Model of Economic Growth', *Economic Journal*, 67(268), pp.591-624

Kaldor, N. (1966), *Causes of the Slow Rate of Economic Growth in the United Kingdom, Inaugural Lecture at the University of Cambridge*, Cambridge: Cambridge University Press

Kaldor, N. (1967), *Strategic Factors in Economic Development*, Frank Pierce Memorial Lecture at Cornell Univeristy, Ithaca: Cornell University Press

Kaldor, N. (1968), 'Productivity and Growth in Manufacturing Industry: a Reply', *Economica*, 35 (November), pp. 385-91

Kaldor, N. (1975), "Economic Growth and the Verdoorn's law. A Comment on Mr. Rowthorn's Article", *Economic Journal*, 85(340), pp.891-896

Leon-Ledesma, M. A. (2000), 'Economic Growth and Verdoorn's Law in the Spanish Regions, 1962-91', *International Review of Applied Economics*, 14(1), pp.55-69

Levine, R. and Renelt, D. (1992), "A Sensitivity Analysis of Cross-Country Growth Regressions", *American Economic Review,* 82, pp.942-63

Lin, J.Y. and Liu, Z. (2000), "Fiscal Decentralization and Economic Growth in China", *Economic Development and Cultural Change,* 49, pp.1-21

Liu, B.Y. and Yoon, B.J. (2000), "China's Economic Reform and Regional Productivity Differentials", *Journal of Economic Development*, 25(2), pp.23-42

Lo, D. (1997), *Market and Institutional Regulation in Chinese Industrialization, 1978-94*, New York: St. Martin's Press

Mankiw, N.G., Romer, D., and Weil, D.N. (1992), "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics*, 107, pp.407-38

McCombie, J.S.L. (1982) 'Economic Growth, Kaldor's Laws and the Static-Dynamic Verdoorn Law Paradox', *Applied Economics*, 14(June), pp.279-94

McCombie, J.S.L. (1983), 'Kaldor's Laws in Retrospect', *Journal of Post-Keynesian Economics*, 5(3), pp.414-29

McCombie, J.S.L. (1985), "Increasing Returns and the Manufacturing Industries: Some Empirical Issues", *The Manchester School of Economic and Social Studies*, 53, pp.55–75.

McCombie, J.S.L. and De Ridder, J.R. (1983), 'Increasing Returns, Productivity, and Output Growth: the Case of the United States', *Journal of Post-Keynesian Economics*, 5(3), pp.373-87

McCombie, J.S.L. and De Ridder, J.R. (1984), 'The Verdoorn's Law Controversy: Some New Empirical Evidence Using U.S. State Data', *Oxford Economic Papers*, 36, 268-284.

McCombie, J.S.L. & Thirlwall, A.P (1994) *Economic Growth and the Balance-of-Payments Constraint*, New York: St. Martin's Press

Oi, J.C. (1999), *Rural China Takes Off: Institutional Foundations of Economic Reform*, Berkeley: University of California Press

Pons-Novell, J. and Viladecans-Marsal, E. (1999), "Kaldor's Laws and Spatial Dependence: Evidence from the European Regions", *Regional Studies,* 33, pp.443-51

Rey, S.J., Montouri, B.D. (1999), "US regional income convergence: A spatial econometric perspective", *Regional Studies,* 33, pp.143–156

Setterfield, M. (ed.) (2002), *The Economics of Demand-led Growth: Challenging the Supply-*

side Vision of the Long Run, Northampton: Edward Elgar

Targetti, F. (1992), *Nicholas Kaldor: The Economics and Politics of Capitalism as a Dynamic System*, Oxford: Clarendon Press

Thirlwall, A.P. (1983), "A Plain Man's Guide to Kaldor's Growth Laws", *Journal of Post-Keynesian Economics*, 5(3), pp.345-58

Unger, J. (2002), *The Transformation of Rural China*, New York: M.E. Sharpe

Wolfe, J.N. (1968), 'Productivity and Growth in Manufacturing Industry: Some Reflection on Professor Kaldor's Inaugural Lecture', *Economica*, 35, pp. 117-26

Wu, Y. (2000), "Is China's Economic Growth Sustainable? A Productivity Analysis", *China Economic Review*, 11, pp.278-96

Yao, Y. and Weeks, M. (2003), "Provincial Income Convergence in China, 1953-1997: A Panel Data Approach", *Econometric Reviews,* 22, pp.59-77

Ying, L.G. (2003), "Understanding China's Recent Growth Experiences: A Spatial Econometrics Perspective", *Annals of Regional Science,* 37, pp.613-628

Young, A. A. (1928), 'Increasing Returns and Economic Progress', *Economic Journal*, 38(152), pp. 527-542.

Yu, D., and Wei, D.Y. (2003), "Analyzing Regional Inequality in Post-Mao China in a GIS Environment", *Eurasian Geography and Economics,* 44(7), pp.514-34