Prediction of the Surplus Rate of Rural Labor Force in China from 2012 to 2050

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ABSTRACT

At present, total rural labor force is about 450 million in China, accounting for about 74% of the total social labor force. According to incomplete statistics, the current working time of each rural labor force less than 100 days each year, of which about 40% is in the hidden unemployment. A large number of rural surplus labors seriously affected the growth of agricultural productivity and farmers' income, impeded the coordinated development of economy and society in urban and rural areas. Therefore, under the new situation how to effectively estimate hundreds of millions of rural surplus labor is of great practical significance. In the paper, we assume that if the marginal revenue is different in various industries or trades, farmers seeking profit maximization will reach the better situation. We can estimate and predict the surplus rate of rural labor force, regarding the average wage of urban employment workers and agriculture (forestry, animal husbandry, fisheries) workers as the marginal revenue of urban labor force and rural labor force, based on fitting curve of exponential function by SPSS statistical software.

Keywords: Rural Labor Force; Surplus Rate; Marginal Revenue; Average Wage; Fitting Curve

1. Introduction

Labor is the most basic of all social existence and development. All social wealth in any society is engaged in production activities, which is the product of human labor and nature. No agricultural labor, no existence and development of agriculture, then no basis of national economy or society. So the agricultural labor is the key factor of the existence and development of agriculture and national economy and society.

From 1990s, capital elements flow into agriculture, the more labor can be replaced by the capital in the elements structure of agricultural inputs, thus releasing large amounts of rural surplus labor. Furthermore, since the reform and opening up in China, rural surplus labor force piled up for increasing agricultural labor productivity, promoting agricultural technology, shrinking arable land and other factors. Since China realizes the accession to the WTO, the international agricultural market had had a direct impact of China agriculture. The other fundamental reasons are as follows: enormous rural population base, high population growth, resulting in a substantial increase of rural surplus labor, which must be more difficult to solve in China.

At present, in China the rural areas presents typically labor resources is surplus to land resources and other production factors greatly, huge population based on rural labor supply has grown faster than the labor demand in rural economic development. If a large number of surplus rural labor employment can not be properly solved, not only human resources is the huge consumption, but the contradiction of the person and the land will become more prominent, the predatory exploitation of arable land and other resources will become increasingly serious. Therefore, we must reduce the surplus labor in rural areas, increase agricultural productivity, and accelerate the implementation of land scale of operation. In 2007 total arable land area in China is 18.26 billion mu, per capita is only 1 mu, only 1/4 of the world average. In China agricultural productivity is 1/40 of the United States, 1/20 of France, 1/3 of Japan, which is far below the world average. In China two outstanding problem of agricultural production is as follows: the first, land size of agricultural production is too small. Under land system of kinda contracting, the blocks of agri-business land are many and scattered. In mid-1980s, the average scale of operation of agri-business land is 9.3 mu, per household contract land was divided into 9.7. In 1990 average household size was dropped to 8.47 mu, 8.2 per household. Second, the technique of agricultural production is relatively low. In 1998 cultivated land in China is only 53.7% of plowing, 17.7% of mechanized sowing, 9.1% of mechanized harvesting. To transfer out of a large number of rural surplus labor resources reasonably is the premise of to achieve the scale of

operation of agricultural land.

It is necessary to cause further concern and reflection in a whole society, that how to solve the surplus rural labor transfer. If such a large number of labor employment can not be resolved in long-term, it will be bound to jeopardize social stability, it may become a serious obstacle to achieve the scientific development objectives. In China the modernization goal will be realized, the transfer of rural surplus labor is a big issue in any case; even some scholars believe that this is a global and fundamental issue. If the transfer of rural surplus labor can not be put in an important agenda, expanded this situation continuously, relied on spontaneous and disorderly transfer of rural surplus labor, the employment in rural areas will be more die-hard, and seriously impact on economic development and social harmony.

In rural areas there are a large number of rural surplus labor, many experts have different views and estimated number of rural surplus labor, the estimated value is a far cry from more than 40 million to 200 million. But no matter what calculation method is a consensus, the number of rural surplus labor is the number of total rural labor minus the agricultural labor requirements, the key is agricultural labor requirements. Former estimation models of rural surplus labor are as follows:

1.1. Per Capita Agriculture Production Method

To calculate by a variety of total crop production, regarding per capita production without surplus labor in a year as the standard, making the degree of mechanization, fertilizer usage, water use as the factors for the model, required labor = total crop production/per capita production. However, this method is too cumbersome and required too much data that is difficult to calculate [1,2].

1.2. Production Function Method

Based on Cobb-Douglas production function, from two production factors of labor and arable land, for $Y = AL^d K^{(1-d)}$, on both sides to take on several purposes, then $LnY = LnA + dLnL + (1-d) LnK$. According to an important economic characteristics of the surplus agricultural labor force, the marginal productivity of labor is zero, namely the marginal labor productivity of the agricultural output is zero [3-5]. By calculating the regression model of time series we identify the year that the sum of labor and arable land area index is closed to 1 (is generally 1978). The model passes various statistical tests, is a production function including the total agricultural output and agricultural labor, cultivated area, $Y = C \times aLand \times bLab$, where Y is the total output of agriculture, Land is the arable land, Lab is the agricultural labor requirements.

Forecasting in accordance with this method rural labor force will be required to be infinite from 2012 to 2050,

the surplus labor force will be infinitely small, which is impossible as the actual situation, and is more errors as the real data. The model is unreasonable, for mainly the factors are ignored in applying process of the arable land can accommodate the labor force, such as agricultural production (such as the level of agricultural mechanization), multiple cropping index, management degree, water, fertilizer and so on, the conditions envisaged is too simple and idealistic, and should be improved in the future.

1.3. Agriculture Arable Land Law

In the calculation of the agricultural labor force requirements, agricultural natural resources, production and management, and agricultural policies are the main factors to determine the agricultural labor demand. In the natural, social, economic and technical conditions, agricultural resources, especially arable land has a decisive effect on the agricultural labor requirements [6,7]. It should be calculated more reasonably, to regard taking full advantage of the agricultural labor force in 1952 as a fixed period, based on historical data the agricultural labor force is calculated as follows:

$$DLt = St/t,$$
$$Mt = 0.4966 \times (1 + \beta)(t - 1952),$$

where DLt is agricultural labor requirements in year t, St is arable land in year t, Mt is per labor arable land in year t, 0.4966 is per labor average arable land (hectares) from 1949 to 1957, β is the rate of change in cultivated land (describing the impact on agricultural production and technological progress in agricultural productivity), the calculation of β is 0.0018.

2. Prediction Method of the Surplus Rate of Rural Labor Force

Some economists on behalf of Lewis forecast the number of surplus rural labor to consider the employment based on the dual economy in developing countries. Since the reform and opening up in China, rural industrial development has been triple economic structure of agriculture, rural industry and commerce as well as urban industry and commerce side by side. Rural surplus labor mainly presents agricultural surplus labor in rural areas, assuming that farmers' economic behavior is rational behavior in pursuit of profit maximization as the goal, that the mobility cost of labor force between industries is equivalent or negligible. Considering this premise, the farmers rationally allocate their own labor by choosing different regions and industries. As long as the marginal revenue is different in various industries or trades, farmers seeking profit maximization will reach the better situation, and the final equilibrium condition of the optimal labor allocation is that the marginal revenue of labor force is equal

in industries or trades, MR1 = MR2 = ⋯ = MRn or AP1 = of AP2 = ⋯ = APn, where MR is the marginal revenue of the rural agricultural labor force in each industry or trade, the AP is the average price or wage of rural agricultural labor force in each industry or trade.

2.1. Calculating the Marginal Revenue of Labor Force

Marginal revenue of non-agricultural labor force and agricultural labor force in rural areas are respectively represented by the average wage of urban employment workers and agriculture (forestry, animal husbandry, fisheries) workers in China Statistical Yearbook (2010), which totally showed increasing trend year by year. Marginal revenue of agricultural labor force has increased from 1541 yuan to 12,958 yuan from 1990 to 2009. Marginal revenue of non-agricultural labor force has increased from 2140 yuan to 32,244 yuan from 1990 to 2009. We can use fitting curve of exponential function to predict the labor force from 2012 to 2050 by SPSS statistical software.

2.2. Calculating the Surplus Rate of Rural Labor Force

Todaro, a American development economist, made a real flows model of rural labor tending to the urban in 1969. He believes that the determining factors is economic structure differences of rural areas and the urban, transferable rural labor migrating to industrial sectors considers the trade-offs of migration costs and benefits, therefore, the flows power is the difference of the expected income level of the urban and rural areas and urban employment probability. The lure of higher and long-lasting income will attract the transferable rural labor increasingly to crowded urban slums. The view of Todaro is the more stimulating and reference for our calculation method [8].

Labor is a means of people's livelihood, aiming to make a living and improve quality of life, people preferred to high labor remuneration of industry sectors in their re-employment, rather than low labor remuneration of that. Therefore, the supply of agricultural labor was decided by the level of economic benefits, labor income, in the agricultural sectors.

We assume that the expected income is equal to the the annual average wage in the next year, following the migration theory of Todaro, so the calculation formula is as follows:

$$SRL = |MR - MR1|/MR \text{ or } SLR = |AR - AR1|/AR$$

where SRL is the surplus rate of rural labor force, MR1 is the expected income of agricultural labor force, MR is the expected income of non-agricultural labor force, AR1 is the annual average wage of agricultural labor force, AR is the annual average wage of non-agricultural labor force.

3. Calculations of the Surplus Rate of Rural Labor Force

3.1. Prediction of Marginal Revenue of Agricultural Labor Force

We can get the average wage of agricultural workers (forestry, animal husbandry, fisheries) from 1952 to 2009 in China Statistical Yearbook (2010) [9], and draw a sequence diagram by SPSS statistical software as shown in **Figure 1**.

According to the sequence tendency in **Figure 1**, we use exponential function, $Y = aX^{bt}$, to fit the average wage of agricultural workers by SPSS statistical software, the results are as follows:

From the above **Tables 1** and **2**, we can see R = 0.990, $R^2 = 0.981$, Sig = 0.000, then conclude that exponential function fits well [10,11]. The concrete fitting curve is shown in **Figure 2**.
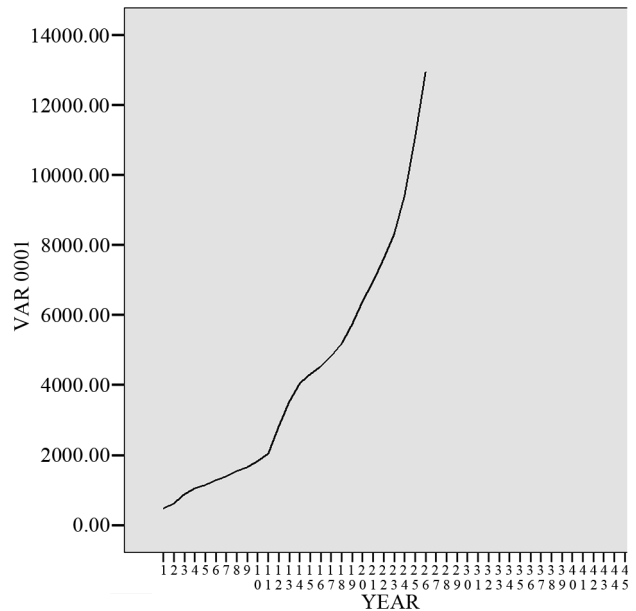

Figure 1. The average wage sequence of agricultural labor force.

Table 1. Model summary of the sequence.

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.990	0.981	0.980	0.131

Table 2. ANOVA of the sequence.

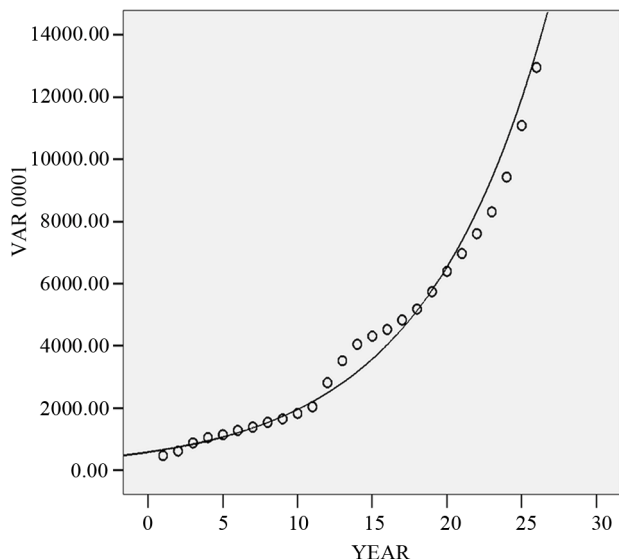|	Sum of Squares	df	Mean Square	F	Sig.
Regression	21.307	1	21.307	1244.999	0.000
Residual	0.411	24	0.017		
Total	21.718	25			

Figure 2. Fitting the average wage of agricultural labor force.

From the above **Table 3**, fitting function of the marginal revenue of agricultural labor force can be got as follows:

$$Y=585.027 \times X^{0.121 \times t} \qquad (1)$$

Using the above fitting function (1), the marginal revenue of agricultural labor force can be forecasted from 2012 to 2050 as shown in **Table 4**.

3.2. Prediction of Marginal Revenue of Non-Agricultural Labor Force

We can get the average wage of urban employment workers from 1978 to 2009 in China Statistical Yearbook (2010) [8]. As the method of forecasting the marginal revenue of agricultural labor force, we use exponential function, $Y=aX^{bt}$, to fit the average wage of urban employment workers by SPSS statistical software, the results are as follows: $R = 0.967$, $R^2 = 0.935$, Sig = 0.000. The concrete fitting curve is shown in **Figure 3**, further from the **Table 5**, the fitting function of the marginal revenue of agricultural labor force can be got as follows:

$$Y=221.734 \times X^{0.104 \times t} \qquad (2)$$

Using the above fitting function (2), the marginal revenue of non-agricultural labor force can be forecasted from 2012 to 2050 as shown in **Table 6**.

3.3. Prediction of the Surplus Rate of Rural Labor Force

The formula of the surplus rate of rural labor force is as follows:

$$SRL = \left| AR - AR1 \right| / AR ,$$

where SRL is the surplus rate of rural labor force, AR1 is the annual average wage of agricultural labor force, AR

is the annual average wage of non-agricultural labor force, the results can be seen from **Table 7**.

Table 3. Coefficients of the fitting function (1).

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Case Sequence	0.121	0.003	0.990	35.285	0.000
(Constant)	585.027	30.906		18.929	0.000

The dependent variable is ln(VAR00001).

Table 4. Prediction of the marginal revenue of agricultural labor force.

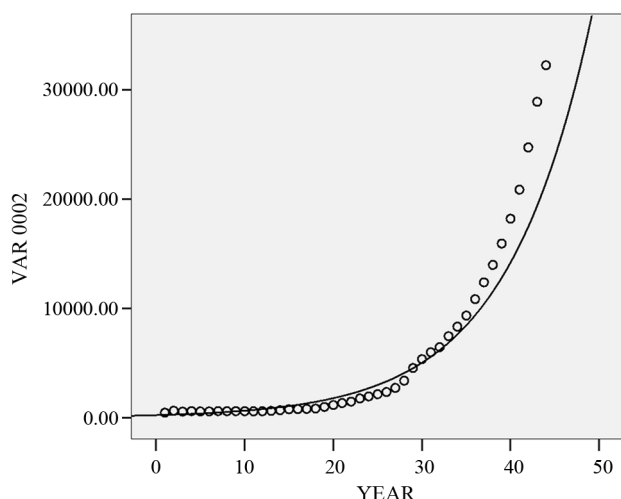| Time	The average wage of agricultural labor force (yuan)
2012	22063.02
2013	24900.87
2014	28103.74
2015	31718.58
2016	35798.38
2017	40402.95
2018	45599.77
2019	51465.04
2020	58084.73
2021	65555.87
2022	73987.99
2023	83504.68
2024	94245.47
2025	106367.8
2026	120049.3
2027	135490.7
2028	152918.1
2029	172587.2
2030	194786.2
2031	219840.6
2032	248117.6
2033	280031.7
2034	316050.7
2035	356702.7
2036	402583.6
2037	454365.9
2038	512808.6
2039	578768.6
2040	653212.6
2041	737232.1
2042	832058.5
2043	939081.9
2044	1,059,871
2045	1,196,197
2046	1,350,058
2047	1,523,709
2048	1,719,696
2049	1,940,892
2050	2,190,539

Figure 3. Fitting the average wage of non-agricultural labor force.

Table 5. Coefficients of the fitting function (2).

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Case Sequence	0.104	0.004	0.967	24.602	0.000
(Constant)	221.734	24.209		9.159	0.000

The dependent variable is ln(VAR00001).

Seen from **Table 7**, applying the exponential function to fit the average wage data, we find that the surplus rate of rural labor force is decreasing year by year from 2012 to 2029, and reaches the minimum in 2029, 0.00118, which implies the marginal revenue of agricultural and non-agricultural labor force tends to be balance in 2029, namely rural labor force stop seeking the profit maximization to migrate to urban.

We predict the surplus rate of rural labor force resumes increasing after 2029, the rural labor force may remain in the rural areas during the process of the urbanization of China.

4. Conclusion

At present, the contradiction of total supply and demand of rural surplus labor force is intertwined in China, and the total supply is greater than the demand, but it is more serious that the skills of rural surplus labor force can not match with industrial structure changes. Migrant worker are a very special group of the urbanization process in China. So we want to know how many is the labor force transferred from rural area? What is the population structure of the rural labor force remaining in rural area? Whether or not transferable rural labor supports new rural construction and meets the needs of agricultural development. In the long run, the supply capacity of trans-

Table 6. Prediction of the marginal revenue of non-agricultural labor force.

Time	The average wage of non-agricultural labor force (yuan)
2012	29421.43[*]
2013	32646.03[*]
2014	36224.05
2015	40194.22
2016	44599.52
2017	49487.65
2018	54911.52
2019	60929.85
2020	67607.79
2021	75017.63
2022	83239.6
2023	92362.7
2024	102485.7
2025	113718.2
2026	126181.7
2027	140011.3
2028	155356.6
2029	172383.8
2030	191277.1
2031	212241.2
2032	235502.9
2033	261314.1
2034	289954.3
2035	321733.4
2036	356995.5
2037	396122.4
2038	439537.6
2039	487711.1
2040	541164.4
2041	600476.3
2042	666288.8
2043	739314.3
2044	820343.5
2045	910253.5
2046	1,010,018
2047	1,120,716
2048	1,243,547
2049	1,379,840
2050	1,531,072

[*]Due to fitting error of the constant, the forecast value is lower than the actual value.

ferable rural labor from rural area to the urban is also the important factors of the industrialization and urbanization of China. Therefore, dynamic changes of transferable rural labor must be paid sustained attention and researched deeply, which has an important significance to improve the relative policy of decision making departments, aiming to establish the personnel compatible with the economic and social development.

Table 7. Calculations of the surplus rate of rural labor force.

Time	Absolute difference of the average wage	the surplus rate of rural labor force（%）
2012	7358.41	0.250104
2013	7745.16	0.237247
2014	8120.31	0.224169
2015	8475.64	0.210867
2016	8801.14	0.197337
2017	9084.7	0.183575
2018	9311.75	0.169577
2019	9464.81	0.155339
2020	9523.06	0.140857
2021	9461.76	0.126127
2022	9251.61	0.111144
2023	8858.02	0.095905
2024	8240.23	0.080404
2025	7350.4	0.064637
2026	6132.4	0.0486
2027	4520.6	0.032287
2028	2438.5	0.015696
2029	**203.4**	**0.00118**
2030	3509.1	0.01835
2031	7599.4	0.03581
2032	12614.7	0.05356
2033	18717.6	0.07163
2034	26096.4	0.09
2035	34969.3	0.10869
2036	45588.1	0.1277
2037	58243.5	0.14703
2038	73,271	0.1667
2039	91057.5	0.1867
2040	112048.2	0.20705
2041	136755.8	0.22775
2042	165769.7	0.2488
2043	199767.6	0.27021
2044	239527.5	0.29198
2045	285943.5	0.31414
2046	340,040	0.33667
2047	402,993	0.35959
2048	476,149	0.3829
2049	561,052	0.40661
2050	659,467	0.43072

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REFERENCES

[1] C. Wang, "Employment Transition in China: From Hidden Unemployment and under Employment to the Efficiency Employment," *Economic Research*, No. 5, 1996, pp. 38-46.

[2] T. Rawski, "On the Number of Agricultural Labor Force in China," *China Rural Survey*, No. 4, 1997, pp. 28-39.

[3] H. L. Wang, "Empirical Analysis on the Estimation of the Number of Agricultural Surplus Labor," *Economic Research*, No. 4, 1998, pp. 52-59.

[4] F. Y. Hou, "Empirical Analysis on the Surplus Scale and Mobility Scale of Rural Labor Force in China," *China Rural Economy*, No. 3, 2004, pp. 13-21.

[5] R. J. Wang, "Actively Exploring New Ways of Surplus Labor Transfer in China," *Theoretical Study*, No. 1, 2004, pp. 5-7.

[6] H. Y. Chen, Z. L. Li and T. Wu, "Structural Model and Optimization of the Transfer of Agricultural Surplus Labor," *Productivity of the System*, No. 1, 1997, pp. 11-13.

[7] J. J. Liu, "Transfer of Rural Labor and Non-formal Employment Opportunities," *Economic Information Daily*, Vol. 12, No. 24, 2003, p. 5.

[8] M. P. Todaro, "A Model of Labor Migration and Urban Unemployment in Less Developed Countries," *American Economic Review*, No. 59, 1969, pp. 138-148.

[9] National Bureau of Statistics, "China Statistical Yearbook," *China Statistics Press*, Beijing, 2010.

[10] L. Z. Li, "Age Structure and Gender-specific Population Growth Mode," *Journal of Xuzhou Normal University (Natural Science)*, Vol. 26, No. 2, 2008, pp. 124-127.

[11] L. X. Yang, G. S. Yang and S. F. Yuan, "Mathematical Models in Population Prediction, for Example as Jiangsu Province," *Changsha Resources and Environment*, Vol. 15, No. 3, 2006, pp. 288-290.

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