Labour Productivity and the Incidence of Surplus Labour: Experience from Chinese Agriculture during Reform[1]

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Abstract

Dualism has long been regarded as a major distinguishing characteristic of the economies of many developing countries. Since the late 1970s, the rural economy of China has experienced enormous changes. The expansion of rural non-agricultural production – in particular, the rapid growth of rural enterprises - has been a remarkable feature of China's development trajectory. The buoyant performance of these enterprises has benefited from the huge supply of surplus agricultural labour. This paper seeks to compare the labour productivities of agriculture and non-agriculture in rural China and to quantify the extent of such surplus labour.

The paper contributes to the pool of studies of rural underemployment and revisits a number of estimates of surplus agricultural labour, including the labour-norm approach and the marginal productivity method. With the newly revised data through various censuses, this study is devoted to the conceptualization, identification and measurement of surplus at national, regional and provincial levels by a stochastic frontier functional specification. Significant assessment will be provided for estimates under different approaches. More importantly, the impact of policies of agricultural reform on the growth of labour productivity and the issue of surplus labour will be critically examined.

The analysis throws light on ways in which the continued existence of the household registration (*hukou*) system and China's accession to the WTO has affected labour mobility and potentially beneficial labour transfers in China. We note, however, that the new government policies on developing "socialist new countryside" may affect the labour migration in the coming decades.

JEL Classification: J64, O53, R23
Keywords: Surplus labour, Agriculture, China

Introduction

China has around 480 million labours in its countryside in 2006, a 57 percent more than that of 1978. Amongst, 299 million were in agriculture.[2] With just 127 million hectare of arable land,[3] Chinese countryside seems not able to support peasants to have their farm jobs. Together with the development of rural enterprises and other non-agricultural sectors, many of those are engaged in all these formal and informal activities since the economic reform initiated in the late 1970s. The issue of how many of them are working in the non-agricultural production and how many on farming are of interest to many policy makers. Yet, the subject of those being treated as surplus labour remains a mystery and attracts academic interest.

The paper contributes to the pool of studies of rural underemployment and revisits a number of estimates of surplus agricultural labour, including the labour-norm approach and the marginal productivity method. With the newly revised data through various censuses, this study is devoted to the conceptualization, identification and measurement of surplus at national, regional and provincial levels by various theoretical specifications.

Agricultural Labour after Reform

Dualism has long been regarded as a major distinguishing characteristic of the economies of many developing countries.

Until as recently as the mid-1980s, China's economy was fundamentally agricultural. Long before the twentieth century, more than 70 percent of the total population were involved in some kind of agricultural activity.[4] Among factor inputs, labour and land have for centuries dominated production processes. Between 1978 and 2005 alone, the rural labour force increased by 77 percent.[5]

Rural China appears to fit the dualistic framework reasonably well.[6] Before 1978, the collectivised institutional framework of agriculture was an effective mechanism for controlling the huge rural population, in accordance

2 2005 figure.
3 2001 figure.
4 See Lamb (1934).
5 Calculation based on *ZGTJNJ 2007*, Table 13-4.
6 See Putterman (1992), pp.4-5.

with the strategic imperative of prioritising heavy industrial development. However, with the modification of this strategy at the end of 1970s, rural enterprises (mainly industrial enterprises) were the main non-agricultural activity that 'absorbed' rural labour, and the peasants were more effective in engaging farming activities under various forms of household responsibility system.[7]

Since the rural reforms, labour has become more mobile than before, making temporary migration possible, even under the official household registration system (*hukou*). The strategy of "leaving the land soil but not the countryside" (*litu bu lixiang*) allows people leaving farm crops and to engage in non-agricultural activities in the countryside, or in neighbouring areas. There are two effects. Firstly, labour has been relatively freer to choose between farming and non-farm work, relieving man-land pressure in most parts of rural China. Secondly, the rapid growth of rural enterprises (especially industrial enterprises) has benefited from the huge labour supply, providing job opportunities to surplus labour and increasing the income of rural population.

Having become a member of WTO in 2001, China faces challenges in sectors demanding higher degree of openness. Agriculture is one of them. The most obvious has been the steady continuing contraction of the cropping sector, since such activities offer relatively low returns to Chinese peasants. Since crops are still the major component in agriculture, increasing pressure to release more redundant labour can be expected and this is reflected in the continuous decline of labour participating in agriculture. Eventually, peasants in the poor countryside received relatively smaller investments for farming. Therefore low-incomed peasants will be even less competitive in a more market-oriented farm sector (because richer peasants benefit more on the price reduction of inputs), with China's WTO accession enacted. Thus income inequality in rural areas will inevitably increase, at least in the short run.

Surplus Labour in Concept

There are several definitional issues concerning the terms 'surplus labour', 'labour surplus', 'disguised unemployment' and 'underemployment'.

While Robinson[8] was probably the first to introduce the concept of *disguised unemployment*, Eckaus made a systematic analysis of the relationship

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7 The most significant arrangement is the *Baogan Daohu* (contracting everything to households).

8 See Robinson (1936).

between technological constraints and surplus labour. Disguised unemployment exists, he argued, when "with agricultural technology remaining unchanged, withdrawal of farm labour would not reduce output".[9] This is because labour is in surplus and more labour-intensive techniques are not available. Eckaus believed that there is some minimum capital-labour ratio even under the most labour-intensive agricultural process. Unfortunately, many developing economies have less capital than is required to utilise their labour and therefore a part of the available supply of labour is unused. In other words, he explains the persistence of surplus labour in terms of the limited technical substitutability of factor inputs in agriculture. China's Great Leap Forward (1958) illustrates this proposition. Although China possessed abundant labour at that time, industrial output did not increase significantly since China failed to meet the minimum capital labour ratio, eliminating the possibility of substitution between labour and capital, even in circumstances when labour was abundant.

Nurkse, on the other hand, defined labour surplus as the zero marginal product of labour when organisational changes are introduced.[10] Georgescu-Roegen pointed out that, under feudalistic farming or individual peasant holdings, employment of the peasant family is governed by maximising total family output rather than by the principle of marginal productivity.[11] Thus, output maximisation is prevalent in most underdeveloped agriculture and this is a reason for the existence of massive underdevelopment.

Lewis was perhaps the first development economist initiated the concept of surplus labour, or in his term – the "unlimited supply of labour". Lewis coined the term labour surplus[12] in both the traditional and modern sectors. His interpretation was to view the concept of labour surplus in terms of the existence of a greater than zero wage when the marginal product of labour was zero. In traditional peasant agriculture, each family member receives an average product regardless of his / her contribution. Since there are no opportunities for receiving a wage higher than the average product, there is no motivation to leave the farm and the average product will exceed marginal product.

The assumption of zero marginal product of labour in the traditional sector ($MP_L \approx 0$) gave rise to considerable debate. Firstly, the implication of zero marginal product is that the cost of labour absorption by the modern sector

9 See Eckaus (1955), pp.539-565.

10 See Nurkse (1953).

11 See Georgescu-Roegen (1963).

12 See Lewis (1954, 1955).

can be minimised. In reality, however, such a transfer might entail a positive opportunity cost,[13] since the modern sector requires a work force with at least some minimum degree of expertise. Yet, empirical research does not provide an unambiguous answer to this question. Secondly, the marginal product of labour could be far more than zero during the harvesting season, even though it may be zero at other periods. In other words, the question of seasonality was not addressed carefully by Lewis. Mehra, for example, has pointed out that during sowing and harvesting seasons, demand for labour is higher than at the other times.[14] Thirdly, Lewis associated a zero marginal product of labour with the marginal product of a worker, whereas others have related it to a man-hour.[15] Lewis responded to this through the example of market stalls, arguing that "they are crowded with people who are not as fully occupied as they would wish to be, and therefore if a certain percentage of them were removed, the amount traded would be the same, since those remained would do more trade".[16] Fourthly, the 'unlimited supply of labour', which is related to zero marginal productivity, has also been the subject of prolonged debate. Here, Lewis noted that 'unlimited' implies that if producers in the modern sector offer additional employment at the level of existing wages, there will be far more workers than they require – in other words, the supply of labour is highly elastic at the current wage.[17]

In response to the criticism of the concept of zero marginal product of labour, Lewis stated:

> "whether marginal productivity is zero or negligible is not at the core of fundamental importance to our analysis. It was probably a mistake to mention marginal productivity at all, since this has merely led to an irrelevant and intemperate controversy".[18]

Most economists define labour surplus in terms of conditions that exist when a portion of the labour force can be removed without causing a reduction in output. It is my opinion that the assumption of zero marginal productivity is most useful as a device to facilitate analytical clarity, suggesting that the marginal output of labour in agriculture in relevant LDCs is very low or even zero. This assumption offers a convenient measure of how the MP_L is increasing

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13 Such as that associated with minimal training for the surplus labour.

14 See Mehra (1966), p.35.

15 See Lewis (1972). P.78.

16 Ibid.

17 Ibid, p.77.

18 Ibid, p.77; Lewis (1954), p.142.

in these developing economies by comparing the trends of marginal products over time.

Measuring Surplus Labour

Comprehensive measurement of the size of surplus labour in China has not been systematic, although efforts have been made by scholars such as Taylor, Wang, Cook, and Yang & Tisdell.[19] Three broad approaches have been used before the 1990s to measure the size of the surplus labour. They are:

- experience method (*jingyanfa*),
- estimation method (*gusuanfa*),
- labour norm method (*laoliding'efa*).

The *experience method (jingyanfa)* is the most traditional approach, and required production team leaders[20] to estimate average labour-hour requirements for agricultural production within their villages. The amount of surplus is obtained by comparing these estimates with actual labour hours [i.e. hours actually worked]. This approach was quite simple to apply to pre-1978 farm conditions.

The *estimation method (gusuanfa)* seeks to determine labour requirements on the basis of a land-labour ratio, designed for a particular year. A comparison is then made, on the basis of this land-labour ratio, between real labour and labour norms associated with the benchmark year, in order to derive the amount of surplus labour. An example of this method is in Guo's analysis.[21] He first calculated the ratio of real agricultural labour to sown area, S. He then estimated the ratio of agricultural labour, R, to sown area at its optimum level,[22] where R is labour use in the benchmark year. Guo assumed that China had attained its highest productivity in terms of land use and labour use in 1957. He further claimed that total agricultural productivity after 1957 was mainly contributed by capital.[23] The new entrants into the labour force since 1957 could be regarded as surplus. According to Guo's estimate, China's labour surplus was about 20 percent of agricultural labour in the 1960s and increased

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19 See Taylor (1993), Wang (1994), Cook (1996) and Yang & Tisdell (1991).

20 Before 1978, rural China was organised in the form of the commune system. The production team was the lowest in the commune hierarchy, and was responsible for organising most agricultural work.

21 See Guo (1993) and Guo & Hu (1991).

22 The sown area at its optimum could be interpreted as the land being used at its largest capacity.

23 See Guo & Hu (1991), p.146.

to 40 percent in the 1980s. The primary criticism of Guo's study lies in the choice of 1957 as the benchmark year – something that Guo fails to explain.

The third approach is the *labour norm method (laoliding'efa)*. This technique, instead of choosing a base year for efficient labour use, requires calculation of total labour requirements and derives the surplus by subtracting these from the actual labour used. Total labour requirements could be obtained by three different ways:[24]

$$D^L = \frac{La}{X} = \frac{Z}{300} = \frac{A}{a} \qquad \text{... (1)}$$

where D^L : labour demand for agriculture; La : total arable land, X : per labourer arable land, Z : sum of arable land and labour required per hectare for each crop, A : values of agricultural output, and a : per capita agricultural output

An initial attempt using this framework was made by Song,[25] who conducted a detailed investigation of the labour force in Nantong county of Jiangsu province in 1981. His calculation was derived as follows:

$$G = \frac{A - F}{A} \qquad \text{... (2)}$$

Song estimated the work days required per hectare *D* in Nantong to be 1,349 work days per hectare, with one workday comprising seven work-hours. He also calculated annual work days per labourer *L* for 343 work days.[26] As the values of total arable land *Q* and rural labour force *A* are given (10.08 million hectares and 0.76 million respectively), labour required for farm cropping *F* was estimated to be 0.328 million. The surplus labour rates in Nantong were found to be about 57 percent. However, some labour (approximately 0.2 million units) was engaged in other sideline production and non-agricultural activities. After appropriate adjustments, the surplus agricultural labour was 232,000 or 31 percent of Nantong's rural labour force in 1981.

Bai conducted a similar survey in 1981 for Ji'an district in Jiangxi province.[27] Bai estimated the labour surplus amounted 299,000 or 24.8

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[24] See Wang (1994).

[25] See Song (1982), pp.121-133.

[26] 2,400 hours divided by 7 hours.

[27] See Bai (1985).

percent.[28] The advantage of Bai's analysis is that he estimated the arable farmland per labour from a micro-study where the behaviour of peasants on farming work was captured. Problems of micro-investigation include the subjectivity of interviewees, and the degree of representativeness of one single survey.

Deng attempted to measure the surplus labour[29] in rural China at a national level (differentiating between developed, less-developed and least-developed regions)[30] Taylor & Banister attempted to derive the size of the surplus by the labour norm approach. Their method was the same as Deng's and Song's but focused on national estimates. They found that the size of surplus labour rose from between 25.6 million in 1978 to 111.3 million in 1987.[31]

Recent attempts on the measurements include the marginal efficiency approach, labour input survey, and the technological efficiency approach.

The marginal efficiency approach employs separate production functions to examine the labour productivity for agriculture and non-agriculture. Although the assumption of profit maximization is plausible in traditional farming, peasant households are treated to allocate their factors according to their best practice or their comparative advantage. The ratio of surplus labour is obtained by comparing the differences of marginal product in two sectors, since labour will move from the sector with lower marginal product or lower income. Liu (1997) and Wang (1998) apply this method to estimate the surplus labour being 25 percent of agriculture, or 120 million labourers.

Two issues are crucial with this approach. First, zero or low marginal product of labour is not a necessary condition of this approach, and thus the concept of surplus labour is somewhat different from the Lewis type. Second,

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28 He then calculated the required labour force, by dividing total arable farmland of Ji'an (392 thousand hectares) by average arable farmland (0.433 hectare), which is 0.905 million. This figure was then subtracted from the total agricultural labour force (1.204 million) and the labour surplus is about 299 thousand or 24.8 percent.

29 See Deng (1985), pp.23-24.

30 Developed regions are those with per capita income of RMB300 or higher, together with 40 percent industrial output from the rural gross value of industry and agriculture; these include Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang, Liaoning, Shandong, and Guangdong. Less-developed regions are those with per capita income of between RMB210 and RMB300, and 15 percent to 40 percent industrial output from the rural gross value of industry and agriculture; these include Hebei, Shanxi, Neimenggu, Jilin, Heilongjiang, Anhui, Fujian, Jiangxi, Hubei, Hunan, Sichuan, and Xinjiang. Least-developed regions are those with per capita income of lower than RMB200, and less than 15 percent industrial output from the rural gross value of industry and agriculture; these include Guangxi, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, and Ningxia.

31 See Taylor & Banister (1991), p.91.

more importantly, peasants are assumed to move out from agriculture once they find greater job opportunities in other sectors. However, institutional barriers are common in many developing countries, and thus farmers in the countryside might not be able or have incentive to obtain jobs from non-agriculture.

The labour input survey method compares the actual workdays of peasants and that under full employment, with the requirement of conducting large scale survey. Wang & Ding (2005) calculated the labour surplus of 46 million (or 14 percent), which is much lower than many other estimates. Cross-households data with no provision on the labour change over time is regarded the disadvantage of this approach.

There are increasing attempts of estimating the surplus labour by the technological efficiency approach. Instead of assuming labour is fully employed and production technology is not change over time at its best practice, the frontier framework is able to separate those variables that affect demand for labour from those that being classified as surplus and / or migration, depending on the model specifications. By measuring the production frontier with input and output data, the surplus labour could be treated the part of inefficiency due between the frontier and the actual output or the inputs required for producing the output lies along the frontier.

The production frontier could be examined the by non-parametric liner programming. The typical method is data envelopment analysis DEA. Ng & (1994) employ this method to calculate the surplus labour for Jiangsu and Sichuan provinces and found that the ratio of surplus are 31~49 percent and 22~41 percent. The frontier can also be assessed by a parametric way of the stochastic framework. With a pre-defined production function, the coefficients are estimated by the maximum likelihood method. Bhattacharyya & Parker (1999) and Guo (2007) applied this approach and found the surplus is around 100~130 million labourers. The advantage of this approach has been the alternative estimates of labour requirement with the assumption that underdeveloped agriculture face technology inefficiency.

Table 1 summaries various works on measures of surplus labour in China.

[Table 1]

Analytical Framework

The labour efficiency measurement of a frontier approach is employed to derive the amount of surplus labour indirectly. The general form of a stochastic frontier approach with panel data can be expressed as the following, after the previous versions contributed by Aigner & Chu (1968), Aigner, Lovell & Schmidt (1977), Meeusen & van den Broeck (1977), and Battese & Coelli (1992):

$$y_{it} = x_{it}^{'}\beta + \left(v_{it} - u_{it}\right) \qquad \ldots(3)$$

where output y is produced by a vector x of inputs by the *ith* firm at time t. Vector β is parameters to be estimated. $\left(v_{it} - u_{it}\right)$ is a composite error, with v_{it}, the normal random errors being assumed to be independently and identically distributed (iid) with $N(0,\sigma_v^2)$, and u_{it} being independently and identically distributed (iid) non-negative truncations $N(\mu,\sigma_u^2)$. u_{it} is the error being expected to capture the technical inefficiency during production. v_{it} and u_{it} are further assumed to be identically distributed of each other and of other independent variables.

Following Diewert (1974), Bhattacharyya & Parker (1999) and Guo (2007), the minimum labour required for producing farm output is expressed as

$$L_{it} = f\left(X_{it},\beta\right)\exp\left(v_{it} - u_{it}\right) \qquad \ldots(4)$$

where L_{it} is the labour input for province *i* at year *t*. $f(.)$ is the function of other inputs required to produce output simultaneously. To model u_{it} there are various possibilities. We assume individual peasants are able to learn from experience for their technical efficiency to change over time systematically and also the changes are more apparent as the time period larger. Thus a time-varying inefficiency specification with $t-1980$ is adopted:

$$u_{it} = u_i \exp\left[\eta\left(t - T\right)\right] \qquad \ldots(5)$$

where is η to be estimated.

Furthermore, to allow technological progress possible through time, a *t* is included. The logarithmic transformation of our minimum labour requirement function *lrq* is then:

$$lrq = \ln l_{it} = \alpha_0 + \sum_j \alpha_j \ln\left(x_{it}^j\right) + \sum_k \beta_k \left(D_i^k\right) + \chi_1 t + \chi_2 t^2 + \delta_t WTO_t + v_{it} - u_{it} \qquad \ldots(6)$$

There are six elements in this required labour function. Other than the constant and the composite errors discussed above, this minimum labour is explained by a vector of inputs and output (land, machineries, chemical fertilizers, and farm output), a vector of dummy for 7 regions, time trend of capturing technological progress, and a dummy to distinguish China's WTO membership in 2001.

Alternatively, we specify u_{it} in form of technical inefficiency function, as suggested by Battese & Coelli (1993):

$$u_{it} = z_{it}\lambda + \varepsilon_{it} \qquad \ldots(7)$$

where z_{it} is a list of provincial-specific endogenous variables that could vary over time to explain the inefficiency, with λ being vector of coefficients to be estimated. ε_{it} is, again, assumed to be iid with zero mean and σ^2 variance that non-negative random term with $\varepsilon_{it} \geq -z_{it}\lambda$.

We propose the following variables for λ in the technical inefficiency function: degree of urbanization, extent of urban-rural income differentials, pace of rural industrialization, impact of China's WTO membership, and time trend.

The degree of urbanization is expected to inversely relate to labour's inefficiency. Higher urban-rural income differentials are expected to lower the labour inefficiency in farming. Similarly, pace of industrialization is expected to be negatively related to the inefficiency of labour demand because more people will tend to work more for the non-agricultural output. With WTO membership, China needs to adjust its economic structure and productivity to cope with the possible competition. A time trend is used to capture the efficiency gain through time, especially in the later period.

The estimated u_{it} , the inefficiency specification either by the error components model of equation (5) or by the technical efficiency effects model of equation (7), in this stochastic frontier can be viewed as inefficient labour use or, alternatively, surplus labour ratio, as proposed by Kumbhakar & Hjalmarsson (1975).

u_{it} can be estimated by a maximum likelihood method in a Cobb-Douglass *lrq* function of equation (6). With the required labour *lrq* and the actual labour *lac*, the surplus labour ratio could be defined as *S*:

$$S_{it} = \left(\frac{lac - lrq}{lac} \right) \qquad \ldots(8)$$

After transformation, S_{it} becomes

$$S_{it} = 1 - \exp(-u) \qquad \ldots(9)$$

This estimated surplus labour is regarded as the part of labour not being used technically efficient. This is somewhat similar to the concept of surplus labour, although it is not completely the same part of labour whose MP is zero or close to zero.

Data

Annual data from 1980 to 2005 at provincial level are used for our analysis. Although Beijng, Tianjin, Shanghai and Chongqing are municipalises at provincial level, their industrial compositions are quite different from the others with insignificant output from agriculture. They are excluded from our sample.[32] Sources of data are from the official ZGTJNJ and the Statistical Compilation of 55 years New China.

Output is measured by the gross value of farming (GVF) at real term (1990 = 100). It is obtained as nominal output to be deflated by the implicit agricultural output deflator:

$$P_{GVF} = \frac{MIGVF_{it}}{CIGVF_{it}} x100 \qquad \ldots(10)$$

where $MIGVF_{it}$ and $CIGVF_{it}$ are the output indexes in market price and comparable price (preceding year = 100) of province i at time t respectively.

Labour is the year-end figure of number of worker in farming. There is no direct data on farming worker. Official labour data include rural labour force and the agricultural labour which is the sum of those in farming, forestry, animal husbandry and fishing. We follow Lin's (1992) practice of weighting the farming output to total agricultural output to obtain the farm labour data indirectly.

Three types of land are used in our estimation. Arable / cultivated land is used to adjust heterogeneity of land for agriculture in different provinces. Sown land of farm crops is directly used to produce farm output. Irrigated land

32 For data consistency, Hainan is excluded from our sample.

is considered more productive than those non-irrigated by 25 percent (Wen, 1993; Tang 1982). The land variable is adjusted as follows:

$$land = arable\_land * \left(\frac{sown\_land}{arable\_land} \right) * \left(\frac{irrigated\_land}{arable\_land} \right) *1.25 \qquad \ldots(11)$$

Farming capital includes power generated by machineries, draft animals, and chemical fertilizer. Animal type capital will be standardized into kilowatts.

The degree of urbanization is measured by the share of urban population to total population. The income gaps are defined by the ratio of average incomes in both urban and rural sectors. The pace of industrialization is measured by the ratio of non-agricultural output to total output at provincial level,

[Table 2]

Estimation Results

The farming labour demand models in Cobb-Douglas form are estimated with both error components stochastic frontier (EC) and technical efficiencies effects stochastic frontier (TE), using the maximum-likelihood estimates provided from the Frontier 4.1 software. The results are reported in Table 3, with the estimates of agricultural labour demand for comparison.

All estimated coefficients of inputs and output are statistically significant except the capital stock and fertilizer in both (TE) and (EC). Output and land are by far the most important variables influencing labour demand in rural China. Other things being equal, they generate minimum labour demand by 60 percent and 12 percent respectively, under the TE estimates. Relatively, our results confirm that land is more important than capital and fertilizer in affecting labour demand in Chinese farming.

Although the second order of time trend is not significantly different from zero, the parameter *t* which representing technological progress, on the other hand, does seem to affect the labour demand in our models, with an average of 2.4 or 2.9 percent decrease in labour demand per annum.

All regional dummies are significant in both models, implying that the regional differences of labour demand in the farm sectors are well captured by our regional classification. Other than the Southwest, all other regions significantly demand for more minimum labour.

The WTO dummy is negative, which is to our anticipations; suggesting that minimum labour demand in farming has been decreasing after China joined the WTO. This could probably be the effect of more labour being transferred to non-agricultural production.

In the time-variant EC model, the negative η indicates that technical efficiency is worsening over time. In the TC model, all inefficiency measures are statistically significantly different from zero, and they show that higher degree of urbanization connects more inefficiency; higher relative urban-rural income gap reduce the size of surplus labour; and more industrialized output contributes higher inefficiency. The two dummy variables also suggest labour efficiency was improving, with China's WTO membership produced a 12.8 percent improvement annually while the time trend generating 5.2 percent.

In addition to the significant log likelihood, the high value of γ , defined as $\frac{\sigma_u^2}{\sigma_u^2+\sigma_v^2}$, denotes that the majority of variation of error terms is from inefficiency components but not from the measurement errors.

[Table 3]

Estimates from TE are used to compute the framing surplus labour at both national and regional levels with equation (9). The surplus labour at national level was around 25 million to 43 million labourers between 1980 and 2005, and it reached its peak in 1994. The size was further declined after China joined the WTO. The relative labour surplus ratio had been varying from 10 percent to 30 percent, which is slightly lower than other measures.

From a regional perspective, our estimation provides some evidence to several commonly held beliefs. First of all, provinces in north China are by far "producing" the largest surplus labour. In 2005, around 30 percent of total surplus originated from this region. Yet, the pattern was in fact changing gradually. For instance, surplus labour was more evenly distributed among regions in the early 1980s, except the North. All over the 1990s and the early 21st century, surplus labour has been growing steadily and again, except the North.

Secondly, southern China is the only region that experienced a reduction of surplus labour in absolute amount from around 6 million to 4 million labourers. This is highly due to the rapid development of the non-agricultural activities in this region. However, due to the increase of population, it is observed that the surplus ratio did not change much with an average of 23 percent.

Thirdly, surplus ratio was remarkably high in provinces located at the northern and eastern China, where heavy industry and commercial activities dominated.

[Table 4]

Concluding Remarks

The issue of surplus labour in China always remains a puzzle to many scholars and policy makers. Academic attempts on estimating the size of this surplus, if any, found vary to a great extent. This is mainly caused by the conceptualization and measurement problem of dealing with surplus labour.

The major conceptual difference is to define which part of labour to be considered as surplus: (1) labour with marginal productivity being very low (close to zero), (2) labour with significant productivity differentials between agriculture and non-agriculture, or between rural and urban. The major measurement problems are four: (1) whether the surplus is referred to that of rural labour, agricultural labour or farming labour; (2) if the surplus labour is regarded as those participating in the farm sector only, there are no direct published data available; (3) if the labour norm approach is employed, the standard labour requirement figures were not available after the late 1990s; and (4) both the production function and frontier approach treat the inefficiency part as the surplus, however, the inefficiency could be ranging from zero marginal products to market wages.

Given these constraints, some suggest that the real issue to look into the labour market in rural China is the behaviour of rural-urban migration, rather than the amount of surplus labour by various methods. However, there are also constraints for this approach.

First, rural-urban migration is still institutionally difficult and incomplete, although not entirely impossible with the recent economic expansion in cities.

Second, those migrants to cities are formerly rural residents and there is no clear-cut that they are entirely from the farming sector. Thus the issue of surplus agricultural labour becomes ambiguous. Third, there has been more rural to rural migration in China, in which many workers are employed by various formal and informal activities in the countryside. The modern sector under Lewis framework is more applicable to the rural area in China, rather than the urban sector. Fourth, the major measurement problem of rural-urban migration has been the lack of reliable official data. Previous studies concentrate on using sample data. Given the vast difference among provinces, rural-urban migration could be misleading to the issue of surplus labour, if conclusions are based on some selected sampled studies.

Our paper attempts to estimate the size of surplus farming labour in rural China at both national and regional levels between 1980 and 2005, the period that China experienced economic reform since the late 1970s and the time China becoming a member of WTO. A stochastic frontier framework of labour demand function in Cobb-Douglas form is adopted and the amount of surplus is derived from the differences between the actual labour and the estimated required labour in farming. Unlike many other estimates of using agricultural labour, an indirect-measured farming labour is applied in this study.

Our results show that farm technical efficiency has been decreasing in China. The WTO membership has effect on the farm labour demand in the countryside. The surplus labour in terms of farming is around 30 million at national level, which is considered to be smaller than other estimates. If our estimates are correct, the amount of surplus agricultural labour in China is either getting smaller, contributed partly by the economic reform, or some measurement inconsistencies existed in the previous studies.

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Table 1: Measurement of Surplus Labour in China

Region	Year	Size#	Percentage##	Method
(1) National	1965	56	24	Estimation
	1970	101	36	
	1975	110	37	
	1980	114	39	
	1985	135	43	
	1988	136	43	
(2) National	1978	26	9	Labour Norm
	1980	75	26	
	1985	105	35	
(3) National	1983	156		Estimation
(4) Nantong, Jiangsu	1981	0.232	31*	Labour Norm
(5) Ji'an, Jiangxi	1981	0.299	25*	Labour Norm
(6) National	1983		28*	Labour Norm
(7) National	1984		40	Experience
(8) National	1985	62		Sampling
(9) National	1986	60		Sampling
(10) National	1987	80		Labour Norm
(11) National	1985	105		Labour Norm
(12) National	1982	90-105	32*	**
(13) National	1982	110	**	**
(14) National	1985	150	30*	**
(15) National	1985	105	**	**
(16) National	1985	70 or less	**	**
(17) Guangdong	1985	6	**	**
(18) Sichuan	1985	1.735	34*	**
(19) Wushi, Jiangsu	1979	0.1	**	**
(20) Shanxi	1987	1.73	31*	**
(21) Shanxi	1984	1.76	23*	**
(22) Hunan	1985	10	46*	**
(23) Anhui	1983	5-7	30-30*	**
(24) National	1994	133	26	Marginal Efficiency
(25) National	1994	119	25	Marginal Efficiency
(26) National	2003	44.9	14	Marginal Efficiency
		34.6	7	Marginal Efficiency
(27) Jiangsu & Sichuan	1978-1992		31-49 22-41	DEA
(28) National	1980-1995	110 – 119	37.5	Stochastic Frontier
(29) National	1996-2005	121-100	37-33	Stochastic Frontier

Notes: #Size: in million persons; ## Percentage: surplus as a percentage of agricultural labour force (*: that of rural labour force) (**: not available).

Sources: (1) Guo (1993); (2) Taylor & Banister (1991); (3) Tian & Lin (1986); (4) Song (1983); (5) Bai (1985); (6) Deng (1985); (7) Chen (1989); (8) Wang (1994); (9) Wang (1994); (10) Wang (1994); (11) Wang (1994); (12) Interview at the Institute of System Science, Chinese Academy of Sciences, 8 May 1987 (indirectly quoted from Taylor (1993)); (13) Interview at the Institute of Rural Development, Chinese Academy of Social Sciences, 19 May 1987 (indirectly quoted from Taylor (1993)); (14) Xu & Ye (1986) (indirectly quoted from Taylor (1993)); (15) Chen & Hu (1989) (indirectly quoted from Taylor (1993)); (16) Shi (1986) (indirectly quoted from Taylor (1993)); (17) Zeng (1987) (indirectly quoted from Taylor (1993)); (18) Lu, Liao, Shu, & Wang (1986) (indirectly quoted from Taylor (1993)); (19) Beijing Review 1984, (indirectly quoted from Taylor (1993)); (20) Xue (1986), (indirectly quoted from Taylor (1993)); (21) Li & Zhao (1985), (indirectly quoted from Taylor (1993)); (22) Cheng (1985), (indirectly quoted from Taylor (1993)); (23) Su & Yu (1984), (indirectly quoted from Taylor (1993)); (24) Wang (1998); (25) Liu (1997); (26) Wang & Ding (2005); (27) Ng & Tsang (2000); (28) Bhattacharyya & Parker (1999); (29) Guo (2007).

Table 2: Descriptive Statistics of Variables, 1980 to 2005

Variable	**Unit**	**Description**	**Mean (S.D.)**	**Max.**	**Min.**
Agricultural output	100 million RMB	Gross value of agriculture at current price	14,241 (11,173)	370,285	37,552
Farming output	100 million RMB	Gross value of farming at current price	8,027 (5,803)	18,766	1,348
Labour	10,000 person	Number of labour work for agriculture	31,227 (1,290)	33,780	28,809
Arable land	1,000 hectare	Land available for farming	128,895 (2,702)	11,773	363
Sown land	1,000 hectare	Sown area for farming	146,761 (3,486)	152,309	141,716
Irrigated land	1,000 hectare	Irrigated area for farming	47,401 (3,971)	53,637	42,973
Machineries	10,000 kilowatt	Equipment directly applied to farming	34,649 (15,738)	66,575	14,050
Draft Animal	10,000 kilowat	Animal used to farming	6,773 (993)	8,351	4,811
Chemical Fertilizer	10,000 tons	Chemical fertilizer applied to agricultural production	2,961 (1,120)	4,635	1,232
Urban Population	10,000 person		43,573 (6,990)	53,101	30,646
Rural Population	10,000 person		53,100 (5,898)	69,829	47,638
GDP	100 million RMB	Gross value of GDP at current price	48,506 (48,276)	172,948	3,730
Non-agricultural Output	100 million RMB	Gross value of Non-agricultural output at current price	27,740 (31,005)	107,179	1,484
Urban per Capita Income	RMB Yuan	Average income of urban population	4,793 (2,565)	9,568	1,316
Rural Per Capita income	RMB Yuan	Average income of rural population	1,752 (826)	3,148	584

Table 3: *Minimum Required Labour Estimates*

	EC Agriculture	TE Agriculture	EC Farming	TE Farming
Inputs and outputs				
Constant	5.537	2.258	3.354	2.944
	(22.085)	(14.768)	(11.995)	(20.793)
Agricultural output	-0.049	0.206		
	(-3.261)	(8.746)		
Agricultural land	0.391	0.217		
	(18.777)	(9.679)		
Farming output			1.042	0.603
			(34.477)	(19.901)
Farming land			0.117	0.120
			(3.234)	(4.820)
Capital stock	-0.008	0.352	-0.263	0.034
	(-0.321)	(13.580)	(-5.320)	(1.093)
Fertilizer	-0.002	0.000	-0.010	0.003
	(-0.707)	(0.063)	(-1.170)	(0.326)
Technology				
t	0.009	-0.021	-0.024	-0.029
	(2.558)	(-3.389)	(-3.366)	(-4.534)
t^2	-0.001	-0.000	0.000	0.000
	(7.061)	(-0.996)	(1.038)	(0.379)
Inefficiency Measures				
Constant		0.467		-0.757
		(6.233)		(-3.198)
Urbanization[a]		0.085		0.917
		(1.237)		(4.495)
Income differentials[b]		-0.151		-0.596
		(-5.910)		(-5.886)
Industrialization[c]		0.082		0.749
		(1.150)		(16.179)
WTO		0.019		0.124
		(0.332)		(1.283)
Time		0.049		0.052
		(9.947)		(5.234)
Dummy				
East	-0.884	-0.009	-0.246	-0.172
	(-6.547)	(-0.353)	(-3.173)	(-5.744)
Northeast	-0.890	-0.331	-0.678	-0.626
	(-6.886)	(-8.754)	(-7.360)	(-15.569)
Northwest	-1.489	0.745	-0.455	0.673
	(-13.350)	(24.706)	(-4.799)	(-18.529)
Southwest	0.005	0.632	0.287	0.402
	(0.038)	(24.446)	(3.873)	(14.368)
South	-0.105	0.150	-0.247	-0.208
	(-1.004)	(4.746)	(-3.357)	(-6.261)
Central	-0.458	0.077	-0.389	-0.162
	(-4.078)	(2.454)	(-4.555)	(-4.727)
WTO	0.030	-0.003	-0.024	-0.066
	(1.951)	(-0.085)	(-0.567)	(-1.436)
η	0.013		-0.036	
γ	0.959	0.973	0.866	0.953
Log likelihood	727.230	205.340	77.102	33.616

Note: Figures in parentheses are t-statistics value. EC: error components stochastic frontier estimate. TE: technical efficiencies effects frontier estimate. [a] ratio of urban population to total population. [b] ratio of urban per capita income to rural per capita income. [c] ratio of non-agricultural output to total output.

Table 4: Estimated Number of Surplus Labour in Chinese Farming, (1980 – 2005) (in 10,000 persons)

	No. of Surplus Labour (in 10,000 persons)								Surplus Labour Ratio (%)							
	N	NE	NW	E	SW	S	C	National	N	NE	NW	E	SW	S	C	National
1980	654	174	112	371	500	599	252	2,662	10.2	16.9	19.4	10.4	10.4	24.9	8.6	12.3
1981	512	137	125	377	505	552	239	2,447	7.5	12.9	21.2	10.3	10.5	23.5	7.8	11.0
1982	516	134	122	446	526	532	240	2,517	7.6	12.8	19.9	12.1	11.0	23.2	7.4	11.2
1983	658	179	102	379	457	468	343	2,586	9.6	16.8	16.4	10.1	9.4	20.2	11.2	11.5
1984	730	197	121	500	558	468	331	2,905	10.7	19.1	19.4	14.1	11.6	20.8	10.9	13.1
1985	916	390	130	664	620	507	431	3,658	15.0	43.2	21.8	22.5	13.7	25.3	16.3	18.5
1986	821	109	114	609	536	470	403	3,062	13.6	11.2	19.9	20.7	12.0	25.3	15.6	15.7
1987	869	181	130	645	543	450	390	3,207	14.4	19.0	23.2	22.9	12.3	23.7	15.1	16.6
1988	1,002	198	157	670	619	472	405	3,523	17.8	21.1	28.5	25.6	14.6	26.2	17.6	19.5
1989	754	131	120	488	404	418	272	2,586	12.8	14.0	21.0	17.8	9.1	22.7	11.0	13.7
1990	746	211	141	474	467	399	309	2,747	12.2	20.2	21.9	16.6	9.9	20.0	11.1	13.6
1991	660	150	144	406	357	407	237	2,362	10.8	14.5	21.9	14.6	7.2	20.1	8.5	11.6
1992	636	176	139	469	392	435	265	2,512	10.8	17.2	21.4	17.2	8.1	22.3	10.1	12.7
1993	726	214	149	600	436	492	331	2,948	11.4	20.0	20.6	20.1	8.5	24.0	12.3	14.1
1994	1,256	338	203	845	751	569	597	4,558	21.2	33.9	28.6	30.1	15.3	29.1	22.7	22.9
1995	1,386	276	184	781	691	554	512	4,384	23.7	28.5	25.1	28.1	13.6	29.5	19.9	22.1
1996	1,290	292	164	761	687	470	558	4,222	22.4	29.9	21.3	28.4	13.4	25.0	22.8	21.5
1997	1,125	249	176	759	604	428	553	3,893	19.8	25.7	22.8	29.1	12.2	22.5	23.9	20.3
1998	1,141	222	178	751	481	389	458	3,619	19.2	18.6	22.8	28.8	13.5	19.3	19.7	19.7
1999	1,137	246	159	773	695	449	497	3,955	18.4	21.3	20.8	29.8	19.9	22.6	21.2	21.4
2000	1,150	224	122	756	707	435	507	3,902	18.4	20.8	13.1	30.6	21.1	23.3	22.9	21.5
2001	1,046	218	230	712	635	400	451	3,692	17.1	19.8	32.4	29.7	19.6	21.6	20.4	20.9
2002	1,025	241	136	703	653	382	439	3,580	17.2	21.9	18.9	30.9	20.9	20.8	20.4	20.9
2003	1,118	269	171	642	669	415	473	3,755	21.0	28.0	26.0	34.0	24.0	23.9	24.0	24.5
2004	1,299	294	177	736	723	466	599	4,295	24.8	32.0	27.0	39.4	26.5	27.4	30.7	28.5
2005	1,209	276	173	665	675	403	493	3,894	23.8	30.8	26.0	37.8	25.9	23.5	25.9	26.6

Sources: Calculated by the author.