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How does the technological progress in telecommunications contribute to the Chinese national economic growth

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ABSTRACT

This study focuses upon the nexus between the factor contribution rates and the growth rate of the Chinese economy. By comparing Solow residual method and Feeder model, we empirically investigate the contribution rate of the telecommunication technology progress to the Chinese economic growth. The results show that the contribution of the industry accounts for as high as 9.87% of the Chinese national economic growth. We argue that a vigorous development of internet communications and 4G technologies may considerably add to the economic development of a county.

KEYWORDS

Solow residual method; Feeder model; Technological progress; Contribution rate.

INTRODUCTION

According to the theory of modern economics, contribute rate usually associated with economic growth and technological progress together. Solow[1] (1957) use technology change rate to represent any form of the production function's changes as production decline, output growth, and the improvement of labor's education and so on ; But Lucas (2003) believes that technology is different from the general sense of knowledge. Technology is knowledge of specific populations or subculture of specific populations, and is something determined by factors beyond our current understanding; later Romer (1990) stressed that as a special technology and human capital inputs, technology is neither a traditional commodity, nor is it a pure public goods, it has a non-competitive and some exclusivity. Thus, methods of calculating contribution rate of technological advance has three main methods: Solow complementary method, R & D Mode method[2], a new economic growth model method[3]. Because the Solow residual value method is simple and intuitive and avoids discussing specific function forms, most scholars use it.

For China where dramatic social changes occur, capital, labor and technological progress will not be able to fully explain the economic grows. The three factors, changes in the economic system, the evolution of the spatial pattern of economic activity, the rapid accumulation of human capital have a profound impact on economic growth. If calculated in accordance with the Solow complementary method, the content that Solow residual contains is so rich that it cannot fully reflect the real contribution of technological progress. So the decomposition of Solow residual is very necessary, in order to enable us to grasp the real contribution of technological advance to economic growth. It has the same problem to estimating the contribution of China Telecom's technological progress on national economic growth rate.

After a comprehensive comparison of several calculation methods of contribution rate, we choose two ways to measure progress in telecommunications technology contribution rate of economic growth. One is Solow complementary method which is widely accepted, one is the Feeder model which is more complex, and we will add some appropriate amendments on them.

USE SOLOW COMPLEMENTARY METHOD TO ESTIMATE THE CONTRIBUTION RATE OF TELECOMMUNICATION TECHNOLOGY ADVANCE TO ECONOMIC GROWTH

Introduction to the Solow complementary method

The basic assumptions of Solow complementary method is: there are only two factors of production, capital and labor and the two are substitutive for each other, can be fitted with a variable proportion; perfectly competitive market conditions, capital and labor are reward as its marginal product; any time, capital and labor can be fully utilized; technological progress is neutral, that is, when the capital-labor ratio (K / L) is unchanged, in the production function before and after The ratio of the marginal product of both factors (dY / dL) / (d Y / d K) remains unchanged.

We assume the following Cobb Douglas production function form:

$$Y = AK^{\alpha} L^{\beta} \quad \textbf{(1)}$$

Where: Y represents output, A represents the technology level, K represents the capital invested, α represents the elastic coefficient of the output of labor, L is the labor input, β represents the elastic coefficient of the output of labor.

In twentieth Century 40, America economist Tinbergen after years of in-depth analysis, the Cobb Douglas equations are transformed, becoming the following formula:

$$Y_t = A_t \cdot K_t^{\ \alpha} \cdot L_t^{\ \beta} \quad \textbf{(2)}$$

The transformation formula (1), is in the lower right corner of each letter with a "t", it seems to be not much change, but its essence fundamentally changed. T represents a clear time, At said t's annual technology level, to understand the true meaning of production expansion factor A, which is brought by the progress of science and technology.

1957 Solow conducted in-depth research into equation (2), and applied mathematical methods to modify the equation, following is the result:

$$y = a + \alpha_K + \beta_1 \quad \textbf{(3)}$$

This model is also known as growth equation. Where: y is the growth rate of year output, k represents annual growth rate of capital investment, l represents annual growth rate of labor input, a represents an annual growth rate of technological progress.

After transposition processing, The formula (3)has became the widely used, famous Solow cofactor

$$a = y - \alpha_K - \beta_1 \quad \textbf{(4)}$$

academic community recognized the formula (4)as calculation method of the growth rate of the progress of science and technology. With the proposal of the contribution rate of science and technology, people need to understand the proportion that progress of science and technology account for economic growth, method to estimate the contribution rate of technology advance to economic growth emerged as the times require

$$E_A = a / y 100\% \tag{5}$$

The ratio of scientific and technological progress and the growth rate of the economic growth is the contribution rate of technology advance to economic growth of years. The formula (5) substitutes into the formula (4) then it comes following:

$$E_A = [1 - \alpha / y \cdot k - \beta / y \cdot 1 \cdot] 100\% \tag{6}$$

The contribution rate of scientific and technological progress calculated by Solow is under assumptions that the returns to scale remains unchanged, and producer equilibrium is achieved and technical changes is the neutral.

In the Solow residual value formula: A is the average annual growth rate of economy lead by progress of science and technology, y is the average annual growth rate of output. k is the average annual growth rate of capital, l is the average growth speed of the workers, α is the elasticity coefficient of capital (referring to the other conditions remaining unchanged, the capital increase of 1%, output increased α %). β is the elasticity coefficient of labor (referring to the other conditions remaining unchanged, increased labor 1%, output increased β%.

It should be noted that, in the Solow approach, capital and labor inputs of the individual components are treated as homogeneous. Here we only consider the number and do not distinguish quality. At present, China's progress in science and technology in the estimates, the majority who use Solow approach does not consider this difference of factor inputs.

By the general steps of Solow method used to estimates the contribution rate of scientific and technological progress are:

(1) Obtain growth rate of output (GDP), capital and labor through statistical data after appropriate treatment;

(2) The value of two parameters;

(3) using linear regression methods to estimate technological progress contribution rate (the rate of technological progress and output growth ratio). α , β , are called output elasticity of capital and labor. About determination of α , β value, many domestic and foreign researchers have conducted thorough research. But because of the substantial sections, large workload of data collection and sorting, at present there is not a widely accepted method for calculating the elasticity coefficient. A relatively simple alternative is empirical reckoning which is based on the current situation of their economic factors. Due to the relatively abundant labor force in our country, the industrial structure is labor intensive, some experts and relevant government departments recommend the use of low α value, or about 0.35[4]. In addition, in order to simplify the calculation, we use $\alpha + \beta = 1$ in general, because the national level of scale efficiency is difficult to judge[5].

CALCULATING THE CONTRIBUTION RATE OF ADVANCEMENT IN TELECOMMUNICATION TECHNOLOGY TO THE TOTAL TELECOMMUNICATION BUSINESS BY MEANS OF SOLOW COMPLEMENTARY METHOD

Respecting the development in the past 30 years of reform and open, we can find that telecommunication industry, as the basic industry of national economy, has achieved a qualitative leap, which changes from weak to strong, from backward to advanced, and from the bottleneck which restricts economic development to the leading industry of the national economy. The rapidly increasing status of telecommunication industry has made tremendous contributions to the rapid development of China's national economy.

Use the growth rate of total telecommunications services, capital investment growth rates and growth rates of employees and other data which from 2000 to 2009,applying regression analysis, with Eviews6.0 software, ordinary least squares estimation for formula (6) are as following:

$$\Delta Y / Y = 0.2685 + 0.258 \Delta K / K + 0.742 \Delta L / L \tag{7}$$

The formula described that the average Chinese telecommunications technology advances was 26.85% in 2000 ~ 2009, during this period, the contribution of the annual fund, employees, technological advances in the telecommunications business growth is shown in TABLE 1:

Wherein: E_K indicates the contribution of funds to the growth of telecommunication services, $E_K = \alpha \bullet \Delta K / K / (\Delta Y / Y) \times 100\%$; EL represents the contribution of practitioner to the growth of telecommunications traffic, $EL = \beta \bullet \Delta L / L / (\Delta Y / Y) \times 100\%$; EA represents the contribution of technical progress on the telecommunications business volume growth, $E_A = 1 - E_K - E_L$.

TABLE 1 : Contribution rate of telecommunications technology progress to the telecom business 2000-2009

Growth rate of telecom service (%)	Growth rate of investment(%)	Growth rate of labor(%)	rate of technical progress (%)	E_K(%)	E_L(%)	E_A(%)
39.96	38.54	2.15	29.91	21	4	75
30.37	14.81	1.85	25.71	11	5	84
26.85	-18.8	-2.42	32.82	-15	-7	122
24.57	6.96	7.16	17.45	6	23	71
41.19	-0.83	-3.36	44.00	-0.44	-6.56	107
26.53	-4.61	2.27	25.75	-4	7	97
26.06	5.54	3.62	22.02	5	11	84
27.38	11.21	4.23	24.65	6	12.1	87.9
19.67	13.11	2.35	26.21	7	14.3	78.7
15.43	14.21	3.24	29.36	9	16.2	74.8

From TABLE 1, we can see that in 2000 ~2009 years, China's telecom industry has higher growth rate than GDP, statistical results as shown in TABLE 2.1. The total average annual growth of telecommunication business is 30%, while the GDP growth rate is around 10%. Telecom value added is the important part of GDP, as seen from TABLE 2.2, since 2001, the telecommunication value added is an important part and telecommunication value added account for more than 2% of GDP (Telecom added value refers to the final results that the telecommunications industry has product both in forms of business or labor production, in the accounting period. Namely, it is the total value that telecommunications industry create for the country), telecom added value in 2006 reached 428 billion yuan, accounted for 2.05% share of GDP.

Advantages and disadvantages of Solow complementary method

Advantage of using solow complementary method to estimated contribution rate of technological advance is obvious, Decomposition in the relevant literature on technological progress Measurement is from Solow (1957). He consider that the growth rate of output that advance in technology contribute is equal to the growth rate of output deducting the contribution that labor and capital make. Solow complementary method avoids complex discussions in the complex discussions of production function and instead, it only concerns about the nature of the function so as to have broad applicability; Solow complementary method coupled with simple calculation, and its intuitive usability of the model is also very strong. But Solow complementary method also has obvious flaws, the contribution of technological progress is the amount of output growth after deducting the residual value of the contribution of labor and capital, which reflects the amount of any residual lead to changes in the production function factor. But in fact, technological progress is not the outside factors except labor and capital which leading to any increase in output. Due to factors solow contained too broad, it is not a true reflection of the reality of technological advances contribution, especially for a transition economy like China[6]. When setting the model we consider the problem. In the next, we estimate contribution rate of telecommunications technology advances to national economic growth by means of Feeder model after amendments in order to make the results more realistic.

ESTIMATE CONTRIBUTION RATE OF TELECOMMUNICATIONS TECHNOLOGY ADVANCES TO NATIONAL ECONOMIC GROWTH BY MEANS OF FEEDER MODEL

Feeder model

In 1983, Feeder (G. Feeder) proposed a two-sector model to calculate the effect that export has in economic growth, which is often referred to Feeder model. In this model, the socio-economic activities are divided into two sectors export and non-export. Feeder's two-sector model is used to estimate the difference of factor productivity between the export and non-export sector, and to measure spillover effects that export has on non-export sector. The contact between the telecommunications industry and other sectors of the economy is very important. Whatever methods to estimate the impact that telecommunication industry has on the national economy have to focus on spillover effects. In view of the direct effect and the spillover effects that telecommunications industry has on economic growth, we will use the Feeder's two-sector model to measure the telecommunications industry's contribution to economic growth. Just as Feeder model, the domestic sector is divided into the telecommunications industry sector and non-telecom sectors[7].

Model enactment of feeder model

Set their production equation for:

$$P = f\left(L_p, K_p\right) \qquad \textbf{(8)}$$

$$N = g\left(L_n, K_n, P\right) \qquad \textbf{(9)}$$

P and N respectively represent the Output of telecom sector and non electric industry department, L and K respectively represent the two major factors of labor and capital Subscript represents the Department, production function(9) suppose, Telecom industry output level P will affect non telecom industry output.

The total amount of Labor (L) and capital (K) can be expressed as:

$$L = L_p + L_n \tag{10}$$

$$K = K_p + K_n \tag{11}$$

Social total product (Y) is the product of two departments, namely:

$$Y = P + N \tag{12}$$

Feeder model will express the relationships between marginal productivity of labor and capital in different sectors:

$$\frac{f_l}{g_l} = \frac{f_k}{g_k} = 1 + \delta \tag{13}$$

f_l represents the marginal output of telecommunications industry division of labor, f_k represents the marginal output of telecommunications industry division of capital, g_l represents the marginal output of non-telecom industry division of labor, g_k represents the marginal output of non-telecom industry division of capital, δ is the difference of marginal production power between the two departments, theoretically it can be greater than, equal to or less than zero. It means a relatively high marginal productivity in telecommunication industry sectors than in non-telecom industry, if δ is great than zero. For (12), make differential on both sides:

$$dY = dN + dP = g_k dK_n + g_l dL_n + g_p dP + (1+\delta) g_k dK_P + (1+\delta) g_l dL_P \tag{14}$$

According to (10), (11), (12), (13), (14), the regression equation can be derived as follows:

$$\frac{dY}{Y} = \alpha \bullet \frac{dK}{Y} + \beta \bullet \frac{dL}{L} + \gamma \bullet \frac{dP}{P} \bullet \frac{P}{Y} \tag{15}$$

(15) Where α , β represents the marginal productivity of capital and labor in non-telecommunications industry sector; γ represents the entire contribution of telecom industry sector to economic growth, $\gamma = \frac{\delta}{1+\delta} + g_p$ ($g_p = \theta \left[\frac{N}{P} \right]$ is the spillover effect of the telecommunications industry) $\frac{dY}{Y}$, $\frac{dL}{L}$ and $\frac{dP}{P}$ are growth rates of the total output, labor and telecommunications industries output; $\frac{P}{Y}$ is the percentage of telecommunications industry output in total output. We treat dK as domestic investment which equals incremental capital stock,due to the incremental capital stock does not exist in the statistics,investment in fixed assets is generally used instead.

So (15) can be rewritten as:

$$\frac{dY}{Y} = \alpha \bullet \frac{I}{Y} + \beta \bullet \frac{dL}{L} + \gamma \bullet \frac{dP}{P} \bullet \frac{P}{Y} \tag{16}$$

Factor productivity parameter γ represents the sum of difference between the two sector and the spillover effect of telecommunications industry. A constant term and a random error term is added to the equation (16), while the random error term assumed to have zero mean and variance of the same characteristics, the equation (16) becomes the desired regression equation.

$$\frac{dY}{Y} = c + \alpha \bullet \frac{I}{Y} + \beta \bullet \frac{dL}{L} + \gamma \bullet \frac{dP}{P} \bullet \frac{P}{Y} + e \tag{17}$$

By equation (17) and estimates of γ , the coefficient of $\frac{dP}{P} \bullet \frac{P}{Y}$, we can obtain for the entire effects telecom industry's has on economic growth.

Feeder model after amendments

In endogenous economic growth model, the accumulation of technology can achieve sustained growth of economy. Both domestic and foreign research literatures show that the contribution to telecom industry growth of technical elements of is relatively large with respect to the labor factor. With reference to the relevant literature, we modified the Feeder model

$$\frac{dY}{Y} = c + \alpha \bullet \frac{dI}{I} + \beta \bullet \exp(\frac{dL}{L}) + \gamma \bullet \frac{dP}{P} + e \tag{18}$$

It should be noted that division of two sectors is a theoretical simplification. Meanwhile, the output of non-telecommunications industry depend on more than the configuration of labor and capital on the department. It also depends on the volume of output in the same period of the telecommunications industry. Thus, there exists a hypothesis: the telecommunications industry sector's economic spillover effects on other sectors take place in the same period. This assumption may not be consistent with the reality, but the use of regression analysis of time series data will not result in large bias.

RESULT AND DISSCUSS

In the model, Y presents gross domestic product (GDP), and GDP is calculated with current price. L represents the number of employees by year-end. We recognize that total fixed asset investment equals to 1, which includes investment in fixed assets of the state-owned economy, collective economy, private economy and other sectors of the economy over the years. As an integrated index, it is a reflection of the scale, speed, direction of investment in fixed assets the annual output of telecommunications industry sector, represents telecommunication traffic. The sample interval is from 1985 to 2009. The data used in the regression model is the time-series data, In order to eliminate large fluctuations of the data, we have to carry out average smoothing process in the raw data. All data come from the China Statistical Yearbook 2005-2010.

TABLE 2 : Regress analysis table based on equation 18

Variable	Coefficient	Std. Error	t-Statistic	Prob.
c	-1.489373	0.746269	-1.995758	0.0598
α ($\frac{dI}{I}$)	0.421117	0.093399	4.508779	0.0002
β ($exp(\frac{dL}{L})$)	1.513244	0.732995	2.064466	0.0522
γ ($\frac{dP}{P}$)	0.098655	0.038088	2.590154	0.0175
R-squared	0.910152	Mean dependent var		0.132777
Adjusted R-squared	0.966675	S.D. dependent var		0.125420
S.E. of regression	0.072410	Akaike info criterion		-2.261920
Sum squared resid	0.104866	Schwarz criterion		-2.065577
Log likelihood	31.14304	Hannan-Quinn criter.		-2.209830
F-statistic	16.33392	Durbin-Watson stat		2.520657
Prob(F-statistic)	0.000013			

We set OLS regression model using Eviews 6.0 statistical software together with data which modified by exponential smoothing. The rate that represnts telecommunications industry's contribution to economic growth is as following. the model estimation results are shown in TABLE 2. In TABLE 2, after significant test on variables, we can see that: growth rate of investment $\frac{dI}{I}$, growth rate of labor supply $\frac{dL}{L}$, growth rate of telecom business volume $\frac{dP}{P}$ is statistically significant (5% significance level). Coefficient of three factors above α, β, γ were 0.421117, 1.513244, 0.098655, adjusted goodness of fit $\text{Adjusted} - R^2$ = 0.966675, the explanatory power of the model is strong.

From the estimated results, what we are more concerned is that γ = 0.098655 which shows that the growth rate of the telecommunications industry's contribution to national economic growth rate is about 9.87%, and that promoting the application of new technologies can effectively improve the telecommunications industry, thus accelerating the growth rate of the national economy.

CONCLUSIONS

Through the empirical research above, we can estimate that the contribution rate of telecommunications technology advances to national economic growth is about 9.87%. The answer is close to the estimates of 10% by Solow complementary method, which validates that our two Empirical researches' conclusions are correct. Thus, advance in telecommunications technology has a remarkably stimulating effect on economic growth, and technological progress and innovation are the fundamental resource of the sustained, rapid and healthy growth of telecommunications industry. So, China should increase investment in new telecommunications technology, such as internet of things, 4G and so on.

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