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Manufacturing, Increasing Returns and Economic Development in China, 1979-2004: A Kaldorian Approach

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Abstract

The aim of this study is to empirically test the validity of the Kaldorian approach to growth and development in China during its reform period of 1979-2004. In order to obtain robust results, both time-series and regional panel data formats are used. The present study finds from both data sets that the Kaldorian hypotheses about economic growth are valid in China during the reform period.

Keywords: Economic growth in China, Kaldor's Laws, increasing returns to scale, manufacturing industry.

JEL Classification: O11, O14, O53, E12

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1. INTRODUCTION

It may be the one of the most serious challenges for development economists to identify and explain the resources of economic growth in China after 1978. Indeed, China has grown on average at a record high of above 9% for a quarter century. The record is higher than even the figures that give rise to the coinage, "Asian Miracle." As a consequence, its impact both on the domestic standard of living and on the world economy is big enough to attract interests of modern economists.

According to the conventional approach to economic growth in China under the name of "growth accounting" coined by Solow (1957), the growth factors would be decomposed into three categories of the growth of labor and capital inputs and technical progress, all of which are supposed to determine supply conditions. In essence, the conventional view believes that one could calculate the extent to which each component contributes to economic growth.

Although the growth accounting approach is the most popular approach in explaining economic growth in China[1], it has left much doubt about its relevance. First, it has been shown that the technological progress that is supposedly measured by the Solow residual in the growth accounting exercises has very little to do with the underlying technical progress; it can be shown with little complication that it merely measures the labor share-weighted average of wage rate and profit rate, but not the technical truth of the economy under examination[2]. Second, the conventional approach is often criticized for the unrealistic assumption of exogenous technical progress, which takes place outside the economic activities. The notion of exogenous technical progress underlies the essential idea of the growth accounting approach in which, to use conventional textbook terms, a shift of the production function due to technical progress can be distinguishable from a movement along a production function induced by changes in inputs. Third, the fact that the growth accounting approach presumes a single sector prohibits, at the beginning of analysis the possibility of dynamic effects on technical progress which may arise from the interactions between various economic activities. To conclude, the growth accounting approach is a far from satisfactory explanation of growth phenomena in China as well as any other economies to which it has been applied.

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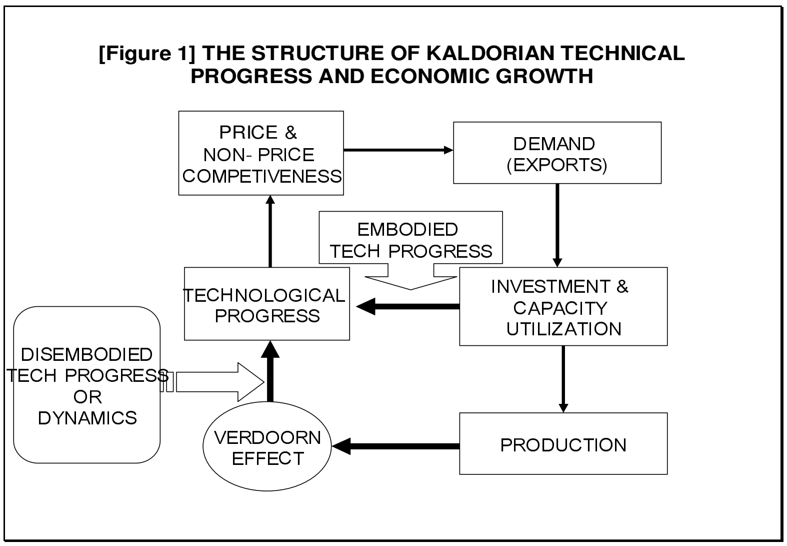
1 Chow(1993), Chow & Li (2002), Hu & Khan (1997) and Young(2001)

2 See, among many, Felipe (1999), Felipe & McCombie (2003). Shaihk (1974; 1980; 1987) are the classic. Particularly, Felipe & McCombie (2002) provides a thorough up-to-date review of growth accounting practices available for the Chinese economy and criticizes for methodological fallacies.

In addition to its consideration on the problem of demand lag[3], one of the prominent features of the Kaldorian development thinking is the fact of viewing economic growth and development as a process in which the effects of interactions between industrial activities are captured. In practice, the manufacturing sector is hypothesized as the "engine of growth" for two reasons. First, it is in manufacturing that increasing returns prevail. Second, under the assumption of dualistic economies in nature, the growth of manufacturing output is considered the net increments to an economy as a whole.



Source: Jeon (2006)

In contrast to the conventional approach, in the Kaldorian line, technical progress is by and large considered as a result, but not exogenous shock[4]. As summarized in [figure 1], an increase in demand for manufacturing goods and service is likely to result in an increase in productivity through two channels. On the one hand, an increase in demand for products leads to more investment and consequently the enhancement of embodied technology. On the other hand, and perhaps more importantly, the growth of output induced by stimuli from the demand side creates disembodied technical progress through interactions between activities.

[3] For a survey of demand-led growth models against the supply-side approach, containing both Kaldorian and Kaleckian growth models as well as general issues in the demand-led theory, see Setterfield (2002).

[4] This viewpoint could be applicable even to the cases of innovation that are regarded as a representative example of exogenous technological development, since the innovations as such are not independent of the economic situation. It is worth mentioning that it has been observed that major technological innovations that have a significant effect on the status of technical progress are likely to be a result of massive R&D investment, the decision on which is usually made in response of a profit expectation which is in turn determined by the demand condition: in this sense, at least, innovations are not exogenous.

The aim of this study is to empirically test the validity of the Kaldorian approach of growth and development in China. In order to obtain robust results, both time-series and panel data formats are used. The present study mainly finds that the engine of economic growth hypothesis is valid for the development path in China during the reform period of 1979-2004.

The outline of this paper is as follows. In section 2, Kaldorian hypotheses for economic growth and development are reviewed and appropriate test specifications are suggested. In section 3, empirical results are provided and discussed. Finally, in section 4, the results are summarized and their implications are briefly discussed.

2. KALDOR'S THREE LAWS AND TEST SPECIFICATIONS

After the first enunciation of the principles of economic development and growth in the course of his Inaugural Lecture at Cambridge in 1966 (Kaldor, 1966), Kaldor (1967, 1968) elaborated and formalized them further in the form of a series of "laws" on economic development and growth[5].

2.1 First Law

The first law maintains that the growth of GDP is positively associated with the growth of the manufacturing sector of the economy: the faster the rate of growth of manufacturing output, the faster the rate of growth of GDP. And, the causality is presumed to run from expansion of the manufacturing sector to GDP growth. Because of this strong positive correlation between the growth of GDP and of manufacturing, the first law is often called "the engine of growth hypothesis". Formally,

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

[5] Although Kaldor's initiatives are often cited and discussed, the fundamental goal of this paper is not to review Kaldor's economic thought on economic growth and development (for intensive reviews of Kaldor's political economy in general, see Lawson *et al.* (1989), Targetti (1992), and Thirlwall (1987)). Instead, this study centers on the research program inspired by Kaldor and the following developments. Kaldor's own ideas are often introduced as a expositional convenience. In effect, as shown in short, the majority of practical test specifications except for a few are not Kaldor's but those developed and suggested by his followers.

where q_{GDP} and q_m are the growth of GDP and of manufacturing, respectively, and a_i ($i = 1, 2$) are regression coefficients. The condition of positive a_2 indicates a positive association between the growth of manufacturing output and the growth of GDP. Using average rate of growth of each variable for twelve developed countries over the sample period of 1953/4 to 1963/4, Kaldor (1966; 1967) reports the empirically estimated equation (1) as follows.

$$q_{GDP} = 1.153 + \underset{(0.040)}{0.614} q_m, \quad R^2 = 0.959 \tag{2}$$

where the figure in parenthesis is the standard error of the slop coefficient, implying statistically different from zero at any conventional significance level. 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.

In equation (2), the fact that the coefficient of q_m (0.614) is less than unity implies that the greater the excess of the growth rate of manufacturing output over the growth rate of GDP, the faster the rate of growth of GDP. According to the numerical result of equation (2), an annual growth rate above 2.99% will be found only in the case where manufacturing output grows faster than GDP. The observation that fast growth of GDP is associated with excess rate of growth of manufacturing over growth rate of GDP was tested and confirmed further. Using the same data sets as those for equation (2), Kaldor estimates as:

$$q_{GDP} = 3.351 + \underset{(0.267)}{0.954} (q_m - q_{nm}), \; R^2 = 0.562 \tag{3}$$

$$q_{nm} = 1.142 + \underset{(0.080)}{0.550} q_m, \; R^2 = 0.824 \tag{4}$$

where, in addition to the definitions of notations used in equation (1) and (2), q_{nm} indicates the rate of growth of non-manufacturing output. In order to remove a share effect of manufacturing, Bairam (1991) suggests to regress the growth of agriculture and service on the growth of manufacturing.

$$q_{nm} = a_3 + a_4 q_m \tag{5}$$

A positive sign of the coefficient of the growth of manufacturing can be considered supportive of the first law.

In contrast to the correlations between the growth of manufacturing and of GDP, there is no such close association between agriculture and mining and GDP, which may support further the hypothesis of manufacturing as the engine of economic growth. However, it is found that the growth of service sector is correlated closely to the growth of GDP, in fact, one to one association. Kaldor suggests that causality should run from growth of GDP to growth of service, since the former leads to more demand for the latter. That is, increasing demand for service accompanied by the expansion of GDP will stimulate the growth of the service sector. This study will utilize equation (1) through (5) 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, there should be some identifiable mechanisms through which fast growing manufacturing sector produces higher productivity of an economy as a whole. Kaldor as well as the economists in favor to the idea of demand-led growth suggest two transmission channels, which consists of the next two laws.

2.2 The Second Law: Kaldor-Verdoorn's Law

The second law states that in the manufacturing sector, the growth of productivity is positively associated with the growth of production, to which Kaldor gave the name of "Verdoorn's Law". The Verdoorn's Law is specified as

$$p_m = b_1 + b_2 q_m \tag{6}$$

where p_m is the growth rate of labor productivity in manufacturing, and b_i ($i = 1, 2$) are regression coefficients. In particular, b_2 is called the "Verdoorn coefficient". As Kaldor was aware of, the specification (6) has a minor problem emerging from definitional identity for the labor productivity $p_m = q_m - e_m$, which implies, in an econometrics sense, a strong correlation between dependent and independent variables. To handle this problem, another specification is suggested.

$$e_m = c_1 + c_2 q_m \tag{7}$$

where e_m is the growth of labor employment in manufacturing, and $c_1 = -b_1$ and $c_2 = 1 - b_2$.

What Verdoorn had verified in his original work was an empirical pattern that in the manufacturing sector an increase in the growth rate of output by one per cent point is attended by an increase in labor productivity by roughly one half per cent point, that is, $b_2 = 0.5$ (or $c_2 = 0.5$). Using the same cross-country data as those which had adopted for estimation of equations related to the first law above, Kaldor (1966, 1967) estimates the equations of (5) and (6) as follows.

$$\begin{array}{c} p_m = 1.035 + 0.484 q_m, \quad R^2 = 0.826 \\ (0.070) \end{array} \tag{8}$$

or

$$\begin{array}{c} e_m = -1.028 + 0.516 q_m, \quad R^2 = 0.844 \\ (0.070) \end{array} \tag{9}$$

which are very similar to Verdoorn's original results. Interestingly enough, according to Kaldor and Cripps & Tarling (1973), it is only in industrial sectors including the construction industry and public utilities as well as manufacturing, but not in other industries like agriculture, that these patterns are found.

The fact that the coefficient of $c_2 = 0.516$ for the growth of manufacturing output in equation (9) is less than unity is interpreted as the existence of substantial static or dynamic increasing returns to scale. In general, the sufficient condition for the Verdoorn Law to hold, that is, for there to be increasing returns to scale, requires statistically significant coefficient $c_2 = 1 - b_2 < 1$, which is satisfied for equations (8) and (9).

The resources 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 increase of capital stock (Bairam, 1987; Dixon & Thirlwall, 1975; McCombie, 1982). In effect, it is well known that Kaldor was a long-lasting critic against distinction between the movement along a production function caused by increase in capital per worker and the shift in the production function caused by technical progress (*inter alios*, Kaldor, 1957). Indeed, a clear-cut distinction between them is the theoretical underpinning of the concept of the Solow-residual as a measure of technical progress (Solow, 1957). There is little sense, however, that capital per worker might increase without a change in status of knowledge and that inventions and/or innovations might otherwise occur without investment and its subsequent increase in capital per worker. In contrast, it makes more sense that technical progress takes place through accumulation of capital.

Second, the Kaldorian type technical progress function sheds much more light on dynamic, rather than static, relations between output and productivity in the manufacturing sector. Static increasing returns relates the level of productivity to the size and scale of a production unit or a single industry, while dynamic increasing returns relate a change of productivity to a change of output. The relationship between changes of output and productivity is dynamic, since, as sketched in [Figure 1], 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). In particular, Young (1928), whose idea has been taken up by the proponents of the Verdoorn Law, suggests that increasing returns are fundamentally a macroeconomic phenomenon in which positive external economies stem from interactions of demand and supply activities between various industries in the manufacturing sector as a whole.

It may be possible to derive the Verdoorn relation in algebraic form (Dixon & Thirlwall, 1975, Targetti, 1992) incorporating both the notion of a technical progress function and dynamic increasing returns to scale.

First, the technical progress function may be written as a function of capital accumulation as follows.

$$p_m = \alpha_1 + \alpha_2 k \qquad (10)$$

where k is the growth of capital per worker. The involved coefficients may be interpreted as follows: α_1 represents disembodied autonomous technical progress and α_2 denotes the coefficient of embodied technical progress induced by capital accumulation. The disembodies technical progress α_1 can partly be the result of pure autonomous technical progress such as innovations and can also be seen partly as dynamic effects resulting from learning by doing and/or external economies in Young's sense. Therefore, α_1 is a function of the growth of output in which the dynamic effect is amplified as the growth of output gets faster.

$$\alpha_1 = \beta_1 + \beta_2 q_m \tag{11}$$

The equation (8) shows that the disembodied technical progress consists of pure autonomous part (β_1) and the dynamic effect (β_2) which results from the growth of output.

Returning back to equation (9), we can introduce an investment function for the variable of capital per worker. If we accept the assumption common in demand-led growth model that investment is an increasing function of current output growth, we may write a function for capital per worker as

$$k = \delta_1 + \delta_2 q_m \tag{12}$$

δ_2 may be called accelerator coefficient (Targetti, 1992, p.168).

Finally, substituting equation (11) and (12) into equation (10), we can derive Verdoorn relation as in equation (6).

$$p_m = b_1 + b_2 q_m \tag{6}$$

where $b_1 = \beta_1 + \alpha_2 \delta_1$ and $b_2 = \beta_2 + \alpha_2 \delta_2$. This equation shows that the Verdoorn coefficient is determined by the effect of dynamic increasing return, technical progress embodied in capital accumulation and the extent that investment response to the growth of output, all of which are related positively to the degree of increasing returns to scale.

The majority of the literature derives the Verdoorn relation from the famous aggregate production function with two inputs, labor and capital, arguing that a variable for capital stock should be included in order to capture the contribution of capital accumulation to productivity growth (Bairam, 1987, Leon-Ledesma, 2000, McCombie, 1983, McCombie & de Ridder, 1983, 1984, Wolfe, 1968). In this view, faster capital accumulation may have positive effects on the labor productivity.

Although the positive effect of capital on the productivity growth can be recognized well, including a capital variable as an independent explanatory variable will lead to a bias. As shown through the derivation procedure above, equation (6) (or equation (7)) is the reduced form equation that the capital effects on productive has already been considered. Furthermore, when capital is considered as one of the factors of production along with labor, all difficulties that are accompanied by notorious neoclassical aggregate production function will seep into the picture through backdoor. As exemplified by, among others, McCombie & Thirlwall (1994, p.180) and Leon-Ledesma (2000), estimation of technical progress could be carried out in terms of "the growth of total factor productivity (TFP, in short)". However, this is not even a measure of technical progress, since the alleged inputs of the factors of production, capital and labor, are not a real measure of the amount that capital and labor are used up in a technical sense, but they are mere measures of distribution between capital and labor. In order for the distribution variables to be considered as the used amount of factors of production, one needs extremely restrictive assumption such as the marginal productivity theory of distribution.

In sum, when it is accepted that the equation (6) were to be derived from an aggregate production function like Cobb-Douglas production function, all disputes regarding increasing returns should be reduced to simple empirical question on the magnitude of corresponding coefficients for each factor of production. Even though it may be possible to settle down the controversies on the magnitude of coefficients practically, their relevance to the subject matter of measuring technical progress will be retrenched by the fact that distribution variable should substitute for input variable.

Returning back to the equation (6), note that, although it is acknowledged that the model assumes intensive interaction process at work between the growth of productivity and of output, it is also true that, in deriving the Verdoorn relation, the growth of output plays the key role as the ultimate driving force leading to fast growth of productivity. That is, the growth of output is treated as the predetermined exogenous variable. The exogeneity of the growth of output has been under tough scrutiny. In order for the growth of output to be exogenous, two qualifications should be satisfied.

The first requirement is related to equation (7). Demand-side oriented economists (Cornwall, 1976, 1977) criticized the original idea in Kaldor (1966, 1967) and Cripps & Tarling (1973) that the culprit of slow economic growth, in particular, in UK could be found in supply-side constraint of exhaustion of labor forces available to meet growing demand for from manufacturing sector. If this were to be the case, the equation (7) for the Verdoorn relation should turns out to be misspecified (Rowthorn, 1975). If there should be a binding labor constraint in manufacturing production, it should have been the growth of employment that is the independent explanatory variable in specifying the Verdoorn relation.

The question as such is correct and the notion of labor shortage as a binding constraint for economic growth has been denied by much of empirical evidences (Cornwall, 1976). Kaldor (1975) has since changed his mind to endorse the denial of labor shortage, and become convinced that the ultimate binding constraint of UK economic growth lies in export performance and balance of payment constraint (Thirlwall, 1983).

The absence of a supply constraint of labor shortage is only a necessary condition for exogenous growth of output with respect to the growth of productivity. It also requires that there were to be no feedback from the growth of productivity to output growth (McCombie & Thirlwall, 1994). Specifically, the question is raised of which variable is endogenous in equation (6). The advocates of conventional production function approach would argue that the growth of productivity should be the cause and the growth of output be the effect, but not the other way round. Here, all growth of productivity would be autonomous in the sense that they should be the result of exogenous technical progress initiated by innovations, inventions, and so forth. In this view, the direction of causation running from the growth productivity to the growth output works through price elastic demand for the output: faster growth of productivity would reduce production cost and hence create lower relative prices of the products, leading to increase in demand for the products with elastic price elasticity, which in turn result in faster growth of output.

However, for the demand-led growth views, this reverse direction of causality is not acceptable for, at least, two reasons. First, the exogeneity of techniques are not reconcilable with the notion of dynamic increasing returns which is obviously observed in manufacturing sector. The assumed causality starting from exogenous technical progress is a denial of dynamic aspect of increasing returns of scale, because the concept of exogenous technical progress as such does not leave any room for interaction between various industries as a whole system as well as dynamic processes of learning and/or creating new knowledge and skills. Second, the conventional explanation as to causal relation between technical progress and the growth of output suffers from the lack of explanation of how technical progresses take place.

Ideally, the relation between the growth of output and of productivity may contain a virtuous (or vicious) circle in which one is associated positively with the other. In practice, therefore, a correct specification may be formed so as to avoid simultaneity bias (Parikh, 1978)[6]. However, it is not the point of the issue in hand that which variable has the priority, but the point is whether or not a model could incorporate acknowledged dynamic process that plays the key role in generating increasing returns. To conclude, the correct specification for the measurement of technical progress will be equation (7) 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.

2.3 Third Law

Kaldor's third law maintains that the growth of productivity of a economy as a whole is positively connected with the growth of output in the manufacturing sector through the labor transferences to the manufacturing sector from the other sectors including agriculture and service. Formally,

$$p_{GDP} = d_0 + d_1 q_m, \quad d_1 > 0 \tag{13}$$

In the Kaldorian line of economic development thinking, the notion of dualist feature is so clearly defined that it can even be extended to the developed economies. An economy is a dual economy if there are wage differentials between the high productivity sectors and the low productivity sectors. Since the wage differentials can be regarded as the direct result of the lack of demand for labors in the high productivity sectors, the dualist character implies surplus labors in the low productivity sectors which will be readily extracted and transferred to the high productivity sector without a loss of output when the demand for labors in the latter sectors rises. Traditionally, the high productivity sectors are generally thought of as manufacturing while the primary and tertiary industries are

[6] To the author's knowledge, Parikh(1978) is the unique empirical study in which a test for exogeneity is designed and conducted in the framework of simultaneous equation model. McCombie (1983) and Bairam (1987), however, criticize it for the lack of theoretical basis as to selecting variables.

considered to be included in the opposite.

Taking into account the existence of surplus labors outside the manufacturing, development economists (Cripps & Tarling, 1973, Drakopoulos & Theodossiou, 1991, Kaldor, 1968, Thirlwall, 1983) have identified two main channels through which the positive effects of labor transferences to the manufacturing sector on the overall productivity are supposed to work. 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 dynamic effects such as learning-by-dong, the externality as the result of interaction between economic activities, etc. 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. Therefore it is argued that it is the rate at which the surplus labors in the low productivity sectors are transferred to the manufacturing that determines the growth of productivity of the economy as a whole (Kaldor, 1968).

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 (Thirlwall, 2003). Replying to a critic, however, Kaldor (1968) tries to find empirical evidences. In his primitive regression analyses basing on data for twelve advanced countries over 1953/4 – 1963/4, he finds that the growth of GDP is correlated with the growth of employment in manufacturing, while the growth rate of GDP is not at all associated with the growth rate of total employment. Reproducing the results,

$$q_{GDP} = 2.665 + \underset{(0.15)}{1.066} e_m, \qquad R^2 = 0.828 \tag{14}$$

$$q_{GDP} = 4.421 + \underset{(0.994)}{0.431} e_{Total}, \qquad R^2 = 0.018 \tag{15}$$

where e_m and e_{Total} are the growth rates of employment in manufacturing and total economy, respectively. The seemingly contradictory results may be reconciled if rates of growth in overall productivity are positively associated with rates of growth of employment in manufacturing and negatively associated with rates of growth of employment outside manufacturing. And, this is confirmed as

$$p_{GDP} = 2.899 + 0.821 e_m - 1.183 e_{nm}, \ R^2 = 0.842 \quad (16)$$
$$\qquad (0.169) \quad (0.387)$$

where e_{nm} is the growth rate of employment outside manufacturing. Considering the information about employment which is contained by definition in the dependent variable, the productivity of GDP, Thirlwall (1983) and Atesoglu (1993) suggest to regress the growth of GDP on the growth of employment in manufacturing and in non-manufacturing sectors as following.

$$q_{GDP} = d_0 + d_2 e_m - d_3 e_{nm} \quad (17)$$

Cripps & Tarling (1973) suggest to substitute the growth of employment in manufacturing for the growth of manufacturing output, and the suggestion has been accepted and tested in practice in Drakopoulos & Theodossiou (1991), Hansen & Zhang (1996) and Thirlwall (2003).

$$p_{GDP} = d_0 + d_4 q_m - d_5 e_{nm} \quad (18)$$

The specification of equation (18) is preferred, because, to quote Cripps & Tarling (1973), "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." The specification of (18) is also justified by the recognition that 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 (17) and (18).

3. Empirical Results

3.1 Data Sets and methodology

The traditional studies use cross-section data across counties. However, this is not suitable to explaining economic growth of an economy over time. In the existing literature, two alternatives test formats for this purpose have been suggested: the one is to use time-series data[7] and the other is to use cross-section data across regions within an economy[8]. Hansen & Zhang (1996)'s study on the Chinese economy is exceptional in that it takes advantage of panel data set across 29 regions. But, this study uses only 7 years of time period over 1985 through 1991.

In order to get robust results, this study exploits both time-series[9] and panel data. All time series data sets used in the following empirical study have been selected from various issues of the *China Statistical Yearbooks* published by the National Statistics Bureau of China. All output values are real at 1978 price. Panel data sets for 24 regions come from online data service of the *All China Data Center* at the University of Michigan that has been authorized by the National Statistics Bureau of China. All output values are real at 1978 price and the deflators are calculated from the information about retail price indices (RPI), which are the only price index available for entire sample period of 1979-2004.

It may be important to mention that the present study uses the secondary industry data as the approximate for manufacturing data, because of the lack of manufacturing data. According to the industrial classification schemes of the National Statistics Bureau of China, the primary industry refers to broad category of agriculture including farming, forestry, animal husbandry and fishery,

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7 Examples include Bairam (1991) for Turkey, Drakopoulos & Theodossiou (1991) for Greece, and Stoneman (1979) for the UK. Confining to tests for Verdoorn's Law, Harris & Lau (1998) and Harris & Liu (1999) are the few examples carrying out cointegration analysis. However, since they are using logarithmic version of the law, it is a static model instead of dynamic model that they estimate. Considering the theoretical underpinnings of Verdoorn's Law, this poses strict limits in interpreting the results. An application of a vector error correction model (VECM) to the dynamic form of Verdoorn's Law is found in Hamalainen & Pehkonen (1995) for four Nordic countries.

8 McCombie & de Ridder (1983) for the US economy

9 Although the author is well aware of the importance and implications of cointegration analysis for a long run analysis, the present study does not carry out cointegration analysis, because unit root tests reveals that most of variables are turned out to be stationary.

while the tertiary industry covers broadly service sectors. The difficulties with data set in terms of the hypotheses laid out above arise from the fact that the secondary industry includes, on top of manufacturing, mining and quarrying, electricity and water and gas, which may require cautions when empirical results are interpreted.

In subsection 3.2, the hypotheses are tested using time-series data sets at the national level. For using time-series data, McCombie (1983) and McCombie & de Ridder (1983) warn that, because an annual data set contains short-term cyclical effects which is not the concerns here, the results are likely to be the mixture of short-term cyclical changes and long-run economic growth. Following Atesoglu (1993), in order to remove short-term cyclical changes, the annual growth rate of each variable is smoothed with 10-year moving average.

Subsection 3.3 uses panel data which have 24 regions for cross-section over the sample period of 1979-2004. Establishing panel data set, the annual growth rate for each variable for 24 regions is also smoothed with moving average.

3.2 Time-series format

The test results using smoothed time-series data are reported in [Table 1].

[Table 1]

3.2.1. First Law

In terms of the first law, the results show the growths of secondary and tertiary industries are strongly correlated with the growth of GDP. The variation of the growth of secondary industry and that of service explains 90% and 89%, respectively, of variation of the growth of GDP. However, there is no evidence for the association between the growth of GDP and the growth of primary industry, which is expected by the hypothesis. These findings may be considered supportive of the engine of economic growth hypothesis. It is noteworthy that the magnitude of the coefficient for service is much smaller than unity and even less than that for secondary industry. The small coefficient may reflect that the growth of GDP in China has been much faster than that of service sector, which is a bit out of patterns reported in the previous studies.

In order to test the share effect of secondary industry, first of all, the growth of GDP is regressed on the differences between the growth of secondary industry and that of non-secondary industry in equation (4). The result shows that the coefficient for the different growth rate is not significantly different from zero, casting a doubt that the detected correlation between the growth of GDP and secondary industry may be the result of a big share of secondary industry in the economy. However, first of all, the share of secondary industry, even though it has increased throughout the sample period, has not been big enough (see, Appendix 2). Second, as demonstrated by equation (5), the growth of the non-secondary sector including primary and tertiary industry is positively correlated with the growth of secondary industry, that is, the economy without the part for secondary industry has grown in accordance with the growth of the latter.

Therefore, the analyses using smoothed time series data shows that Kaldor's first law holds good in China during the reform period. In another words, the secondary industry has played a key role in overall growth of GDP of the Chinese economy.

3.2.2 Second Law

Moving on to the second law, we estimate in equation (6) Verdoorn's Law using Kaldor's specification with the growth of employment in secondary industry being the dependent variable. In addition to the observation of high R-squared value of 0.98, a test for whether or not the coefficient of 0.17 is statistically equal to unity rejects the null hypothesis with F-statistic of 163.76. Therefore, we obtain the significant Verdoorn coefficient of 0.83. The Verdoorn coefficient means that every 1 per cent increase in output is associated with 0.83 per cent increase in productivity in the secondary industry, implying very big increasing return to scale.

In terms of comparative perspective, the magnitude of the Verdoorn coefficient of 0.8276 is exceptionally big in the literature, and, sometimes, may be considered unrealistic, leading to doubt about estimation biases. Even if the various sources of biases such as simultaneity bias, measurement errors, and so forth, are taken into account, it would be still safe to conclude that one of the major factors that count for the unusually fast economic growth during the reform period in China is obviously increasing return to scale in the secondary industry. Referring back to the theoretical discussions in the above section, the high scale elasticity should imply that the dynamic interaction process has been so energetic that it has led to fast technical progresses.

3.2.3. Third Law

Finally, the Third law has been tested by using two specifications: the one, equation (7), is suggested by Thirlwall (1983) and Atesoglu (1993) in which the growth of GDP is regressed separately on the growth of employment in the secondary industry and in the non-secondary industry; the other one, equation (8), is proposed by Cripps & Tarling (1973) in which the growth of overall productivity for the entire economy is regressed on the growth of output of secondary industry and on the growth of employment in the non-secondary industry.

Equation (7) shows a reasonable level of R-squared value of 0.65. The signs of the coefficients are as expected by the third law in which, for the third law to hold, the growth of employment in the secondary industry should be associated positively with the growth of GDP, while that of the non-secondary industry should be correlated negatively. The coefficient for the growth of employment in the secondary industry is significant at 5 % significance level, but that of the non-secondary industry does not significant.

Observing the Cripps & Tarling's specification, however, it is hard to conclude that the non-significance of the coefficient for growth of the non-secondary industrial employment might imply a fail of the third law. In fact, as shown in equation (8), the overall productivity of the Chinese economy is associated negatively with the growth of non-secondary industrial employments and negatively with the growth of productivity instead. And, the R-squared value is as high as 0.96. Considering the theoretical predictions that labor transfer from non-manufacturing to manufacturing will enhance the overall productivity of an economy as long as the increase in products in the manufacturing industry is the net increments, these findings suggest good operation of the third law.

In sum, in terms of empirical tests using smoothed time series data, the Kaldorian approach to the economic growth in China over 1979-2004 is satisfactory. It shows that the growth of GDP is positively correlated with the expansion of the secondary industry which is turned out as the industry having high increasing returns of scale. Furthermore, the productivity of the overall economy is negatively correlated with the growth of non-secondary industrial employments.

3.3 Panel data format

As well known, using panel data are considered to have several important advantages in terms of empirical robustness[10]. Panel data analyses in this subsection utilize the same specifications as those used for time-series analyses. It would be informative to acknowledge at the beginning some preliminaries about test procedures of panel data analyses that are adapted here. First, as mentioned earlier, to remove short-term cyclical effects this study uses smoothed time series for each regions. Second, for each specification, a random or fixed effect model was chosen according to preliminary test result of Hausman test. Third, only 24 regions out of 31 administrative divisions [see Appendix1] have been chosen because of data availability[11]. Finally, in addition to a random or fixed effect model estimations, the present study estimates within effect models as well. Basically, within effect models are cross-sectional analyses across regions using average values of variables over entire sample periods, which is equal to the traditional cross-sectional study across countries[12]. All test results are reported in [Table 2].

[Table 2]

3.3.1 First Law

Equation (1)-(5) and (9)-(13) test the first law. First of all, it is observed that the growth of GDP is positively correlated with the growth of the secondary industry and of the tertiary industry, implying operation of the first law. In particular, the coefficient of 0.61 implies that a region with secondary output growth of 1 per cent above the average for all regions will grow 0.61 per cent above the average for all regions. In contrast to the result for time-series data, it is also detected from equation (2) that the coefficient for the primary industry is also significant.

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10 For the advantages of panel data as such, see Baltagi (2005).

11 The regional divisions for which reliable panel data sets are not available include Tibet, Tianjin, Shandong, Guangxi, and Gansu. Furthermore, the Chongqing municipality was until March 14, 1997 a part of Sichuan. In order to get consistence in the data for the whole period during 1979-2004, we merged Chongqing into Sichuan.

12 In some senses, in the literature, cross-sectional analysis across regions within an economy is considered to be preferable to cross-country studies. For the advantages of using regional data within an economy, see McCombie & de Ridder (1983) and McCombie & Thirlwall (1994, pp.203-4).

The tests of share effect in the form of equation (4) may cast a doubt about the reliability of the result of equation (1) in terms of operation of the first law, since it has small R-squared value even though the coefficient for the difference of the growth rate of secondary industry and non-secondary industry are significant.

However, the low R-squared value does not necessarily imply the break down of the engine of economic growth hypothesis. First of all, it is recalled that, as in national level, the shares of secondary industry have not had an appreciable increase in the most of regions. Second, we do not consider here the effect of natural disasters such as flood catastrophes that affect seriously the output of agriculture (Hansen & Zhang, 1996). Third, as shown in equation (5), when the growth of non-secondary output is regressed on that of secondary industry output, the estimation with fixed effect model reveals a result which is supportive of the hypothesis, that is, the growth of the secondary output is correlated with the growth of the other industries. Finally, but most importantly, the hypothesis should be viewed in terms of its rationale. In effect, as we will see in short, the tests for remaining two laws explaining specific channels through which the first law works provide good supportive evidences for the hypothesis.

Hausman specification tests may have some implications for regional development patterns. As well known, the degree of industrialization is uneven in China among regions. In terms of panel data analysis, recall the fact that Hausman test is basically the test for correlation between unobserved heterogeneity and an explanatory variable(s). The uneven pattern of industrialization may make one expect an unobserved effect favorable to a fixed effect model, reflecting the fact that a growth pattern of secondary industry or of agriculture is a consequence of Chinese reform policies and consequential uneven degree of industrialization among regions. If this is the case, unobserved regional heterogeneity should be correlated with the explanatory variable of the growth of secondary industry or of agriculture. In our estimations and Hausman tests, it is the two cases of equation (1) and (2) that Hausman tests are favorable to fixed effect model. Otherwise, when the explanatory variables contain a component of service sector, Hausman test indicate random effect model, implying that the growth of service industry is not correlated with regional heterogeneity. In sum, our test results for the characteristics of unobserved effect show that the growth patterns of secondary industry and of agriculture vary with the location of the individual regions, while the growth of service sector is not correlated with region's own characteristics.

It would be worth noting that the coefficient estimated using panel data format are very similar in its magnitudes to that of time series data. The coefficient for the growth of the secondary industry was 0.6815 in the time-series format, and it is 0.6102.

3.3.2 Second Law

The second law is estimated and tested with a fixed effect model, as Hausman test indicates. Equation (6) reports the estimation of Kaldor’s specification. It is observed that R-squared value is as high as 0.95, implying a close correlation between the growth of employment and that of output in the secondary industry.

It is tested and proved that the coefficient for the growth of secondary output is not statistically equal to unity at any conventional significance level (F-statistic=317.58). This test result shows that the secondary industry in China has experiences an appreciable increasing return to scale, which is in accordance with the result from time-series data.

3.3.3 Third Law

The specifications for the third law are estimated as equations of (7) and (8) in [Table 2]. The estimation of equation (7) that the variables for the growth of employments in different sectors are included appears to be quite poor. When it is estimated in a random effect model as Hausman test indicates, all variable coefficients are not significant, R-squared value is ignorable, and the signs are not as theoretically expected as well.

In contrary, the estimation of the specification in which the growth of secondary outputs instead of the growth of employment is included as a explanatory variable, show completely opposite results. All coefficients are significant even at 1% significant level. The negative sign for the employment growth in the non-secondary industry would indicate the positive effect of surplus labor transfers on the growth of overall productivity of the economy, which is the major point that the third law maintain. The estimation also shows that the growth of secondary industrial outputs has contributed positively to the overall productivity, which is another theoretical prediction in terms of surplus labor transference. As mentioned in the previous section, transfers of surplus labor from agriculture to manufacturing would increase the overall productivity of an economy, since it is a net increase of output of the economy as a whole.

The poor result of estimation in equation (7) might be explained by provincial migrations in China during the reform period. It is well known observation that the reform period has witnessed a large-scale internal migration in China from rural to urban area. More importantly in terms of our panel data, because of uneven regional distribution of urbanization and development, a massive internal migration has taken place between provinces as well (Zhu & Poncet, 2003). However, the third law relating labor transferences to productivity growth is concerned with labor reallocation among industries and assumes implicitly a constant labor pool in the sense that there is no inflow and outflow of labor forces.

Contrary to the theoretical underpinning of the third law, the regional panel for China contains changes in employment of labor forces that have immigrated into from other regions as well as those of industrial reallocations within a region. Therefore, the unexpectedly poor result of equation (7) in which the growth of industrial employment only is concerned may not necessarily imply break down of the third law in China. For a country study with regional data, the Cripps & Tarling's specification in the form of equation (8) matches better the initiative rationale of the third law, implying that the third law holds well in China during the sample period.

4. Conclusion

After laying out the theoretical background and test specifications, the present paper has empirically tested the hypotheses of the manufacturing sector as the engine of economic growth in China. All the empirical test results were supportive of the validity of the hypothesis in China during the reform period of 1979-2004 and the test results were similar with both smoothed time series data and panel data.

First, the secondary industry has played a key role in overall growth of GDP of the Chinese economy, which is the fundamental message of the Kaldorian economic development thinking. This finding is elaborated further by subsequent empirical tests for two hypotheses that explain the mechanism through which the first law works.

Second, the secondary industry has been the key industry in the development processes in China during the reform period, since it was the secondary industry that revealed appreciable increasing returns to scale. This finding is sharply contrast to the conventional approaches in which a constant return to scale is assumed (Chow, 1993, Chow & Li, 2002) or only a tiny technical progress is detected (Young, 2003).

Third, the other reason for the engine of economic growth hypothesis to work 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). This hypothesis is supported by empirical tests as shown in the previous sections.

The empirical findings in this paper may have further implications for understanding of the outstanding economic performance in China in general. Considering the fact that the test specifications used in this paper were designed and derived from the demand-side approach, we could extend the interpretation of the supportive results found here toward the general validity of demand-led approach to growth in the Chinese economy.

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[Appendix 1] Divisions of Administrative Area in China

	Area	Division
1	Eastern	Beijing
2	Eastern	Tianjin
3	Eastern	Hebei
4	Eastern	Shanghai
5	Eastern	Fujian
6	Eastern	shandong
7	Eastern	Guangdong
8	Eastern	Liaoning
9	Eastern	Jiangsu
10	Eastern	Zhejiang
11	Eastern	Hainan
12	Eastern	Guangxi
13	Central	Inner_Mongolia
14	Central	Jilin
15	Central	Hubei
16	Central	Shanxi
17	Central	Heilongjiang
18	Central	Anhui
19	Central	Jiangxi
20	Central	Hunan
21	Central	Henan
22	Western	Qinghai
23	Western	Xinjiang
24	Western	Shaanxi
25	Western	Sichuan
26	Western	Yunnan
27	Western	Guizhou
28	Western	Gansu
29	Western	Ningxia
30	Western	Tibet
31	Western	Chongqing

Source: China Statistical Yearbook, 2005

[Appendix 2] Composition of Gross Domestic Product, 1978-2004

Data in this table are calculated at current prices.

Year	Gross Domestic Product	Primary Industry	Secondary Industry	Industry	Construction	Tertiary Industry	Transport, Post and Tele-communication Services	Wholesale, Retail Trade & Catering Services
1978	100	28.1	48.2	44.4	3.8	23.7	4.8	7.3
1979	100	31.2	47.4	43.8	3.6	21.4	4.6	5.5
1980	100	30.1	48.5	44.2	4.3	21.4	4.5	4.7
1981	100	31.8	46.4	42.1	4.3	21.8	4.3	5.3
1982	100	33.3	45.0	40.8	4.2	21.7	4.5	3.8
1983	100	33.0	44.6	40.0	4.6	22.4	4.5	3.9
1984	100	32.0	43.3	38.9	4.4	24.7	4.6	5.8
1985	100	28.4	43.1	38.5	4.6	28.5	4.5	9.8
1986	100	27.1	44.0	38.9	5.1	28.9	4.7	9.2
1987	100	26.8	43.9	38.3	5.6	29.3	4.6	9.7
1988	100	25.7	44.1	38.7	5.4	30.2	4.4	10.8
1989	100	25.0	43.0	38.3	4.7	32.0	4.6	10.0
1990	100	27.1	41.6	37.0	4.6	31.3	6.2	7.7
1991	100	24.5	42.1	37.4	4.7	33.4	6.5	9.7
1992	100	21.8	43.9	38.6	5.3	34.3	6.3	10.3
1993	100	19.9	47.4	40.8	6.6	32.7	6.1	8.9
1994	100	20.2	47.9	41.4	6.5	31.9	5.7	8.7
1995	100	20.5	48.8	42.3	6.5	30.7	5.2	8.4
1996	100	20.4	49.5	42.8	6.7	30.1	5.1	8.2
1997	100	19.1	50.0	43.5	6.5	30.9	5.1	8.3
1998	100	18.6	49.3	42.6	6.7	32.1	5.3	8.4
1999	100	17.6	49.4	42.8	6.6	33.0	5.4	8.4
2000	100	16.4	50.2	43.6	6.6	33.4	6.0	8.2
2001	100	15.8	50.1	43.5	6.6	34.1	6.1	8.1
2002	100	15.3	50.4	43.7	6.7	34.3	6.1	8.1
2003	100	14.4	52.2	45.2	7.0	33.4	5.7	7.9
2004	100	15.2	52.9	45.9	7.0	31.9	5.6	7.4

Source: China Statistical Yearbook 2005 (CD version)

[Table 1] Kaldor's Laws in China: Time-series, 1979-2004

1. First Law

	Dependent Variable	Independent Variables							D-W Stat	R-squared
		constant	q_second	q_primary	q_service	q_second - q_nonsecond	AR(1)	AR(2)		
(1)	q_gdp	2.9231	0.6414				0.7477		1.5028	0.9065
(2)		8.2217		0.120092*			1.1145	-0.6031	1.5630	0.7793
(3)		4.1047			0.4581		0.9090	-0.1015	2.2391	0.8949
(4)		8.7796				0.0257*	0.9893	-0.5113	1.6523	0.7585
(5)	q_nonsecond	5.2281	0.3570				0.7488		1.5042	0.5535

2. Second (Verdoorn) Law

	Dependent Variable	Independent Variables			DW stat	R-squared
		constant	q_second	AR(1)		
(6)	e_second	-3.2622	0.1724	0.9378	2.2559	0.9808

3. Third Law

	Dependent Variable	Independent Variables				AR(1)	AR(2)	DW stat	R-squared
		constant	e_second	e_nonsecond	q_second				
(7)	q_gdp	11.6650	1.5393	-0.311*		0.9357		1.6723	0.6456
(8)	p_gdp	3.9279		-0.7018	0.5194	0.1951	-0.2339	1.829	0.9601

(*) indicate that the corresponding coefficient is "not significant" at 5% level.

[Table 2] Kaldor's Laws in China: Regional Panel Data, 1979-2004

1. First Law

	Dependent Variable	Independent Variables: q_second	q_primary	q_service	q_second - q_nonsecond	AR(1)	AR(2)	R-squared	Model
(1)	q_gdp	0.6102				0.7615		0.9561	Fixed
(2)			0.2428			1.1753	-0.2978	0.9302	Fixed
(3)				0.7519		-0.1643		0.5517	Random
(4)					0.3919	0.2594		0.2080	Random
(5)	q_nonindustry	0.3402***				0.7203		0.8423	Fixed

2. Second Law

	Dependent Variable	Independent Variables: q_second	AR(1)	R-squared	Model
(6)	e_second	0.2171	0.9456	0.9221	Fixed

3. Third Law

	Dependent Variable	independent Variable: e_second	e_nonsecond	q_second	AR(1)	R-squared	Model
(7)	q_gdp	0.0317*	0.0405*		0.8813	0.0001	Random

(8)	p_gdp	-0.7576	0.5379	0.9083	0.9518	Fixed

(*) indicate that the corresponding coefficient is "not" significant at 5% level.