Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 13 (19): 3921-3925, 2013
ISSN 1812-5654 / DOI: 10.3923/jas.2013.3921.3925

Estimation and Forecast of the Agricultural Surplus Labor Force in China from 2012 to 2040

[1]Wei Wang, [2]Weishuang Qu, [3]Zhihao Wang and [3]Chang Liu
[1]School of Graduate,
[2]School of Economics, Harbin University of Commerce, People's Republic of China
[3]Model Laboratory, Millennium Institute, United State of America

Abstract: Since the reform and opening up in China, the transfer of rural surplus labor force has made great achievements but there were some difficulties that can not be ignored. From an objective perspective, at present there were a large number of rural surplus labor forces in China rural areas, who are not high quality, strong farmer's mentality and monotonic diversion channels, resulting in so slow transfer process. In the study, it was firstly assumed that if the marginal revenue is different in various industries or trades, farmers seeking profit maximization will reach the better situation. The second, the surplus rate of agricultural labor force can be calculated by SPSS statistical software. The average wage of urban employment workers was regarded as the marginal revenue of non-agricultural labor force. The average wage of agriculture (forestry, animal husbandry, fisheries) workers was regarded as the marginal revenue of agricultural labor force in rural areas. The exponential function was used to fit the time series of the average wage. Finally, the agricultural surplus labor force was estimated and forecasted in China from 2012 to 2040.

Key words: Surplus rate, agricultural labor force, marginal revenue, average wage, curve fitting

INTRODUCTION

Labor resources is currently excess to land resources and other production factors evidently in China rural areas, generous population based on rural labor supply has grown more quickly than demand for labor in rural economic development. If a large supply of rural labor is not employed well, not only human resources is the enormous consumption, but the person and the land may contradict each other prominently, the brutal exploitation of arable land and other resources will become more and more critical. Therefore, the imperative thing should be to 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 one 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. Second, the technique of agricultural production is relatively low. 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 develops continuously and disorderly, the employment in rural areas will be extremely severe, thus negatively impacting 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 40-200 million. But no matter what calculation method is a consensus, the number of rural surplus labor = the number of total rural labor-agricultural labor requirements, the key is agricultural labor requirements.

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

Corresponding Author: Zhihao Wang, School of Economics, Harbin University of Commerce, People's Republic of China

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 (Rawski, 1997; Wang, 1996; Wang and Zhao, 2012; Wang *et al*., 2012).

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. By calculating the regression model of time series, the year was identified that the sum of labor and arable land area index is closed to 1 (is generally 1978). The model, Y = C×aLand×bLab, that has passed various statistical tests is a production function, where Y is the total output of agriculture, land is the arable land, lab is the agricultural labor requirements (Fengyun, 2004; Dimova and Wolff, 2011; Wang, 1998, 2004; Zhong *et al*., 2008).

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 because several main factors (such as agricultural production, multiple cropping index, management degree, water and fertilizer) that are associated with the arable land and the labor force are not taken into account. Therefore this model should be further improved in the future.

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 (Chen *et al*., 2012; Liu, 2003; Manuel, 2012; Yao *et al*., 2010). It should be calculated more reasonably, to regard 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:

$$Dlt = St/Mt$$

$$Mt = 0.4966\times(1+\beta)\ (t-1952)$$

In the above first formula, DLt is agricultural labor requirements, St is arable land, Mt is per labor arable land in year t. In the second formula, 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) and the calculation of β is 0.0018.

Based on the former estimation model and method, the surplus rate of agricultural labor force was calculated to estimate and forecast the agricultural surplus labor force from 2012 to 2040 in the study. The results will provide reference for the urbanization of the population and implement decision support for the government policy adjustment.

CALCULATION MODEL AND METHOD OF THE AGRICULTURAL SURPLUS 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 varies in different industries or trades, farmers will seek profit maximization in order to reach a better living condition. The final equilibrium condition of the optimal labor allocation is that the marginal revenue of labor force is the same in various industries or trades (Maroufy and Final, 2009; Darwish, 2007; Fengyum, 2004). The function of the final equilibrium condition is MR1 = MR2 =...= MRn or AP1 =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.

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 in 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.

Calculating the surplus rate of agricultural labor force: The calculation equation is as follows:

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

where, SLR is the surplus rate of agricultural labor force, MR1 is the marginal revenue of agricultural labor force, MR is the marginal revenue 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.

Estimating the agricultural surplus labor force: The calculation formula is as follows:

$$Slt = SLRt \times Lt$$

where, SLt is the amount of agricultural surplus labor force in year t, SLRt is the surplus rate of agricultural labor force in year t, Lt is the amount of total agricultural labor force in year t.

CALCULATIONS AND FORECASTING OF THE SURPLUS RATE AND AGRICULTURAL SURPLUS LABOR FORCE

Forecasting marginal revenue of non-agricultural labor force (2012-2040): The average wage of urban employment workers can be get from 1952 to 2009 in China Statistical Yearbook in 2010. The solid line with a real sequence was drawn by SPSS statistical software as shown in Fig. 1.

According to the sequence tendency in Fig. 1, the exponential function, $Y=aX^{bt}$, was used to fit by SPSS statistical software, the results are as following.

Table 1 shows the exponential model description, including model name, dependent variable, equation, independent variable, constant and so on.

$R = 0.967$, $R^2 = 0.935$, $F = 605.255$, $Sig = 0.000$ can be seen from the above Table 2 and 3, then the conclusion is that exponential function fits well. The dotted line with a fitting sequence was also shown in Fig. 1.

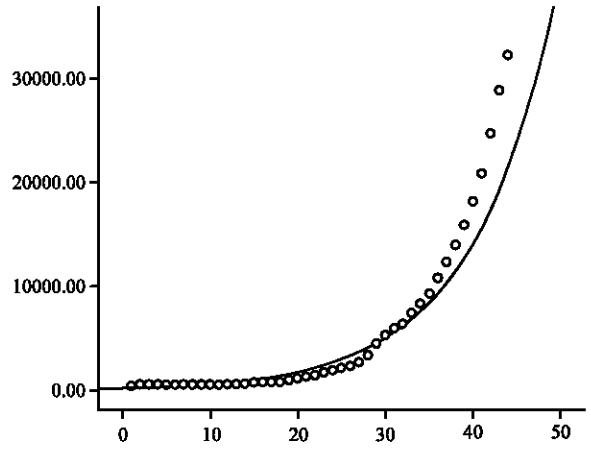

Fig. 1: Average wage sequence of non-agricultural labor force and its fitting curve

Table 1: Fitting exponential model description

Model name		MOD_4
Dependent variable	1	VAR00001
Equation	1	Exponential(a)
Independent variable	Case sequence	
Constant	Included	
Variable whose values label observations in plots		Unspecified

a: The model requires all non-missing values to be positive

Table 2: Fitting exponential model summary

R	R Square	Adjusted R square	Std. error of the estimate
0.967	0.935	0.934	0.356

Table 3: ANOVA of fitting exponential model

Variables	Sum of squares	df	Mean square	F	Sig.
Regression	76.691	1	76.691	605.255	0.000
Residual	5.322	42	0.127		
Total	82.013	43			

Table 4: Coefficients of fitting exponential model

	Unstandardized coefficients		Standardized coefficients		
Variables	B	Std. error	Beta	t	Sig.
Case sequence	0.104	0.004	0.967	24.602	0.000
(Constant)	221.734	24.209		9.159	0.000

From the above Table 4, fitting function of the marginal revenue of non-agricultural labor force can be get as follows:

$$Y = 221.734 \times X^{0.104 \times t}$$

Using the above fitting function, the marginal revenue of non-agricultural labor force can be forecasted from 2012 to 2040 as shown in Table 5.

Forecasting marginal revenue of agricultural labor force (2012-2040): The average wage of agricultural labor force (forestry, animal husbandry, fisheries) can be get from 1978-2009 in China Statistical Yearbook in 2010.

Table 5: Forecasting of the marginal revenue of non-agricultural labor force

Time	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	83239.60
2023	92362.70
2024	102485.70
2025	113718.20
2026	126181.70
2027	140011.30
2028	155356.60
2029	172383.80
2030	191277.10
2031	212241.20
2032	235502.90
2033	261314.10
2034	289954.30
2035	321733.40
2036	356995.50
2037	396122.40
2038	439537.60
2039	487711.10
2040	541164.40

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

Table 6: Forecasting of the marginal revenue of agricultural labor force

Time	Average wage of non-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	106367.80
2026	120049.30
2027	135490.70
2028	152918.10
2029	172587.20
2030	194786.20
2031	219840.60
2032	248117.60
2033	280031.70
2034	316050.70
2035	356702.70
2036	402583.60
2037	454365.90
2038	512808.60
2039	578768.60
2040	653212.60

Table 7: Forecasting of the surplus rate and the agricultural surplus labor force

Time	Absolute difference of the average wage	Srplus rate of agricultural labor force (%)	Ttal agricultural labor force	Aricultural surplus labor force
2012	7358.41	0.250104	4.43E+08	1.11E+08
2013	7745.16	0.237247	4.37E+08	1.04E+08
2014	8120.31	0.224169	4.31E+08	96607658
2015	8475.64	0.210867	4.25E+08	89578961
2016	8801.14	0.197337	4.18E+08	82549506
2017	9084.70	0.183575	4.11E+08	75395951
2018	9311.75	0.169577	4.01E+08	68019850
2019	9464.81	0.155339	3.90E+08	60509046
2020	9523.06	0.140857	3.80E+08	53502943
2021	9461.76	0.126127	3.70E+08	46671374
2022	9251.61	0.111144	3.61E+08	40106613
2023	8858.02	0.095905	3.50E+08	33584767
2024	8240.23	0.080404	3.37E+08	27060512
2025	7350.40	0.064637	3.25E+08	21005065
2026	6132.40	0.048600	3.13E+08	15231647
2027	4520.60	0.032287	3.03E+08	9781338
2028	2438.50	0.015696	2.94E+08	4606904
2029	203.40	0.001180	2.83E+08	333839
2030	3509.10	0.018350	2.73E+08	5017444
2031	7599.40	0.035810	2.64E+08	9453114
2032	12614.70	0.053560	2.56E+08	13692498
2033	18717.60	0.071630	2.48E+08	17748656
2034	26096.40	0.090000	2.40E+08	21626982
2035	34969.30	0.108690	2.33E+08	25353473
2036	45588.10	0.127700	2.27E+08	28933546
2037	58243.50	0.147030	2.20E+08	32327825
2038	73271.00	0.166700	2.13E+08	35517174
2039	91057.50	0.186700	2.07E+08	38579650
2040	112048.20	0.207050	2.00E+08	41500146

As the above way of calculating the marginal revenue of non-agricultural labor force, the fitting function of the marginal revenue of agricultural labor force can be get as follows:

$$Y = 585.027 \times X^{0.121 \times t}$$

Using the above fitting function, the marginal revenue of agricultural labor force can be forecasted from 2012 to 2040 as shown in Table 6.

Forecasting the surplus rate and the agricultural surplus labor force (2012-2040): The equation of the surplus rate of agricultural labor force is as follows:

$$SLR = |AR-AR1|/AR$$

where, SLR is the surplus rate of agricultural 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 shown in Table 6 as following.

Seen from Table 7, the surplus rate of agricultural labor force is decreasing year by year from 2012 to 2029 and achieves the minimum, 0.00118, namely the marginal revenue of agricultural and non-agricultural labor force tends to be balance. The surplus rate of rural labor force resumes increasing after 2029.

Seen from Table 7, the agricultural surplus labor force in rural areas is decreasing year by year from 2012 to 2029, the amount of agricultural surplus labor force tends to achieve the minimum, 333839. Although the agricultural surplus labor force resumes increasing after 2029, the non-agricultural labor force may not migrant to rural areas, namely the rural labor force may stay their place during the process of the urbanization in China. The results are basically the same as the prediction trend of previous studies but this study presents the specific turning point year and the actual quantity of surplus labor force.

CONCLUSION

In this study, the surplus rate of rural labor force was estimated and forecasted, then the surplus labor force of rural areas was calculated in China. At present, the contradiction of total supply of rural surplus labor force is intertwined with its total demand in China. It presents more serious the supply is greater than the demand and the quality of rural surplus labor force can not match with industrial structure needs. The surplus labor force is a very special group of the urbanization process, so it should be known how many is the labor force transferred from rural areas. Whether or not transferable rural labor force supports new rural construction and meets the needs of agricultural development. In the long run, the supply capacity of transferable rural labor from rural areas 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 policies decision making of relative rural areas.

ACKNOWLEDGMENT

This study is partially supported by the Humanities and Social Sciences Fund of Ministry of Education under Grant 12YJC790190 and NSFC under Grant 71240007 in China, the Social Science Foundation under Grant 08C066, the Youth Science Technology Foundation under Grant QC07C117 in Heilongjiang Province in China. Thanks for the help.

REFERENCES

Chen, Z., Q. Chen and Y. Li, 2012. Empirical study on the influence of rural labor transfer upon rural economic development in China Jiangxi-based on industrial structure deviation. J. Serv. Sci. Manage., 5: 180-186.

Dimova, R. and F.C. Wolff, 2011. Do downward private transfers enhance maternal labor supply? evidence from around Europe. J. Population Econ., 3: 911-933.

Fengyun, H., 2004. Empirical analysis on the surplus scale and mobility scale of rural labor force in China. Chin. Rural Econ., 3: 13-21.

Liu, J.J., 2003. Transfer of rural labor and non-formal employment opportunities. Econ. Inform. Daily, 12: 5-5.

Manuel, A.G., 2012. Equilibrium dynamics in the neoclassical growth model with habit formation and elastic labor supply. Theoretical Econ. Lett., 5: 465-469.

Rawski, T., 1997. On the number of agricultural labor force in China. China Rural Survey, 4: 28-39.

Wang, C., 1996. Employment transition in China: From hidden unemployment and under employment to the efficiency employment. Econ. Res., 5: 38-46.

Wang, H., 1998. Empirical analysis on the estimation of the number of agricultural surplus labor. Econ. Res., 4: 52-59.

Wang, R.J., 2004. Actively exploring new ways of surplus labor transfer in China. Theor. Study, 1: 5-7.

Wang, W. and D. Zhao, 2012. Investigation on employment conditions of domestic workers in China. China Popul. Resour. Environ., 5: 192-194.

Wang, W., J. Wang and Z. Wang, 2012. Prediction of the surplus rate of rural labor force in China from 2012 to 2050. Modern Economy, 3: 557-562.

Yao, S.B., Y.J. Guo and X.X. Huo, 2010. An empirical analysis of the effects of China's land conversion program on farmers income growth and labor transfer. Environ. Manage., 3: 502-512.

Zhong, T.Y., X.Y. Zhang and X.J. Huang, 2008. Impact of labor transfer on agricultural land use conversion at rural househ old level based on logit model. Chin. Geographical Sci., 4: 300-307.