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Contribution of Institutional Change to China's Rural Industrial Growth

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Abstract:

This paper identifies sources of rapid growth in China's rural industry. This has made a major contribution to China's economic growth in recent years. From empirical analysis with a two-sector model, it was found that institutional change in the economic reform period, which removed restrictions on intersectoral labour mobility, has been a major source of the rapid growth in rural industry. Institutional change was also found to have accelerated economic growth at the aggregated economy level.

JEL classification: O18, O40, P21

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1. RURAL INDUSTRIAL GROWTH AND INSTITUTIONAL CHANGE

China experienced rapid economic growth during the period of economic reform beginning in 1978. In this period, development of the non-state sector, particularly the rural nonagricultural industrial sector (or Township and Village Enterprise Sector, TVE[1]), played an extremely important role. In 1979-94, annual output growth rate of the TVE sector was 23% on average[2], twice the nation-wide growth rate[3]. During this period, employment in the TVE sector increased from 28 million to 120 million, accounting for 27% of total rural labour in 1994. TVEs' share of total gross industrial output increased from 9% to 44% in the same period (SSB1995, 364-75)[4].

The question naturally arises: What has been the major contributing factor to this dramatic growth of rural industry? This study hypothesizes that an important source was institutional change in the rural economy that removed various restrictions on labour allocation against non-agricultural activities. These institutional changes resulted in a massive transfer of rural labour, and other factors, from the traditional agricultural sector to the rural industrial sector, which accelerated rural industrial growth.

In the pre-reform period, although Commune and Brigade Enterprises (CBEs, the predecessors of TVEs) were allowed, or even encouraged, by central policy (1958-78), development of rural industrial enterprises was actually restricted by various types of institutional constraints.

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[1] Official data for the TVE sector include almost the entire rural non-agricultural enterprises sector, except the state-owned enterprises located in the rural area. In total TVE output, industry accounted for ¾ in 1994. Agricultural production would be included in the TVE sector only if it is organized in a form of enterprise. This part is negligible, and accounted for only 1.4% of TVE output in 1994 (SSB 1995: 365). In this study, the whole TVE sector will be approximately treated as the rural non-agricultural industrial sector.

[2] The constant price output data provided by the Ministry of Agriculture show an over 30% annual growth rate in this period (BTVEa 1991-93, BTVEb 1996). These data are likely overvalued due to insufficient deflating. The 23% growth rate was derived from a recalculation of constant price output by the author.

[3] Offical data for Gross Output are not available for 1993 and 94. It can be derived as around 11.5% in 1979-94 average. Growth rate of GNP is 9.6% in the same period (SSB 1993, 95).

[4] Other data sources suggest either a share of 42% (SSB 1995: 365, 375) or over 50% (Economic Daily 1995, various issues), but the latter seems less reliable.

First, production was basically restricted to a few areas as subsidiary sectors of agriculture.

Second, these enterprises had to be strictly collectively owned and under the control of the communes' administration. Private enterprises were prohibited.

Third, distribution of bank funds, and many important inputs, were subject to the government plan and only guaranteed for state-owned enterprises.

Fourth, there were restrictions on geographic migration, not only from rural to urban, but also among different rural areas.

Fifth, according to the government policy, CBEs (or TVEs in the later stage) should not compete with agriculture for labour. The collectives could not transfer its labour, capital, or land to non-agricultural activities without fulfilling the state quota for agricultural production[5] (Kondo 1978: 142; LBSC 1987: 6-190).

These institutional restrictions ensured the government providing cheap agricultural products to urban residents to support its "heavy industry priority" development strategy (see Dong 1988, and Lin, Cai and Li 1994) during the central planning period. It also protected the central-planning system from the threat of free-market competition, and prevented "capitalism".

Under these restrictions, non-agricultural activities in the rural area were underdeveloped in the pre-reform period. A huge rural population and labour force remained in a limited land area (0.13 hectors per rural resident in 1978), with very low agricultural productivity (0.39 ton of grain output per rural resident). In 1978, after twenty years of development, the Commune and Brigade Enterprises employed 28 million workers, only accounting for 9% of total rural labour (SSB 1995: 59, 331-64).

[5] This was also true in some stage of the reform period. For example, using 1980-82 data from a case study, Chang (1993) found a negative, and significant, relationship between the share of the TVE employment in the rural labour (as the dependent variable) and per capita state quota for grain production (as one independent variable). In his study, this relationship became insignificant in 1983-85.

There have been some major institutional changes during the period of economic reform. The most important being the introduction of the Household Responsibility System (HRS) in 1979-83, and the abolition of the People's Commune System in 1983-84. These changed agriculture from collective-based production to household-based production. Since then, farmers are no longer strictly tied to the land, and have more choice in allocating their labour among sectors. Controls on migration have been relaxed although not removed.

Another important change, led by the industrial reform that started in 1984, was the significant reduction of the impact of the government plan for industrial sectors, and the liberalization of input-output control. Entry barriers against non-state enterprises were also removed. Discriminatory regulations against private business were gradually removed, or reduced, but local policies differ from region to region.

Finally, government quotas on agricultural output were softened and reduced, although there have been some periods of retightening of these controls.

This study attempts to measure the contribution of institutional changes on China's rural industrial growth. In the light of theories of growth and economic development (see Solow 1956, Swan 1956, Uzawa 1962 for neoclassical growth theory; Lucas 1988, Romer 1986, 90 for endogenous growth models; Lewis 1954, Ranis and Fei 1961 for "dual economy" models; Beladi. and Naqvi 1987, Batra and Scully 1972, for growth models with wage differentials), a two sector model, incorporating an institutional factor, has been established, to estimate and calculate this effect, and to attribute rural industrial growth and rural economic growth to different factors.

Although most growth models focus on a "long run growth path", a short run dynamic in the real world, especially in a developing country, may play an important role in economic growth over a fairly long period (see Sato 1963, Lucas 1988, and King and Rebelo 1993). The central concern in this study is the transitional dynamics of rural industrial growth related to the institutional effects on factor reallocation.

2. A TWO SECTOR MODEL EXAMINING INSTITUTIONAL EFFECTS ON GROWTH

The model is established under the following assumptions:

1). The rural industrial sector and the agricultural sector constitute a rural economy. Rural industry uses capital K_1 and labour L_1 to produce homogeneous output Q_1, and agriculture uses capital K_2, labour L_2 and land D to produce output Q_2. Both products can be sold outside the rural economy, and their prices are determined exogenously. The price of Q_i (i=1,2, for rural industry and agriculture, respectively) at the initial year is $P_{i(0)}$, so the real value of Q_i, measured by the constant prices in year 0, is $Y_i=Q_iP_{i(0)}$.

2). Production in each sector has the characteristic of diminishing marginal factor productivity, i.e., $\partial Y_i / \partial L_i > 0$, $\partial Y_i / \partial K_i > 0$, $\partial^2 Y_i / \partial L_i^2 < 0$, and $\partial^2 Y_i / \partial K_i^2 < 0$.

3). Labour is assumed to be imperfectly mobile between the two rural sectors, and immobile between rural and urban areas. Rural-urban migration will be ignored here and considered in future studies[6].

4). Wages are determined by the value of marginal product of labour (VMPL) in each sector. Labour allocation is then determined by the relative VMPL between the two sectors. Therefore given an exogenously determined quantity and growth rate of total rural labour L, L_1 and L_2 and their growth rates are determined endogenously.

5) Institutional restriction is assumed to be equivalent to a transaction cost to labour reallocated from agriculture to rural industry[7], similar to a payroll tax on industrial employment. It is proportional to workers' net earnings with a proportionality factor t ($t \geq 0$), either borne by workers or by firms. Then wages in the two sectors are related by:

[6] In 1980s, transfer of rural labour in China was mainly within the rural economy, i.e., between the agricultural sector and the rural industrial sector. Rural-urban migration increased significantly in the early 90s. However, detailed data is not currently available.

[7] The physical adjustment cost of labour transfer, e.g., cost of transport and accommodation, etc., is ignored in this study.

$$w_2 = \frac{w_1}{1+t}$$

where w_1 is the labour cost to industrial firms, inclusive of the transaction-cost (payroll-tax-equivalent), and $\frac{w_1}{1+t}$ is the wage net of the "tax", received by industrial workers; w_2 is the income received by agricultural labourers. Firms set:

$$w_1 = VMPL_1$$

$$w_2 = VMPL_2$$

$$\therefore \quad \frac{VMPL_1}{VMPL_2} = \frac{w_1}{w_2} = 1 + t = B_L$$

where B_L is ratio of the two VMPLs. $B_L > 1$ when institutional barriers exist, and $B_L = 1$ otherwise.

Therefore, institutional barriers lead to a MPL gap between the two sectors and result in a misallocation of labour. The MPL ratio B_L then can be considered as an indicator for institutional barriers on labour allocation. It will be referred to as the "institutional factor". An institutional change, say a reduction in institutional restrictions, will lead to a decrease in B_L, resulting in a reallocation of labour from agriculture to rural industry.

6). K_1 and K_2, are also determined endogenously according to the relative value of the marginal product of capital (VMPK) in the two sectors. The total capital stock K in the rural economy is given exogenously.

7). To allow capital market imperfections, the prices of capital are assumed to be related by: $r_2 = \frac{r_1}{1+s}$, where r_i is the price of capital in the ith sector and s is an imposed restriction, equivalent to a tax or a subsidy on gains of industrial capital ($s > -1$).

Firms set:

$$r_i = VMPK_i$$

Then

$$\frac{VMPK_1}{VMPK_2} = \frac{r_1}{r_2} = 1 + s = B_K$$

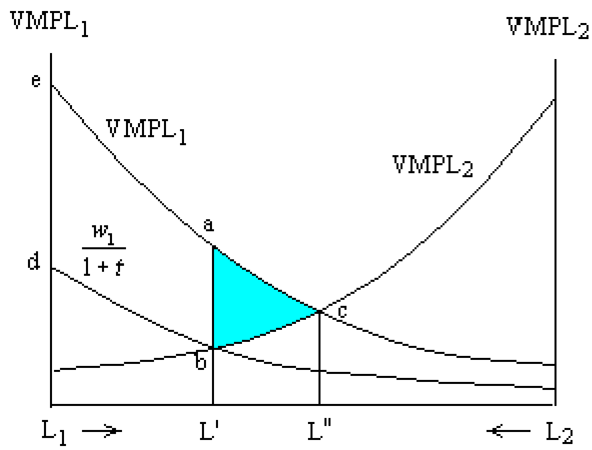
B_K is the ratio of the two VMPKs. $B_K > 0$.

8). Cultivated land, D, is given exogenously and, is used only in the agricultural sector.

The basic idea of the model is illustrated in Figure 1.

Figure 1

Institutional Cost and Labour Reallocation



In Figure 1, the horizontal axis represents the total rural labour force L, divided into industrial labour L_1 (read from left to right) and agricultural labour L_2 (read from right to left). The vertical axis represents the VMPLs in the two sectors. Note that the two VMPL curves are in opposing directions. Without institutional restriction, i.e., labour that is fully mobile between sectors, VMPLs (and wage rates) in the two sectors would converge at point *c*, the intersection of the two VMPL curves. Equilibrium allocation of labour in the two sectors would be L_1L'' and $L''L_2$, respectively. When institutional restrictions exist, labour allocation is determined by point *b*, where $\frac{w_1}{1+t} = w_2$. An institutional cost to transfer of labour is represented by the vertical distance between the $VMPL_1$ curve and the curve denoted as $\frac{w_1}{1+t}$, where the latter represents the industrial wage, net of institutional cost, received by workers. Thus, $VMPL_1 > VMPL_2$, and a gap exists between the two VMPLs (equal to the distance between *a* and *b*). Labour is underallocated in the industrial

sector as L_1L', and overallocated in the agricultural sector as $L'L_2$. The triangle *abc* shows the deadweight loss to the economy[8].

When institutional change occurs, i.e., t is reducing, and the $\frac{w_1}{1+t}$ curve shifts upwards. This moves the intersection point along the $VMPL_2$ curve to the right, leading to a convergence of VMPLs and a reallocation of labour from agriculture to industry. At the extreme, if the institutional cost approaches zero, the labour force will be reallocated as L_1L'' and L_2L'' respectively. In this case, the two VMPLs fully converge, and B_L=1,

In the period of transition, the reallocation of labour will result in faster growth in rural industry and a net gain to the economy (equal to the area *abc* in Figure 1). Although this is only a "short-run effect", the output of the economy will permanently achieve a higher level. How high a growth rate can be achieved in the adjustment period and how long the fast growing period will take, depends on the level of the original institutional cost, and the speed of institutional change. The higher the pre-existing institutional cost, or the faster the institutional adjustment, the higher the growth rate that can be achieved. On the other hand, the higher the pre-existing cost, or the slower the institutional reform, the longer the adjustment period will take.

When capital stock in each sector is endogenously determined, the institutional effect on rural industrial growth will be stronger. This can be explained as follows.

Given the production technology $\partial Y_i / \partial L_i > 0$, $\partial Y_i / \partial K_i > 0$, $\partial^2 Y_i / \partial L_i^2 < 0$, and $\partial^2 Y_i / \partial K_i^2 < 0$, a reallocation of labour from agriculture to industry, induced by institutional changes, will lead to a decrease in MPL and an increase in MPK in industry, but opposite changes in agriculture. VMPLs will converge, and VMPKs will diverge (if initially $VMPK_1 \geq VMPK_2$). The changes in VMPKs will lead to a flow of capital from agriculture to industry, further result in a VMPK convergence. In the adjustment process,

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[8] This is based on the assumption that the institutional restriction is a tax-equivalent barrier. If it is a real cost for obtaining and keeping the job, the deadweight loss would be greater, equal to the area *abc*+*abde*.

the increasing K_1 will retard the decrease in $VMPL_1$, and expand the institutional effect on labour reallocation, therefore further accelerating rural industrial growth.

Note that institutional change may not be the only reason for labour reallocation between sectors. For instance, technological progress in the industrial sector can lead to an upwards shift of both the $VMPL_1$ curve and the $\frac{w_1}{1+t}$ curve, followed by a reallocation of labour. For simplicity, this effect is ignored in the current analysis.

The model is specified as follows. For simplicity, Cobb-Douglas production functions are chosen for both sectors.

Production function in rural industry:

$$Y_1 = A_1 K_1^{\alpha_1} L_1^{\beta_1} \qquad (0<\alpha_1<1,\ 0<\beta_1<1) \tag{1}$$

Production function in agriculture:

$$Y_2 = A_2 K_2^{\alpha_2} L_2^{\beta_2} D^{\gamma} e^{\eta R} \qquad (0<\alpha_2<1,\ 0<\beta_2<1,\ 0<\gamma<1,\ R>0) \tag{2}$$

where Y_i is constant price output of the ith sector (i=1,2), L_i and K_i is labour and capital in the ith sector, respectively, D is land used in the agricultural sector; R is land irrigation ratio[9] (R=irrigated land / total cultivated land; $0 \le R \le 1$). $D^{\gamma} e^{\eta R}$ then is the contribution of effective land to output. A_i represents the level of total factor productivity (TFP) in sector i. α_i, β_i, and γ are the elasticities of output with respect to capital, labour and land, respectively. η is the coefficient of irrigation ratio.

To allow technical progress, following Solow (1956), A_i is assumed to be a function of time, $A_i = A_i(T) = A_{i(0)} e^{g_i T}$, where g_i is the rate of TFP growth, $A_{i(0)}$ is a constant as the initial level of TFP, and T is a time trend. Hence, Equations (1) and (2) can be written as:

$$Y_1 = A_{1(0)} e^{g_1 T} K_1^{\alpha_1} L_1^{\beta_1} \tag{1'}$$

$$Y_2 = A_{2(0)} e^{g_2 T} K_2^{\alpha_2} L_2^{\beta_2} D^{\gamma} e^{\eta R} \tag{2'}$$

[9] Empirical study found it is important to distinguish the additional contribution of irrigated land area from total land area on agricultural output. Omission of R from the agricultural production function caused biased estimation.

Alternatively, to allow fluctuations of TFP over time, A_i (i=1,2) can be written as $A_{i(t)}=A_{i(0)}a_{i(t)}$, where $a_{i(t)}=A_{i(t)}/A_{i(0)}$ for year t, so that changing A_i in each year can be described in logarithm form. In this case, the above equations can be written as:

$$Y_1 = A_{1(0)}a_{1(t)}K_1^{\alpha_1}L_1^{\beta_1} \tag{1''}$$

$$Y_2 = A_{2(0)}a_{2(t)}K_2^{\alpha_2}L_2^{\beta_2}D^{\gamma}e^{\eta R} \tag{2''}$$

The labour cost (equilibrium wage) determined by VMPLs:

$$w_1 = P_1\frac{\partial Y_1}{\partial L_1} = P_1\beta_1 A_1 K_1^{\alpha_1}L_1^{\beta_1-1} = \beta_1\frac{P_1Y_1}{L_1} \tag{3}$$

$$w_2 = P_2\frac{\partial Y_2}{\partial L_2} = \beta_2 A_2 K_2^{\alpha_2}L_2^{\beta_2-1}D^{\gamma}e\eta^{R} = \beta_2\frac{P_2Y_2}{L_2} \tag{4}$$

where w_i is the value marginal product of labour (in current price) or the equilibrium wage rate in sector i; P_i is the price index for industrial and agricultural products, respectively.

Labour allocation condition with institutional barriers:

$$w_1 = B_L w_2 \qquad (B_L \geq 1) \tag{5}$$

where $B_L>1$ indicates institutional barriers on labour transfer from industry to agriculture. The magnitude of B_L relates to the level of institutional cost.

The labour supply constraint:

$$L_1 + L_2 = L \tag{6}$$

where L is the total labour supply in the rural economy.

We substitute Equation (3) and (4) into (5) to get

$$\beta_1\frac{P_1Y_1}{L_1} = B_L\beta_2\frac{P_2Y_2}{L_2} \tag{7}$$

Assuming that B_L varies at a constant rate g_L over time, Equation (7) can be written as:

$$\beta_1\frac{P_1Y_1}{L_1} = B_{L(0)}e^{g_L T}\beta_2\frac{P_2Y_2}{L_2} \tag{7'}$$

Alternatively, to allow irregular changes of B_L, it can be written as:

$$\beta_1 \frac{P_1 Y_1}{L_1} = B_{L(0)} b_{L(t)} \beta_2 \frac{P_2 Y_2}{L_2} \quad (7")$$

where $B_{L(0)}$ is the initial level of B_L, g_L is the growth rate of B_L, $b_{L(t)}=B_{L(t)}/B_{L(0)}$.

Constraint of capital (K is the exogenous total capital stock in the rural economy):

$$K_1 + K_2 = K \quad (13)$$

Price of capital r_i is determined by the value of marginal product of capital in each sector:

$$r_1 = P_1 \frac{\partial Y_1}{\partial K_1} = \alpha_1 P_1 A_1 K_1^{\alpha_1 - 1} L_1^{\beta_1} = \alpha_1 \frac{P_1 Y_1}{K_1} \quad (14)$$

$$r_2 = P_2 \frac{\partial Y_2}{\partial K_2} = \alpha_2 P_2 A_2 K_2^{\alpha_2 - 1} L_2^{\beta_2} D^{\gamma} e^{\eta R} = \alpha_2 \frac{P_2 Y_2}{K_2} \quad (15)$$

Capital allocation between the two sectors is subject to the following condition:

$$r_1 = B_K r_2 \qquad (B_K > 0) \quad (16)$$

where B_K is the ratio of VMPKs, and $B_K \neq 1$ represents the capital market imperfection.

Combine Equations (14) and (15) with (16) to get

$$\alpha_1 \frac{P_1 Y_1}{K_1} = B_K \alpha_2 \frac{P_2 Y_2}{K_2} \quad (17)$$

For possible variation of B_K, equation (17) can be written as either of the following:

$$\alpha_1 \frac{P_1 Y_1}{K_1} = B_{K(0)} e^{g_K T} \alpha_2 \frac{P_2 Y_2}{K_2} \quad (17')$$

$$\alpha_1 \frac{P_1 Y_1}{K_1} = B_{K(0)} b_{K(t)} \alpha_2 \frac{P_2 Y_2}{K_2} \quad (17")$$

Equations (1), (2), (6), (7), (13) and (17) constitute the two sector model. From this model, the institutional effect on allocation of labour and capital, and then on output growth, can be derived as follows. (For simplicity, B_K is assumed to be a constant. This assumption will be justified later.) These effects are expressed in terms of elasticity of labour, capital and output with respect to the institutional factor B_L.

For the industrial sector:

$$E_{L_1 B_L} = -Z / X \quad (20)$$

$$E_{K_1 B_L} = -W / X \quad (21)$$

$$E_{Y_1B_L} = -(\alpha_1 W + \beta_1 Z) / X \tag{22}$$

For the agricultural sector:

$$E_{L_2B_L} = \frac{Z}{X} \cdot \frac{L_1}{L_2} \tag{23}$$

$$E_{K_2B_L} = \frac{W}{X} \cdot \frac{K_1}{K_2} \tag{24}$$

$$E_{Y_2B_L} = (\alpha_2 W \frac{K_1}{K_2} + \beta_2 Z \frac{L_1}{L_2}) \frac{1}{X} \tag{25}$$

where $E_{L_iB_L}$, $E_{K_iB_L}$ and $E_{Y_iB_L}$ are elasticities of labour, capital and output in the *i*th sector with respect to B_L. Z, W and X are defined as follows:

$$Z = (1-\alpha_1) + (1-\alpha_2) K_1 / K_2$$

$$W = \beta_1 + \beta_2 L_1 / L_2$$

$$X = 1 - \alpha_1 - \beta_1 + (1-\alpha_2-\beta_1)\frac{K_1}{K_2} + (1-\alpha_1-\beta_2)\frac{L_1}{L_2} + (1-\alpha_2-\beta_2)\frac{K_1 L_1}{K_2 L_2}$$

Clearly both *Z* and *W* are positive. It can also be proved that, in the situation currently under consideration, *X* is positive. Therefore these elasticities for industry are all negative, but those for agriculture are all positive (see Appendix 1). This suggests that when the institutional cost is reduced, both labour and capital are reallocated from agriculture to rural industry, generating a positive effect on industrial growth, but a negative effect on agricultural growth.

The institutional effect on aggregated rural economic growth is:

$$E_{YB_L} = \frac{Y_1}{Y} E_{L_1B_L} + \frac{Y_2}{Y} E_{L_2B_L} = -\frac{Y_1}{Y}\left(\beta_1 \frac{t}{1+t} \cdot \frac{Z}{X} + \alpha_1 \frac{s}{1+s} \frac{W}{X}\right) \tag{26}$$

It can be proved that, when $B_L > 1$, E_{YB_L} is negative, unless there exists a very serious discriminative policy on capital allocation against agriculture, or α_1 and β_1 take unusual values (Appendix 1). This indicates that, although institutional effects on industry and agriculture are in the opposite direction, the total effect of reducing institutional barriers has a positive effect on economic growth.

The elasticities give the institutional effect on sectoral or overall economic growth, i.e., growth rates with respect to the rate of change of B_L.

Using δ and θ to represent $E_{Y_1B_L}$ and $E_{Y_2B_L}$ respectively, the growth rates of the two sectors and the rural economy can be decomposed as[10]:

$$\dot{Y}_1 = g_1 + \alpha_1 \dot{K}_1^N + \beta_1 \dot{E}_1^N + \delta g_L + \varepsilon_1$$

$$\dot{Y}_2 = g_2 + \alpha_2 \dot{K}_2^N + \beta_2 \dot{E}_2^N + \gamma \dot{D} + \eta \frac{dR}{dt} + \theta g_L + \varepsilon_2$$

$$\dot{Y} = \frac{Y_1}{Y}(\dot{Y}_1^N + g_1 + \delta g_L) + \frac{Y_2}{Y}(\dot{Y}_2^N + g_2 + \theta g_L) + \varepsilon$$

where the growth rate with superscript "*N*" is the "natural" growth rate for that variable, defined as the would-be input or output growth rate, if, without institutional change and TFP progress. g_i is TFP growth rate, g_L is change rate of B_L, and ε is the growth residual.

Note that, let $\lambda = E_{YB_L}$, the last equation can also be written as:

$$\dot{Y} = \frac{Y_1}{Y}(\dot{Y}_1^N + g_1) + \frac{Y_2}{Y}(\dot{Y}_2^N + g_2) + \lambda g_L + \varepsilon$$

3. THE EMPIRICAL MODEL AND DATA

Based on the model provided in the last section, empirical analysis is carried out to investigate the actual contribution to growth from factor endowment growth, TFP growth, and institutional-change-induced factor reallocation. The first two can be directly estimated from the model, but the institutional effect is calculated from changes of the institutional factor B_L, which will be estimated from the model.

For empirical analysis, the logarithm form of the above model is taken. Dummy variables for different regions and for some particular periods are added. Dummies and time trends that found statistically insignificant in some equations were omitted and treated as having a zero value coefficient, unless they are necessary for the equation.

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[10] Nevertheless, δ, θ, and λ can not be directly estimated, since they are non-constants, and g_L is unknown. Instead, g_L will be estimated first from the model, then value of δ, θ, and λ for each year can be derived from equations (22), (25) and (26).

Version I (with time trends for g_i and g_L):

$$\begin{aligned} \ln Y_1 &= \ln A_{1(0)} + g_1 T + \alpha_1 \ln K_1 + \beta_1 \ln L_1 \\ &= C_{11} REG_1 + C_{12} REG_2 + C_{13} + g_1 T + g_{1M1} M_1 T + \alpha_1 \ln K_1 + \beta_1 \ln L_1 \end{aligned} \quad (1')$$

$$\begin{aligned} \ln Y_2 &= \ln A_{2(0)} + g_2 T + \alpha_2 \ln K_2 + \beta_2 \ln L_2 + \gamma \ln D + \eta R \\ &= C_2 + g_2 T + g_{2M1} M_1 T + \alpha_2 \ln K_2 + \beta_2 \ln L_2 + \gamma \ln D + \eta R \end{aligned} \quad (2')$$

$$\begin{aligned} \ln(P_1 Y_1 / L_1) - \ln(P_2 Y_2 / L_2) &= \ln(B_{L(0)} \beta_2 / \beta_1) + g_L T \\ &= C_3 + g_L T + g_{Lm2} M_2 T + g_{LR1} REG_1 T + g_{LM2R1} REG_1 M_2 T \end{aligned} \quad (3')$$

$$\begin{aligned} \ln(P_1 Y_1 / K_1) - \ln(P_2 Y_2 / K_2) &= \ln(B_{K(0)} \alpha_2 / \alpha_1) + g_K T \\ &= C_{41} REG_1 + C_{42} REG_2 + C_{43} \end{aligned} \quad (4')$$

subject to the constraint of capital and labour:

$$L_1 + L_2 = L \quad (5)$$

$$K_1 + K_2 = K \quad (6)$$

where REG_is (i=1,2) are dummy variables for regions 1 and 2, M_is (i=1,2) are dummies for periods 1980-85 and 89-92, respectively.

In Equation (1'), C_{11}, C_{12} and C_{13} constitute $\ln A_{1(0)}$, the original level of TFP, for rural industry. $C_{11}+C_{13}$ is equal to $\ln A_{1(0)}$ for region 1; $C_{12}+C_{13}$ is that for region 2; and C_{13} is that for region 3. g_1+g_{1M1} is the TFP growth rate for the period 1980-85, and g_1 is that for the rest period.

In Equation (2'), C_2 is equal to $\ln A_{2(0)}$ for agriculture, regional dummies were omitted due to insignificance. g_2 and g_{2M1} are TFP growth rate, same as those in Equation (1').

Equation (3') and (4') are rearranged from Equation (7') and (17') of the last section by moving variables $\ln P_2Y_2/L$ and $\ln P_2Y_2/K$ to the left hand side, and all constants to the right. Now the RHS of Equation (3') is constituted by a constant C_3, representing $\ln(B_{L(0)}\beta_2/\beta_1)$, and time trends for rate of changing B_L in different regions (region 1 and regions 2-3) in different periods (1980-88 and 89-92). Since both $\ln(B_{L(0)}\beta_2/\beta_1)$ and β_i (i=1,2) can be estimated from the system, then $B_{L(0)}$ can be calculated.

Regional dummies were omitted due to insignificance. But growth rate of B_L was found to be different between region 1 and other regions. For region 1, g_L+g_{LR1} is equal to the growth rate of B_L in 1981-88, g_L+g_{LM2}+g_{LR1}+g_{LM2R1} is equal to that rate in 1989-92. For other regions, g_L is the growth rate of B_L in 1981-88, and g_L+g_{LM} is that rate in 1989-92.

The RHS of Equation (4') is constituted by the constant C_{43} and regional dummies. C_{41}+C_{43} is equal to $\ln(B_{K(0)}\alpha_2/\alpha_1)$ for region 1, C_{42}+C_{43} is that for region 2, and C_{43} itself for region 3. Time trends are omitted due to insignificance.

Equation (5) and (6) are identities that do not need to be estimated.

Version II (with dummy variables for annual changes):

$$\ln Y_1 = C_{11} REG_1 + C_{12} REG_2 + C_{13} + C_{1(t)} T_t + \alpha_1 \ln K_1 + \beta_1 \ln L_1 \quad (1'')$$

$$ln\, Y_2 = C_2 + C_{2(t)} T_t + \alpha_2\, ln\, K_2 + \beta_2\, ln\, L_2 + \gamma\, ln\, D + \eta R \quad (2'')$$

$$\ln(P_1 Y_1 / L_1) - \ln(P_2 Y_2 / L_2) = C_3 + C_{3(t)} T_t + C_{31t} REG_1 T_t \quad (3'')$$

$$\ln(P_1 Y_1 / K_1) - \ln(P_2 Y_2 / K_2) = C_{41} REG_1 + C_{42} REG_2 + C_{43} + C_{4t} T_t \quad (4'')$$

$$L_1 + L_2 = L \quad (5)$$

$$K_1 + K_2 = K \quad (6)$$

Equations (1"), (2"), (3") and (4") are derived from Equations (1"), (2"), (7") and (17") in the last section, respectively.

In version II, a series of dummy variables for each year, T_t (T_t=1 for year t, T_t=0 otherwise; t=1981,...92) are used to replace the time trend in Version I. C_{ij} (i=1…4 for the four equations, j=1…3 for the three regions) represents the intercept terms in the four equations: $\ln A_{1(0)}$, $\ln A_{2(0)}$, $\ln(B_{L(0)}\beta_2 / \beta_1)$, and $\ln(B_{K(0)}\alpha_2/\alpha_1)$. Regional differences can be obtained by the same way as for Version I, e.g., C_{11}+C_{13}=$\ln A_{1(0)}$ for region 1, C_{13} alone is that for region 3. The change in the intercept term in year *t* is represented by C_{ijt} that corresponding to different regions or for all the regions, e.g., for region 1, $\ln A_{1(1992)}$=C_{11}+C_{13}+$C_{1(1992)}$, $\ln(B_{L(1992)}\beta_2 / \beta_1)$ =C_3+$C_{3(1992)}$+$C_{31(1992)}$.

The following are definitions for variables and parameters, and data description.

Endogenous variables:

Y_i: Gross Output Value[11] of the *i*th sector in1980 constant price.

K_i: Calculated capital stock for each sector in 1980 constant prices[12].

L_i: Labour supply in each sector.

Exogenous variables:

K: Total capital stock in the rural economy, K=K_1+K_2.

L: Total rural labour, L=L_1+L_2.

D: Cultivated land area used in agriculture.

R: The irrigation ratio (irrigated land area to total cultivated land area).

P_1: Industrial Producer Price Index, $P_{1(1980)}$=1.

P_2: Purchasing price index for agricultural products, $P_{2(1980)}$=1.

T: Time trend for the period 1980–92. T=t-1980 at year t (t=1980...92).

Dummy variables:

REG_1: Regional dummy for the ten east coast provinces[13]: Liaoning, Beijing, Tianjin, Hebei, Shandong, Shanghai, Jiangsu, Zhejiang, Fujian, and Guangdong. REG_1=1 for the above provinces and *REG*1=0 otherwise. Hainan is excluded due to data shortage.

REG_2: Regional dummy for the nine provinces in the central area or non-coastal east areas: Jilin, Heilongjiang, Neimenggu (Inner Mongolia), Shanxi, Henan, Anhui, Jiangxi, Hubei, and Hunan.

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[11] Rural individual and private enterprises are included in TVEs since 1984. An earlier estimation by the author using the published constant price output data caused systematic overvaluation of productivity changes in rural industry. The data were found to be seriously underdeflated. To solve the problem, current price output and IPPI (industrial producer price index) were used to recalculate the constant price output.

[12] K_1 is calculated from the value of fixed assets and working capital of TVEs. K_2 is calculated from Original Value of Farmers' Household Productive Fixed Assets, Major Agricultural Machinery, Annual Application of Chemical fertilizer, the compound prices and price indexes of them.

[13] There are 30 provinces in Mainland China, including four autonomous regions and three large cities that administratively at the provincial level.

Nine north-west and south-west provinces, excluded from *REG*1 and *REG*2, fall into region 3. They are Shaanxi, Gansu, Ningxia, Qinghai, Xinjiang, Sichuan, Yunnan, Guizhou, and Guangxi. Xizang (Tibet) is excluded due to lack of data.

M_1 and M_2: Dummy variables for the earlier period of economic reform, 1980-85, and a later period, 1989-92, respectively. M_1=1 for year 1980-85 and =0 otherwise. M_2=1 for year 1989-92 and =0 otherwise.

T_t: A series of annual dummy variables. T_t=1 for year t (t=1981…92), T_t=0 otherwise.

Parameters:

A_i: Level of total factor productivity in the *i*th sector.

$A_{i(0)}$: Constant for the value of A_i in the initial year (1980).

g_i: Instantaneous growth rate of A_i, i.e., TFP growth rate in the *i*th sector.

α_i, β_i, and γ: Elasticities of output with respect to capital, labour and land, respectively.

η: Coefficient of irrigation ratio.

B_L: The ratio $VMPL_1/VMPL_2$.

B_K: The ratio $VMPK_1/VMPK_2$.

$B_{L(0)}$ and $B_{K(0)}$: Constants, the initial level (1980) of B_L and B_K.

g_L and g_K: Instantaneous changing rate of B_L and B_K, respectively.

C_{ij}: Constant or coefficient of dummies; i=1…4 for equations, and j=1…3 for regions.

C_{ijt}: coefficient of annual dummies T_t, t=1980…92.

Panel data are used at the provincial level for the period 1980-92 (except 81~84, 87). The data set includes 28 provinces for 8 years. Total observations are 224. Original data came from BTV(a), BTV(b), RSED, and SSB (various years). Calculations are made by the author [14].

[14] Data and detailed calculation see Wang (forthcoming): Appendix 1 and 2.

4. ESTIMATION RESULTS

The model is estimated simultaneously using the Three-Stage-Least-Squares (3SLS) method. The estimation results are shown Table 8-10 of Appendix 2. Both versions show high R-squared values[15]. Most estimates are statistically highly significant.

Both versions suggest a constant returns to scale character in both rural industry and agriculture[16]. Capital, labour and land are all significant except land in version II. Land has a relative low share in agricultural output, however, the contribution of land to output is also reflected from the coefficient of irrigation ratio. Estimated shares of factors in output are shown in Table 1.

TABLE 1. ESTIMATION RESULTS: FACTOR CONTRIBUTION

	Version I		Version II	
Industry				
Capital	0.60		0.60	
Labour	0.41		0.40	
Equation R^2		0.987		0.989
Agriculture				
Capital	0.50		0.53	
Labour	0.44		0.45	
Land	0.06		0.03	
Irrigation ratio	0.14		0.084	
Equation R^2		0.921		0.919

Source: From Table 8 in Appendix 2.

TFP growth rates in both sectors, g_is, are found to be positive and significant in 1981-92, and obviously larger in 1981-85 than in 86-92, suggested by both versions. Although no significant difference was found in TFP growth among the three regions, the initial

[15] The relatively low R^2s for Equation (3') and (4') seems to have resulted from the fact that the RHS of the equations are constituted by only constant, dummies and time trends. Since most of the estimates are significant, the low R^2s for the two equation does not necessarily suggest low explanation power of them.

[16] See Appendix 3 for the test. An early estimation by the author using un-recalculated output data obtained an increasing returns to scale result for rural industry. The IRS result appears to be a biased estimation.

industrial TFP level in region 1 (east coast area) was much higher than regions 2 and 3. (see Table 2).

TABLE 2. TFP GROWTH BY SECTORS AND REGIONS

Parameter	Region 1	Region 2	Region 3 or overall	Average
Version I				
Industry				
TFP(80)	1.84	1.48	1.20	1.52
$g_{1(81\text{-}85)}$			8.6%	8.6%
$g_{1(86\text{-}92)}$			4.0%	4.0%
Agriculture				
TFP(80)			0.99	0.99
$g_{2(81\text{-}85)}$			6.3%	6.3%
$g_{2(86\text{-}92)}$			2.6%	2.6%
Version II				
Industry				
TFP(80)	1.82	1.47	1.18	1.50
TFP(85)	3.05	2.46	1.98	2.52
TFP(92)	3.19	2.58	2.08	2.64
Agriculture				
TFP(80)			1.16	1.16
TFP(85)			1.41	1.41
TFP(92)			1.59	1.59

Source: calculated from Table 8-9 in Appendix 2.

The fast TFP growth during 1980-85 in both sectors is coincident with major rural reforms — first the introduction of the Household Responsibility System, and then abolition of the Commune System. This suggests that institutional change also had effect on productivity growth at the sectoral level. The slowdown of TFP growth after 1985 indicates that the effect diminished with time. In addition, annual estimates in version II suggest that, industrial TFP dropped in several short periods, i.e., in 1986, 89, and 91; and agricultural TFP dropped in 86 and 89 (see Table 9 in Appendix 2). Both of these are coincident with the application of contractionary macro economic policies.

From the estimation results, the values of B_L and B_K (the VMPL and VMPK ratios between the two sectors) and their rates of change (g_L and g_K) are calculated and shown in Table 3. They illustrate that industrial MPL was nearly 3 times as high as agricultural

MPL, indicating a high institutional cost on labour allocation, against non-agricultural activities. A generally diminishing trend of B_L was found in 1981-88 (not for all the regions), suggesting convergence of MPLs; but a rapid increasing trend was also found in 1989-92. According to the model specification, this indicates a continued reduction of institutional restrictions on labour reallocation in the first period, but increasing institutional restriction after 1989.

TABLE 3. CHANGING INSTITUTIONAL FACTORS

	Region 1	Region 2	Region 3 or overall	Average
B_L				
Version I				
$B_L(80)$			2.92	2.92
$g_{L(80-88)}$	2.4%	-5.6%	-5.6%	-2.9%
$g_{L(89-92)}$	5.9%	20.6%	20.6%	15.7%
Version II				
$B_L(80)$	3.15	2.55	2.55	2.75
$B_L(88)$	3.14	2.29	2.29	2.57
$B_L(92)$	5.22	3.68	3.68	4.19
B_K				
Version I				
$B_K(80)$	0.80	0.64	0.43	0.62
$g_{K(80-88)}$	-	-	-	
$g_{K(89-92)}$	-	-	-	
Version II [a]				
$B_K(80)$	0.74	0.61	0.40	0.58
$B_K(88)$	0.71	0.59	0.39	0.56
$B_K(92)$	0.82	0.68	0.45	0.65

a. Most estimates for B_K in version II are insignificant.
Source: calculated from Table 8-10 in Appendix 2.

The estimate of B_K is smaller than 1, without significant change during 1981-92[17]. This suggests a lower MPK in TVEs than in agriculture, probably resulted from lower interest rates on bank loans for TVEs than for agriculture (Wang: forthcoming).

[17] Therefore we can accept a constant B_K hypothesis. The expression of institutional factor elasticities that derived earlier (see Section 2) therefore is valid. They were derived under the assumption of constant B_K.

To compare the Cobb-Douglas estimate of B_L, a translog version of the model was estimated. Although accurate estimates are not available, the result indicates the same directions of changing MPL ratio during the two periods (see Appendix 4).

Two questions may be raised. The first, does the result indicate correct direction of institutional changes during the two periods? The second, does the estimated extent of changing MPL ratio reflect the extent of institutional change?

On the first question, although there were policy fluctuations in the early period of reform, there was a general tendency towards reduction of institutional restrictions before 1988. However, a major change, from this trend, occurred in 1989 that attempted to partly reinstall central planing control, and protect the state sector from competition from the non-state sector. Many TVEs were force to close down in 1989-90. A reverse flow of labour, from rural industry to agriculture, occurred. The situation changed again in 1992, when a new policy was announced to accelerate market-oriented economic reform.

Table 4 listed major policies and institutional changes from 1977 to 1995, compared with the change in TVE employment. It indicates a clear relationship between rapid rural industrialization and institutional reform. The restoration of old restrictive policies in 1981, 89 and 90 all resulted in direct reduction in TVE employment. In 1989 and 90, more than one million TVE workers each year lost their job, this is much more serious than in 1981.

Therefore the estimated decreases in B_L before 1989, and increase since 1989, are basically consistent with the observed institutional change. However, the positive effect on TVE employment from relaxing central control in 1991, and market oriented reform in 1992, is not reflected by a drop in the estimated B_L. On the contrary, there is still a sharp increase in B_L in 1991-92.

TABLE 4. IMPACT OF POLICY CHANGES ON TVE EMPLOYMENT

(10,000 persons)

Year	Major policy change	TVE Employment	Changes, + or -
1977	relaxing control on TVE employment competing with agriculture	2328	532
1978	a.a., start agricultural reform	2827	499
1979	HRS allowed only in exceptional cases; restrict TVEs competition with SOE for inputs	2909	82
1980	HRS introduced to some remote areas	3000	91
1981	contractionary policies; further strengthen control on TVEs	2970	-30
1982	abolishing communes, introducing HRS nation-widely	3113	143
1983	a.a. allow rural private firm to employ up to 5 workers	3235	122
1984	abolishing discriminative policy on TVEs; preferential policy in finance & tax applied to TVEs	5208	1973
1985	relaxing control on human capital transfer to TVEs	6979	1771
1986	a short-lasting contractionary policy, relaxed later	7937	958
1987	continue reform	8805	868
1988	a.a. later start protecting SOEs, enhance control on TVEs, abolish preferential policy for TVEs	9546	741
1989	reinstall central control; tightening restriction on TVEs; and a contractionary macro policy	9367	-179
1990	a.a.	9265	-102
1991	relaxing restriction on TVEs	9609	344
1992	restart market oriented reform, encourage TVEs	10581	972
1993	a.a.	12345	1764
1994*	contractionary macro policy	12018	-327
1995	continue reform	12862	844

Note: a.a. = as above. * In 1994 there was an adjustment of the TVE statistics. The appeared reduction in TVE employment in this year was resulted from this adjustment.

Sources: LBSC 1987, 6-190; SSB 1993, 94-96.

Regarding the second question, from Tables 3 and 4, it can be concluded that the estimated speed of MPL divergence after 1989 seems too high, compared with the estimated speed of convergence in 1981-88, and real changes in TVE employment. In other words, there may have been some non-institutional factors causing MPL divergence in the period from the late 1980s and early 1990s.

A number of non-institutional factors can be considered:

1) A possible over-stating of agricultural labour can result in an underestimation of agricultural MPL, and therefore an estimated MPL divergence. This is possible, because the rural-urban migration was not deducted from agricultural labour, due

to the shortage of data. Rural-urban migration was basically negligible in the 1980s, but became quite large in the 1990s. This might be the main reason for the estimated increases in B_L in 1991-92.

2) A possible overvaluation of TVE output data can result in an overestimation of industrial MPL. Although an under-deflation problem has been corrected in this study, some data bias is still possible. For instance, there have been a number of reports of local governments over-reporting TVE output in recent years (*Economic Daily* 1993-5, various issues; also see Rawski 1993).
3) Possible faster human capital accumulation in TVEs than in agriculture may result in a MPL divergence, since human capital was not distinguished from the labour force in the statistical data. This effect would be more significant in the later period than early, when more educated people joined the TVE sector.
4) Faster technical progress in the TVE sector may have a temporary effect on MPL divergence.

In summary, the estimation result for changing B_L is basically consistent with the observed direction of institutional changes. But the MPL gap since late 1980s is likely to have been overestimated due to some non-institutional effects and data problems.

In the following section, calculations are made to derive the expected change of B_L that would be induced purely by institutional changes. This will be based on the estimate of initial B_L and information for the real transfer of labour between the two sectors. Using the model framework, the contribution of institutional changes on rural industrial growth can be derived. Other contributions, i.e., the contribution of natural growth of factor endowments and TFP growth, are also calculated.

5. A DECOMPOSITION OF GROWTH: CONTRIBUTION OF INSTITUTIONAL EFFECT AND OTHER FACTORS

In this section, the growth rates of rural industry, agriculture, and the rural economy at the aggregated level, are decomposed and attributed to the institutional effect and other factors. Calculation of the institutional effect will be base on the following assumptions:

1. Without institutional change, there would be no factor reallocation between sectors, and the labour growth rate of the two sectors would be equal to the growth rate of rural labour (similarly to capital)[18], i.e., $\dot{E}_1^N = \dot{E}_2^N = \dot{E}$, $\dot{K}_1^N = \dot{K}_2^N = \dot{K}$. We can call $\dot{E}_i^N$ and $\dot{K}_i^N$ as the natural growth rates of labour and capital.
2. The MPL differential at the beginning year (1980) was entirely caused by institutional restrictions. Therefore the estimated $B_{L(1980)}$ indicates the true institutional barriers on labour allocation.

From assumption 1, the sectoral output growth rate, if induced purely by natural growth of inputs, can be further defined as the natural growth rate of output, denoted by $\dot{Y}_i^N$, where $\dot{Y}_1^N = \alpha_1 \dot{K}_1^N + \beta_1 \dot{E}_1^N$, and $\dot{Y}_2^N = \alpha_2 \dot{K}_2^N + \beta_2 \dot{E}_2^N + \gamma \dot{D} + \eta(dR/dt)$. The natural growth rate of the rural economy is a weighted aggregation of $\dot{Y}_1^N$ and $\dot{Y}_2^N$.

The actual sectoral input growth rate can then be decomposed into two components: 1) the natural growth rate; and 2) the institutional effect on factor reallocation. The actual sectoral output growth rate can be decomposed into four parts: 1) the natural growth rate; 2) the institutional effect through factor reallocation; 3) the TFP growth; and 4) a residual, i.e., growth induced by excluded effects or statistical errors.

The contribution of TFP growth to each sector is calculated year by year from the estimated TFP level from Version II of the model. TFP growth in the rural economy

[18] This is a little different from the model, since if $\alpha_1 \neq \alpha_2$ and $\beta_1 \neq \beta_2$, with other conditions being equal, the growth rate of the two sectors would be different. This would induce a reallocation of factors through changing relative MPLs and MPKs. Since the differences will be small, this effect on factor reallocation is neglected.

(excluding the institutional effect on factor reallocation) is derived from the weighted TFP growth rates of the two sectors. TFP growth may result from technical progress, but also from efficiency increase at the firm level that induced by institutional change.

The major issue of the decomposition is to derive the institutional effect on growth. First the institutional effect on labour growth in the *i*th sector (i=1,2) is derived as:

$$\dot{E}_i^{ns} = \dot{E}_i - \dot{E}_i^{N} = \dot{E}_i - \dot{E}$$

where $\dot{E}_i^{ns}$ is the institutional effect on growth rate of L_i, through labour reallocation; $\dot{E}_i$ is the actual growth rate of L_i, $\dot{E}$ is the actual growth rate of total rural labour

Then the expected g_L, i.e., the rate of change of the expected B_L (defined as the expected MPL ratio that would be purely induced by institutional barriers), can be derived from $\dot{E}_i^{ns}$ and the elasticity $E_{L_i B_L}$ (see Section 2, Equation 20) as:

$$g_L = \dot{E}_1^{ns} / E_{L_1 B_L}$$

Then the expected B_L, for the years after 1980, can be derived from the expected g_L and the estimated B_L (1980). The calculated national level $E_{L_i B_L}$, expected g_L and B_L are shown in Table 5.

TABLE 5. ESTIMATED AND EXPECTED B_L

	1980	1985	1986	1988	1989	1990	1991	1992
$\dot{E}_i^{ns}$		13.75 [a]	10.41	6.57 [b]	-4.05	-3.76	1.17	8.36
$E_{L_1 B_L}$	-16.08	-10.62	-8.62	-7.17	-7.16	-6.99	-6.56	-6.10
Expected B_L								
Rate (g_L)		-1.30% [a]	-1.21%	-0.92% [b]	0.57%	0.54%	-0.18%	-1.37%
Level	2.75	2.58	2.55	2.50	2.52	2.53	2.52	2.49
Estimated B_L	2.75	2.54	2.62	2.57	2.81	3.17	3.66	4.19

a. 1981-85 average. b. 1987-88 average.
Source: Table 10-13 in Appendix 2.

The two different trends of changing relative MPLs (estimated, and expected) are compared in the last two rows of the table, and shown in Figure 2.

Figure 2. Estimated MPL Ratio and
Institutional Change Induced MPL Ratio

In Figure 2, the expected MPL ratio, induced by institutional barriers on labour allocation, shows a slow, but clear, converging tendency from 1980 to 92. This indicates a gradual reduction in institutional restrictions on labour reallocation, during the economic reform. A mild divergence only appeared in 1989-90, when anti-market policy changes occurred. The estimated and the expected MPL ratios are consistent in 1981-88, but show a rapid divergence after 1989. As discussed earlier, this was most probably a result of 1), an unrecorded rural-urban migration at the end of the 80s and in the 90s; 2) overreporting of industrial output in the recent years, and 3) faster human capital growth in the TVE sector.

Since the expected B_L is derived from the real transfer of labour (and estimated B_{L} in 1980 only), it avoids the data problem and therefore seems far more reliable[19].

Based on the expected g_L and B_L, and the elasticities of capital and output with respect to B_L[20], the institutional effects on the growth rate of capital and output in each sector, and at the aggregated level, are derived.

Table 6 gives the calculation results for decomposition of the annual growth rates of rural industry at the national level. Table 7 shows the decomposition of industrial, agricultural, and aggregated rural economic growth, as the average in 1981-92. Other results are shown in Appendix 2, Table 13.

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[19] Although, by taking off the effect of human capital growth (if data available), the expected MPLs might converge faster than they appeared.

[20] See Equations 21-26 in Section 2. These elasticities are non-constants, their values in each year are calculated by using the estimated parameters and nation-wide data for L_{i}, K_{i}, and Y_{i} (see Appendix 2: Table 11 for data, and Table 12 for calculated elasticities).

TABLE 6. DECOMPOSITION OF RURAL INDUSTRIAL GROWTH [a] (%)

Growth rate	1981-85 [b]	1986	1987-88 [b]	1989	1990	1991	1992
Actual	26.70	23.59	21.47	2.82	9.14	13.29	35.26
Natural	8.34	17.45	11.90	5.40	6.13	10.06	10.58
Inst.effect	**10.89**	**7.63**	**4.45**	**-2.61**	**-2.39**	**0.72**	**4.94**
TFP[c]	10.33	-13.68	1.12	-0.37	2.91	-1.44	14.84
Residual	-2.86	12.19	4.00	0.40	2.49	3.95	4.90

Note: a, instantaneous growth rates. b, average growth rate in that period. c, the estimated TFP growth in 1986 may not be accurate.
Source: Calculated from Table 5 and Table 12-13 in Appendix 2.

TABLE 7. DECOMPOSITION OF GROWTH AND INSTITUTIONAL EFFECT

1981-92 average (%)

Growth rate[a]	Industry	Agriculture	Aggregated
Actual growth	21.7	6.0	13.3
Natural growth	9.6	8.3	9.0
Inst. effect	**6.0**	**-2.3**	**1.1**
TFP growth	4.7	2.6	3.5
Residual	1.5	-2.7	-0.3

Note: a, instantaneous growth rate.
Source: Calculated from Table 13 in Appendix 2.

The significant findings can be summarized as follows:

1. Institutional changes made the major contribution to the accelerating rural industrial growth in 1981-92 (6% in average). This is higher than the contribution of TFP growth (4.7%). These two effects, together, contributed half of the industrial growth rate of 22%, aside from the contribution of factor endowment growth.
2. The negative effect of institutional change on agricultural growth, resulting from factor outflow, was far smaller than the positive effect on rural industrial growth, because of productivity differences between sectors. In the aggregate, institutional changes positively contributed to growth of the rural economy.
3. Short term policy changes towards re-centralization had a clearly negative effect on rural industrial growth and overall economic growth in 1989-90.

4. Compared with its dramatic contribution in 1981-85, institutional effects on rural industrial growth diminished after 1985. Although, it was still considerably high (5%) in 1992.
5. As indicated by the derived level of expected B_L (see Table 5 and Figure 2), although institutional barriers were steadily reduced, they still existed at a considerably high level in 1992. This suggests further institutional reform is necessary and that would still be an important source for rapid rural industrial growth in a medium term future, possibly another 15-20 years, by extrapolate the same trend into the future[21].
6. Although they are small in value (see Table 7), growth residuals were positive in rural industry and negative in agriculture. This is coincident with the finding that, MPK in rural industry was continuously smaller than in agriculture. This suggests an overallocation of capital in rural industry and an underallocation in agriculture, possibly resulted from the lower interest rates of bank loans for TVEs than agriculture (see Wang: forthcoming).

6. CONCLUSION

This paper examines the reason for the rapid growth of China's rural industry during the period of economic reform, emphasizing the contribution of institutional changes on industrial growth through factor reallocation between agriculture and rural industry.

A two sector model is established to investigate the institutional effect as well as the contribution of other factors on growth. The model indicates that, in the situation under consideration, a reduction in institutional barriers on labour mobility will result in a

[21] To get this result, it is assumed that, the expected B_L was arround 2 in 1992, after taking off the human capital effect.

reallocation of both labour and capital between sectors, leading faster growth in rural industry in the transitional period, and also accelerating overall economic growth. MPL gap will converge too.

Empirical estimation using this model finds a large initial MPL gap between the two sectors, and a converging tendency of MPLs in 1981-88, indicating a reduction in institutional barriers, but a diverging tendency after 1989 is also found. By subtracting non-institutional effects, the MPL gap that resulted from institutional barriers is found to be reduced through out the whole period under study, except for an increase in 1989-90.

Derived from the estimation, it is found that the reduction in institutional barriers made a major contribution to the acceleration of rural industrial growth in 1981-92, 6% on average from a 22% annual growth rate. This effect was diminishing, but still important, in 1992.

The agricultural growth rate was reduced, due to factor reallocation between sectors, by only 2%. Overall growth of the rural economy was found to be accelerated, suggesting a net gain from the improvement in factor allocation[22].

TFP increases made another important contribution to growth - 4.7% in rural industry and 2.7% in agriculture. TFP growth may also reflect institutional change, at the firm level.

Although institutional change has made an important contribution to rural industrial growth, the remaining MPL differential is still high, suggesting a high potential for rapid growth of rural industry in the future, from further removal of institutional barriers.

Institutional changes played a very important role in the rapid rural industrial growth and overall economic growth. However, this is a “short-run effect” that will eventually

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[22] It should be pointed out that, in this study, the positive institutional effect on economic growth might be more or less underestimated. This is because the higher rate of capital formation in industry than in agriculture. If we take this effect into account, capital formation in the rural economy should be endogenously determined, directly relating to institutional change. In this case the “natural” output growth rates in both sectors would be lower, and the institutional effects would be higher.

fade away. Technological progress and human capital improvement will become more and more important, for long run sustainable growth in the rural economy.

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APPENDIX 1. THE SIGN OF THE INSTITUTIONAL EFFECT

In section 2, Equations (20) and (21) give

$$E_{L_1B_L} = -Z / X \tag{20}$$

$$E_{K_1B_L} = -W / X \tag{21}$$

where

$$X = (1-\alpha_1-\beta_1)+(1-\alpha_2-\beta_1)\frac{K_1}{K_2}+(1-\alpha_1-\beta_2)\frac{L_1}{L_2}+(1-\alpha_2-\beta_2)\frac{K_1L_1}{K_2L_2}$$

$$W = \beta_1+\beta_2\frac{L_1}{L_2}$$

$$Z = (1-\alpha_1)+(1-\alpha_2)\frac{K_1}{K_2}$$

Clearly both Z and W are positive since $0<\alpha_i<1$ and $0<\beta_i<1$. If $X>0$, $E_{L_1B_L}$ and $E_{K_1B_L}$ would be negative. An overall proof would be mathematically complicated. The following discussion shows that, these elasticities are negative if

a) both sectors are constant returns to scale (CRS),

b) Capital-labour ratio in rural industry is higher than agriculture, and

c) $\alpha_1 > \frac{APL_2}{APL_1}\alpha_2$[23].

In a CRS case, the first term in the right hand side expression of X is equal to zero and the last term is positive, since $1-\alpha_1-\beta_1=0$ and $1-\alpha_2-\beta_2=\gamma>0$. The signs of the second and third terms are uncertain. X can be written as:

$$\begin{aligned} X &= (1-\alpha_2-\beta_1)\frac{K_1}{K_2}+(1-\alpha_1-\beta_2)\frac{L_1}{L_2}+(1-\alpha_2-\beta_2)\frac{K_1L_1}{K_2L_2} \\ &= (\beta_2-\beta_1)\frac{K_1L_2-K_2L_1}{K_2L_2}+\gamma\frac{K_1L_1+K_1L_2}{K_2L_2} \end{aligned}$$

We know $\frac{K_1L_2-K_2L_1}{K_2L_2}>0$ since $\frac{K_1}{L_1}>\frac{K_2}{L_2}$. Then X would be positive if:

[23] These conditions are hold in the situation under consideration. CRS is tested and proved in Appendix 3. The higher capital-labour ratio is true, particularly because labour is underallocated in rural industry and overallocated in agriculture, due to institutional restrictions. Therefore agriculture is far more labour intensive and less capital intensive than industry. In addition, estimation shows $\alpha_1 > \alpha_2$.

$$\beta_2 - \beta_1 > -\gamma \frac{K_1 L_2 + K_1 L_1}{K_1 L_2 - K_2 L_1}$$

To simplify it, assume MPK_1=MPK_2. Then the above condition can be expressed as:

$$\frac{\alpha_1}{\beta_1} MPL_1 > \frac{\alpha_2}{\beta_2} MPL_2$$

or

$$\alpha_1 APL_1 > \alpha_2 APL_2$$

where MPK_i, MPL_i and APL_i (i=1,2) are marginal product of capital, labour, and average product of labour in the ith sector, respectively. In Cobb-Douglas production function, $MPK_1 = \alpha_1 \frac{Y_1}{K_1}$, $MPL_i = \beta_i \frac{Y_i}{L_i}$, and $APL_i = \frac{Y_i}{L_i}$.

$MPL_1 > MPL_2$ is the precondition under consideration, it is the result of institutional restrictions on labour allocation. $APL_1 > APL_2$ also holds since agriculture is more labour intensive than rural industry. Thus, the above condition holds except the case of $\alpha_1 \leq \frac{APL_2}{APL_1} \alpha_2$. When institutional restriction exists, $\frac{APL_2}{APL_1}$ would be significantly smaller than 1, therefore $\alpha_1 \leq \frac{APL_2}{APL_1} \alpha_2$ is only a special case.

This result indicates that, when there exists institutional restriction against the rural industrial sector, a reduction in this restriction can result in a transfer of labour and capital into the industrial sector (i.e., $E_{L_1 B_L} < 0$, $E_{K_1 B_L} < 0$), except in a special case that α_1 is unreasonably far smaller than α_2.

It is more complicated in the increasing returns to scale case. Positive $E_{L_1 B_L}$ and $E_{K_1 B_L}$ may be derived. However, this would not mean a reduction in institutional restrictions lead to an inverse reallocation of labour from the high productivity sector to the lower one. Rather, it would suggest that, during the transitional period, an increase in industrial labour, as a result of reducing institutional cost, might lead to an increase in the MPL gap between sectors. In this case, the value of B_L would no longer indicate the level of institutional cost.

The following is a discussion for the sign of E_{YB_L}, i.e., elasticity of aggregated output with respect to B_L.

First, changes in Y, as the effect of institutional changes, is the aggregation of the institutional effect on Y_1 and Y_2:

$$\frac{dY}{dB_L} = \frac{dY_1}{dB_L} + \frac{dY_2}{dB_L} = \frac{\partial Y_1}{\partial L_1}\frac{dL_1}{dB_L} + \frac{\partial Y_1}{\partial K_1}\frac{dK_1}{dB_L} + \frac{\partial Y_2}{\partial L_2}\frac{dL_2}{dB_L} + \frac{\partial Y_2}{\partial K_2}\frac{dK_2}{dB_L}$$

Note that dL_2= -dL_1 when L (i.e., L_1+L_2) being unchanged. The equation is rearranged to get

$$\frac{dY}{dB_L} = (MPL_1 - MPL_2)\frac{dL_1}{dB_L} + (MPK_1 - MPK_2)\frac{dK_1}{dB_L},$$

$$\frac{dY}{dB_L} = (MPL_1 - MPL_2)E_{L_1B_L}\frac{L_1}{B_L} + (MPK_1 - MPK_2)E_{K_1B_L}\frac{K_1}{B_L}$$

Using the information in Equations (20) and (21) in section 2, the above equation can be rewritten as:

$$E_{YB_L} = -(MPL_1 - MPL_2)\frac{Z}{X}\frac{L_1}{Y} - (MPK_1 - MPK_2)\frac{W}{X}\frac{K_1}{Y}$$

$$= -\left(\frac{MPL_1 - MPL_2}{MPL_1}\right)MPL_1\frac{Z}{X}\frac{L_1}{Y} - \left(\frac{MPK_1 - MPK_2}{MPK_1}\right)MPK_1\frac{W}{X}\frac{K_1}{Y}$$

According to the definition, $\frac{MPL_1 - MPL_2}{MPL_1} = \frac{t}{1+t}$, and $\frac{MPK_1 - MPK_2}{MPK_1} = \frac{s}{1+s}$ (1+t=B_L and 1+s=B_K, see section 2). The above equation can then be written as

$$E_{YB_L} = -\frac{Y_1}{Y}\left(\beta_1\frac{t}{1+t}\cdot\frac{Z}{X} + \alpha_1\frac{s}{1+s}\frac{W}{X}\right) \qquad (26')$$

By definition, t>0 and s>-1. In CRS technology, Z>W since capital-labour ratio in the industrial sector is higher than agricultural sector. Given that W, X and Z are all positive, the above equation suggests that:

If s=0 (i.e., MPK_1=MPK_2), or s>0 (i.e., B_K>1), E_{YB_L} is negative.

If s<0 but $\left|\frac{s}{1+s}\right| < \frac{\beta_1}{\alpha_1}\cdot\frac{t}{1+t}\cdot\frac{Z}{W}$, E_{YB_L} is negative.

The above conditions state that, the institutional factor elasticity of output is negative as long as MPK_1 is not sufficiently smaller than MPK_2, or α_1 is not sufficiently greater than β_1. In other words, unless if there exists a very serious discriminative policy on

capital allocation against agriculture, or in some unusual cases of α_1 and β_1, and if the reduction in institutional cost is only on labour mobility, institutional change would positively contribute to economic growth. The above condition also suggests that, the larger the MPL gap, the smaller the possibility for E_{YB_L} to be non-negative.

APPENDIX 2: TABLES FOR ESTIMATION RESULT AND DATA

TABLE 8. ESTIMATION RESULTS: PRODUCTION FUNCTIONS, RELATIVE MPL AND MPK

		Version I		Version II	
Variable	Coefficient	(1') Industry	(2') Agricul.	(1") Industry	(2") Agricul.
K_i	α_i	0.599	0.504	0.603	0.527
		(19.67*)	(18.44*)	(20.31*)	(21.54*)
L_i	β_i	0.406	0.442	0.396	0.447
		(14.28*)	(32.92*)	(14.09*)	(37.71*)
D	γ		0.061		0.027
			(2.28')		(1.14)
R	η		0.137		0.084
			(3.16")		(2.41')
REG_1	C_{11}	0.425		0.431	
		(11.23*)		(11.90*)	
REG_2	C_{12}	0.210		0.217	
		(7.79*)		(8.47*)	
Constant	C_{13}, C_2	0.184	-0.013	0.167	0.146
		(2.44')	(0.13)	(2.30')	(1.21)
T	g_i	0.040	0.026		
		(9.18*)	(6.77*)		
M_1T	g_{iM}	0.046	0.037		
		(7.00*)	(5.40*)		
Eq R^2		0.987	0.921	0.989	0.919
		Version I		Version II	
Variable	Coefficient	(3')MPL ratio	(4')MPK ratio	(3')MPL ratio	(4')MPK ratio
REG_1	C_{41}		0.622		0.602
			(8.60*)		(8.82*)
REG_2	C_{42}		0.411		0.414
			(6.81*)		(7.62*)
Constant	C_3, C_{43}	1.071	-0.851	0.936	-0.904
		(16.87*)	(16.52*)	(11.89*)	(9.31*)
T	g_L	-0.056			
		(5.17*)			
M_2T	g_{LM}	0.262			
		(8.47*)			
REG_1T	g_{LMR1}	0.080			
		(4.52*)			
REG_1M_2T	g_{LMR2}	-0.227			
		(2.99")			
	Eq R^2	0.224	0.206	0.282	0.258

Notes: Values in parentheses are t-ratios. T-ratios with ' are significant at 5% level; " at 1% level; and * at 0.1% level.

TABLE 8. CONTINUED: ANNUAL CHANGES

IN TFP, MPL, AND MPK (VERSION II)

Variable	Coefficient	(1")industry	(2")agriculture	(3")MPL ratio	(4")MPK ratio
T_{85}	$C_{i(85)}$[a]	0.516	0.200	-0.133	0.372
		(12.37*)	(3.21*)	(1.23)	(2.92")
T_{86}	$C_{i(86)}$	0.382	0.191	-0.085	0.114
		(8.81*)	(3.05")	(0.79)	(0.90)
T_{88}	$C_{i(88)}$	0.404	0.223	-0.105	-0.046
		(8.61*)	(3.52*)	(0.97)	(0.36)
T_{89}	$C_{i(89)}$	0.400	0.209	-0.029	-0.030
		(8.32*)	(3.28*)	(0.27)	(0.24)
T_{90}	$C_{i(90)}$	0.427	0.248	0.091	-0.021
		(8.56*)	(3.87*)	(0.84)	(0.16)
T_{91}	$C_{i(91)}$	0.414	0.257	0.232	-0.015
		(7.88*)	(4.00*)	(2.15')	(0.12)
T_{92}	$C_{i(92)}$	0.563	0.320	0.368	0.098
		(10.28*)	(4.95*)	(3.39*)	(0.77)
REG_1T_{80}	$C_{31(80)}$			0.212	
				(2.34')	
REG_1T_{85}	$C_{31(85)}$			0.351	
				(4.23*)	
REG_1T_{86}	$C_{31(86)}$			0.303	
				(3.62*)	
REG_1T_{88}	$C_{31(88)}$			0.313	
				(3.76*)	
REG_1T_{89}	$C_{31(89)}$			0.337	
				(4.06*)	
REG_1T_{90}	$C_{31(90)}$			0.342	
				(4.13*)	
REG_1T_{91}	$C_{31\ 91)}$			0.347	
				(4.19*)	
REG_1T_{92}	$C_{31\ 92)}$			0.349	
				(4.20*)	

a. The subscript i denotes the corresponding coefficients in the four equations (i=1,...4).

TABLE 9. TFP LEVEL AND CALCULATED GROWTH

(FROM VERSION II)

	1980	1985	1986	1988	1989	1990	1991	1992
TFP level								
Region1								
Industry	1.82	3.05	2.66	2.72	2.71	2.79	2.75	3.19
Agricul.	1.16	1.41	1.4	1.45	1.43	1.48	1.5	1.59
Region2								
Industry	1.47	2.46	2.15	2.20	2.19	2.25	2.22	2.58
Agricul.	1.16	1.41	1.4	1.45	1.43	1.48	1.5	1.59
Region3								
Industry	1.18	1.98	1.73	1.77	1.76	1.81	1.79	2.08
Agricul.	1.16	1.41	1.4	1.45	1.43	1.48	1.5	1.59
TFP growth								
Industry		10.33%	-13.68%	1.12%	-0.37%	2.91%	-1.44%	14.84%
Agricul.		3.90%	-0.71%	1.75%	-1.39%	3.44%	1.34%	5.83%
Aggregate		6.41%	-7.05%	1.40%	-0.78%	3.12%	-0.36%	11.77%

Source: Calculated from the estimation result of version II, see Table 8.

TABLE 10. CHANGING MPL RATIO AND MPK RATIO

(FROM VERSION II)

	1980	1985	1986	1988	1989	1990	1991	1992
MPL ratio								
Region 1	3.15	3.17	3.17	3.14	3.47	3.93	4.55	5.22
Region 2	2.55	2.23	2.34	2.29	2.48	2.79	3.22	3.68
Region 3	2.55	2.23	2.34	2.29	2.48	2.79	3.22	3.68
Average	2.75	2.54	2.62	2.57	2.81	3.17	3.66	4.19
MPK ratio								
Region 1	0.74	1.07	0.83	0.71	0.72	0.72	0.73	0.82
Region 2	0.61	0.89	0.69	0.59	0.59	0.60	0.60	0.68
Region 3	0.40	0.59	0.45	0.39	0.39	0.40	0.40	0.45
Average	0.58	0.85	0.66	0.56	0.57	0.57	0.58	0.65

Source: Calculated from the estimation result of version II, see Table 8.

TABLE 11. NATION-WIDE INPUT AND OUTPUT DATA AND GROWTH RATES

	1980	1985	1986	1988	1989	1990	1991	1992
Labour (mil.person)								
L_1	30.0	69.8	79.4	95.5	93.7	92.6	96.1	106.2
L_2	286.7	300.9	300.5	305.2	315.7	327.4	334.8	331.8
L	316.7	370.6	379.9	400.7	409.4	420.1	430.9	438
$\hat{}L_1$		16.89%	12.89%	9.23%	-1.90%	-1.18%	3.71%	9.99%
$\hat{}L_2$		0.97%	-0.13%	0.78%	3.38%	3.64%	2.24%	-0.90%
^L		3.14%	2.48%	2.67%	2.15%	2.58%	2.54%	1.63%
Capital (bil.yuan)								
K_1	50.4	126.4	196	323.4	351.4	392.3	480.4	595.2
K_2	95.4	135.1	148.1	170.4	181.1	187.3	193.5	200
K	145	261.5	344.1	493.8	532.5	579.6	673.9	795.2
$\hat{}K_1$		18.39%	43.87%	25.04%	8.30%	11.01%	20.26%	21.43%
$\hat{}K_2$		6.96%	9.19%	7.01%	6.09%	3.37%	3.26%	3.30%
^K		11.79%	27.45%	18.06%	7.55%	8.48%	15.07%	16.55%
Land (mil.mu)								
D	1489	1453	1443	1436	1436	1435	1435	1431
^D		-0.49%	-0.69%	-0.24%	0.00%	-0.07%	0.00%	-0.28%
Irr.ratio	0.448	0.455	0.46	0.464	0.469	0.496	0.502	0.509
Price index								
P_1	1	1.101	1.143	1.418	1.682	1.751	1.860	1.986
P_2	1	1.276	1.358	1.871	2.151	2.095	2.053	2.123
Output (bil.yuan)								
Y_1	65.7	249.6	316	485.5	499.4	547.2	625	889.2
Y_2	197.6	291.2	301.1	331	341.3	367.3	380.1	404.2
Y	263.3	540.8	617.1	816.5	840.7	914.5	1005.1	1293.4
$\hat{}Y_1$		26.70%	23.59%	21.47%	2.82%	9.14%	13.29%	35.26%
$\hat{}Y_2$		7.76%	3.34%	4.73%	3.06%	7.34%	3.43%	6.15%
^Y		14.40%	13.20%	14.00%	2.92%	8.41%	9.45%	25.22%
Production coefficient [a]								
$\alpha 1$	0.599							
$\alpha 2$	0.504							
$\beta 1$	0.406							
$\beta 2$	0.442							
γ	0.061							
η	0.137							

Notes: 1=industry and 2=agriculture. Capital and output are calculated in 1980 constant price. 1 mu =1/15 hectare. Variable with ^ is instantaneous growth rate. a. No variation over time.
Sources: Wang (forthcoming); SSB various years; BTV 1991-93; and estimation result in Table 8.

TABLE 12. INSTITUTIONAL ELASTICITY AND EXPECTED B_L

	1980	1985	1986	1988	1989	1990	1991	1992
Institutional coefficients[1]								
X	0.041	0.081	0.122	0.185	0.189	0.204	0.245	0.301
Z	0.663	0.865	1.057	1.342	1.363	1.44	1.632	1.877
W	0.452	0.509	0.523	0.544	0.537	0.531	0.533	0.547
Institutional elasticity[2]								
$E_{L_1 B_L}$	-16.08	-10.62	-8.62	-7.17	-7.16	-6.99	-6.56	-6.10
$E_{L_2 B_L}$	1.68	1.80	2.15	2.09	2.20	2.05	1.90	1.89
$E_{K_1 B_L}$	-10.97	-6.25	-4.28	-2.94	-2.85	-2.60	-2.17	-1.82
$E_{K_2 B_L}$	5.79	4.79	4.87	4.80	5.47	5.26	4.98	4.97
$E_{Y_1 B_L}$	-13.10	-8.06	-6.08	-4.71	-4.64	-4.43	-4.01	-3.62
$E_{Y_2 B_L}$	3.66	3.21	3.40	3.34	3.73	3.55	3.35	3.34
E_{YB_L}	-0.52	-1.20	-1.23	-1.16	-1.25	-1.21	-1.14	-1.24
Expected B_L								
Grow.rate[3]		-1.30%	-1.21%	-0.92%	0.57%	0.54%	-0.18%	-1.37%
Value[4]	2.75	2.58	2.55	2.50	2.52	2.53	2.52	2.49
Estimat. B_L[5]	2.75	2.54	2.62	2.57	2.81	3.17	3.66	4.19

Note:
1, 2. Definitions see Section 2, Equation 20-26.
3, 4. Calculated from estimated B_L (1980), $\bar{E}_i^{ins}$ and $E_{L_i B_L}$.
5. Average of estimated regional B_L from version II, see Table 10.

TABLE 13. DECOMPOSITION OF INDUSTRIAL AND AGRICULTURAL GROWTH[a] (%)

Growth	1981-85[b]	1986	1987-88[b]	1989	1990	1991	1992
Labour							
L_1							
actual	16.89	12.89	9.23	-1.90	-1.18	3.71	9.99
natural	3.14	2.48	2.67	2.15	2.58	2.54	1.63
inst.eff.	13.75	10.41	6.57	-4.05	-3.76	1.17	8.36
residual	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L_2							
actual	0.97	-0.13	0.78	3.38	3.64	2.24	-0.90
natural	3.14	2.48	2.67	2.15	2.58	2.54	1.63
inst.eff.	-2.18	-2.61	-1.89	1.23	1.06	-0.30	-2.53
residual	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital							
K_1							
actual	18.39	43.87	25.04	8.30	11.01	20.26	21.43
natural	11.79	27.45	18.06	7.55	8.48	15.07	16.55
inst.eff.	8.86	5.68	2.98	-1.62	-1.43	0.41	2.59
residual	-2.26	10.73	4.00	2.38	3.97	4.78	2.29
K_2							
actual	6.96	9.19	7.01	6.09	3.37	3.26	3.30
natural	11.79	27.45	18.06	7.55	8.48	15.07	16.55
inst.eff.	-5.45	-5.22	-3.99	2.87	2.82	-0.87	-6.45
residual	0.61	-13.05	-7.06	-4.33	-7.93	-10.94	-6.80
Output							
Y_1							
actual	26.70	23.59	21.47	2.82	9.14	13.29	35.26
natural	8.34	17.45	11.90	5.40	6.13	10.06	10.58
inst.eff.	10.89	7.63	4.45	-2.61	-2.39	0.72	4.94
TFP	10.33	-13.68	1.12	-0.37	2.91	-1.44	14.84
residual	-2.86	12.19	4.00	0.40	2.49	3.95	4.90
Y_2							
actual	7.76	3.34	4.73	3.06	7.34	3.43	6.15
natural	7.33	14.93	10.28	4.76	5.42	8.72	9.06
inst.eff.	-3.54	-3.57	-2.78	1.98	1.92	-0.59	-4.34
TFP	3.90	-0.71	1.75	-1.39	3.44	1.34	5.83
residual	0.07	-7.31	-4.52	-2.29	-3.44	-6.04	-4.40
Y							
actual	14.40	13.20	14.00	2.92	8.41	9.45	25.22
natural	7.71	16.17	11.19	5.16	5.98	9.57	10.09
inst.eff.	1.59	1.88	1.22	-0.75	-0.65	0.21	1.74
TFP	6.41	-7.05	1.40	-0.78	3.12	-0.36	11.77
residual	-1.31	2.20	0.19	-0.71	-0.04	0.03	1.62

a. All calculated as instantaneous growth rate. b. As average in that period.

Sources: Calculated from Table 8-12.

APPENDIX 3. TEST FOR CONSTANT RETURNS TO SCALE

The following are tests for constant returns to scale in the rural industrial and agricultural sectors. Based on the empirical model in Section 2, subtract lnL_1 from both the LHS and the RHS of Equation (1'), and subtract lnL_2 from both sides of Equation (2'), to get

$$\begin{aligned} ln\,Y_1 - ln\,L_1 &= C_{11} REG_1 + C_{12} REG_2 + C_{13} + g_1 T + g_{1M} M_1 T \\ &+ \alpha_1 (ln\,K_1 - ln\,L_1) + (\alpha_1 + \beta_1 - 1)\, ln\,L_1 \end{aligned} \tag{1'*}$$

$$\begin{aligned} ln\,Y_2 - ln\,L_2 &= C_2 + g_2 T + g_{2M} M_1 T + \alpha_2 (ln\,K_2 - ln\,L_2) \\ &+ (\alpha_2 + \beta_2 + \gamma - 1)\, ln\,L_2 + \gamma (ln\,D - ln\,L_2) + \eta R \end{aligned} \tag{2'*}$$

Test 1

H_1: $\alpha_1 + \beta_1 - 1 \neq 0$ against

H_2: $\alpha_1 + \beta_1 - 1 = 0$

Test 2

H_1: $\alpha_2 + \beta_2 + \gamma - 1 \neq 0$ against

H_2: $\alpha_2 + \beta_2 + \gamma - 1 = 0$

Using the same model and same estimation method (3SLS), the following results are obtained:

$\alpha_1 + \beta_1 - 1 = 0.004$ (t-ratio=0.347)

$\alpha_2 + \beta_2 + \gamma - 1 = -0.018$ (t-ratio=-0.834)

Since both results are insignificant, the non-constant returns to scale hypothesis H_1 in both tests are rejected. This suggests that both the rural industrial and agricultural sectors exhibit a constant returns to scale technology.

APPENDIX 4. A TRANSLOG ESTIMATION FOR MPL DIFFERENTIAL

In Section 3, a Cobb-Douglas production function estimation suggests a general converging tendency of MPLs in rural industry and agriculture, during 1980-88, but a diverging tendency after 1989. To confirm the correctness of the result, an alternative estimation is carried out using translog functions.

The following is the model in a translog format[24]:

Production functions:

$$\ln Y_1 = \beta_{11} + \beta_{12} \ln L_1 + \beta_{13} \ln K_1 + \beta_{14} (\ln L_1)^2 / 2 + \beta_{15} (\ln K_1)^2 / 2 + \beta_{16} \ln L_1 \ln K_1 \quad (1)$$

$$\begin{aligned} \ln Y_2 &= \beta_{21} + \beta_{22} \ln L_2 + \beta_{23} \ln K_2 + \beta_{24} (\ln L_2)^2 / 2 + \beta_{25} (\ln K_2)^2 / 2 \\ &+ \beta_{26} \ln L_2 \ln K_2 + \beta_{27} \ln D + \beta_{28} (\ln D)^2 / 2 + \beta_{29} \ln D \ln L_2 + \beta_{20} \ln D \ln K_2 \end{aligned} \quad (2)$$

Wage determination:

$$w_1 = \partial Y_1 / \partial L_1 = (\beta_{12} + \beta_{14} + \beta_{16} \ln K_1) Y_1 / L_1 \quad (3)$$

$$w_2 = \partial Y_2 / \partial L_2 = (\beta_{22} + \beta_{24} + \beta_{26} \ln K_2 + \beta_{29} \ln D) Y_2 / L_2 \quad (4)$$

Labour allocation condition:

$$\begin{aligned} Y_1 / L_1 = [&B_L (\beta_{22} + \beta_{24} + \beta_{26} \ln K_2 + \beta_{29} \ln D) \\ &/ (\beta_{12} + \beta_{14} + \beta_{16} \ln K_1)] Y_2 / L_2 \end{aligned}$$

or

$$\begin{aligned} \ln(Y_1 / L_1) - \ln(Y_2 / L_2) = \ln B_L &+ \ln(\beta_{22} + \beta_{24} + \beta_{26} \ln K_2 + \beta_{29} \ln D) \\ &- \ln(\beta_{12} + \beta_{14} + \beta_{16} \ln K_1) \end{aligned} \quad (5)$$

It is difficult to derive the accurate value of B_L from Equation (5). Calculating B_L using all the estimated coefficients could result in large errors due to the pile-up of estimating errors. However, since in reality K_1 grew much faster than K_2, and D was decreasing during the whole sample period (1980-92), the RHS of Equation (5) can be expected to be a decreasing vector across time, if B_L was unchanged or decreasing. If the

[24] For simplicity, the exogenous capital assumption is adopted. This may result in a smaller value of derived institutional effect, but will not result in wrong direction of estimated institutional changes.

RHS of the equation exhibited an increasing tendency, an increasing B_L would be suggested. Thus Equation (5) is replaced by

$$\ln(Y_1 / L_1) - \ln(Y_2 / L_2) = C + a_1 T + a_2 T_2 + a_3 REG1T + a_4 REG1T_2 \qquad (5')$$

where C is a constant; T and T_2 are two time trends for the period of 1980-88 and 89-92, respectively (T=t-1980 for year t in 1980-88, and T=0 otherwise. T_2=t_2-1980 for year t_2 in 1989-92, and T_2=0 otherwise). REG1 is a dummy variable for region 1. The time trends and regional dummy used in this equation are consistant with the Cobb-Douglas estimation. a_1~ a_4 are the coefficients, represents growth rate of the RHS in different periods and different regions.

The above model, i.e., Equations (1), (2), and (5’), is estimated using a 3SLS method. The same data set is used with the Cobb-Douglas estimation. The result is shown in Table 14. All estimates are statistically significant at 0.1% level, except $REG1T_2$.

TABLE 14. TRANSLOG ESTIMATION RESULT

variable	coefficient	t-ratio
T	-0.055	-4.90
T_2	0.155	4.08
REG1T	0.037	4.41
$REG1T_2$	-0.013	0.26
C	1.218	18.98

System R^2=0.94
Equation (5’) R^2=0.99

The result suggests that the RHS of the equation consists of decreasing vectors for 1980-88, and increasing vectors for after 1989. In the first period, the decrease in region 1 is slower than in the other regions. In the second period, it increases rapidly in all regions. This indicate the same trend of changing B_L as the Cobb-Douglas estimates.

The above result shows consistency between Cobb-Douglas estimates and translog estimates.