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by

Shi Li-He

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AN ANALYSIS OF THE PRODUCTION FUNCTION OF THE TECHNICAL STRUCTURE OF CHINESE AGRICULTURE*

SHI LI-HE

1. INTRODUCTION

The purpose of this paper is to estimate the aggregate production function in China's agriculture through the cross-section data of 1979,1980,1981, and 1982,and to understand the basic production technical structure of agriculture in China. As the results of estimating parameters, we can determine the technical progress of China's agriculture. The models of production function in the system are Cobb-Douglas type and the improved Egaitsu-shigeno type which is based on the former.

2. THE PRESENT CONDITIONS IN CHINA'S AGRICULTURE

The development of agriculture and the balance between food and population are China's fundamental economic problems. Although the output valued agriculture accounts for only a quarter of the Gross National Product (in 1980), it is the key to the living standard of the Chinese farmers, who make up at least 80 percent of the population, and is the main source for the income of China's foreign exchange. The slogan that agriculture is the foundation of the national economy has remained a central Chinese economic policy ever since.

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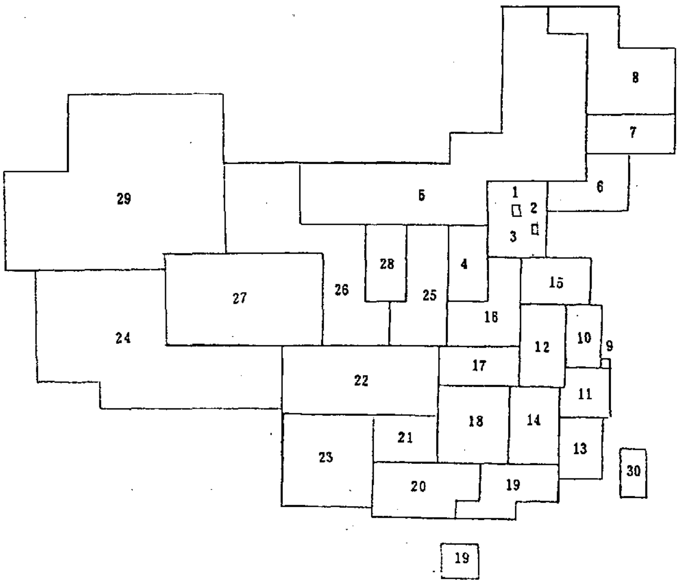
FIG.1 ADMINISTRATIVE DIVISION OF CHINA



1. Beijing
2. Tianjin
3. Hebei
4. Shanxi
5. Inner Mongolia Autonomous Region
6. Liaoning
7. Jilin
8. Heilongjiang
9. Shanghai
10. Jiangsu
11. Zhejiang
12. Anhui
13. Fujan
14. Jianxi
15. Shandong
16. Henan
17. Hubei
18. Hunan
19. Guangdong
20. Guangxi Zhuang Autonomous Region
21. Guizhou
22. Sichuan
23. Yunnan
24. Tibet Autonomous Region
25. Shanxi
26. Gansu
27. Qinghai
28. Ningxia Hui Autonomous Region
29. Xinjiang Uygur Autonomous Region
30. Taiwan

As indicated in FIGURE 1. Including Taiwan China has 22 provinces, five Autonomous regions and three municipalities-Beijing, Tianjin, and Shanghai. Its territory is about 25 times larger than that of Japan. It is only smaller than the Soviet Union and Canada and is the third largest country in the world.

The development of agriculture in China is closely linked to the development of the whole national economy. Many of China's exports are either agricultural raw materials or consumer goods based on agriculture. Therefore, flourishing agriculture boosts exports. It also reduces the foreign exchange cost on imports of farm products, which makes it possible to enlarge the capacity of the foreign exchange on importing machinery and commodities for the procuction in industry. Thus, if agriculture performs well, not only can it raise the level of agricultural production itself, but also improve the trade composition of the national economy, and vice versa, if agriculture is weak.

But there are some problems in China's agriculture. Generally speaking, the main problems seem to be the increase of the population and the scarcity of cultivable land and social capital. In particular, the cultivated area is scarce in china. According to the official estimation, the cultivated area is about 10.4 percent of the total area of land, and most land is situated in sparsely populated and inaccessible regions of North-west China, such as; Xinjiang, Qinghai and Xizang (Tibet). The concentration of cultivated land lies in East China, the North-east plain, and in some parts of the south and South-west regions (see FIGURE 2).

FIG.2 MULTIPLE-CROP INDICES OF CHINESE AGRICULTURE

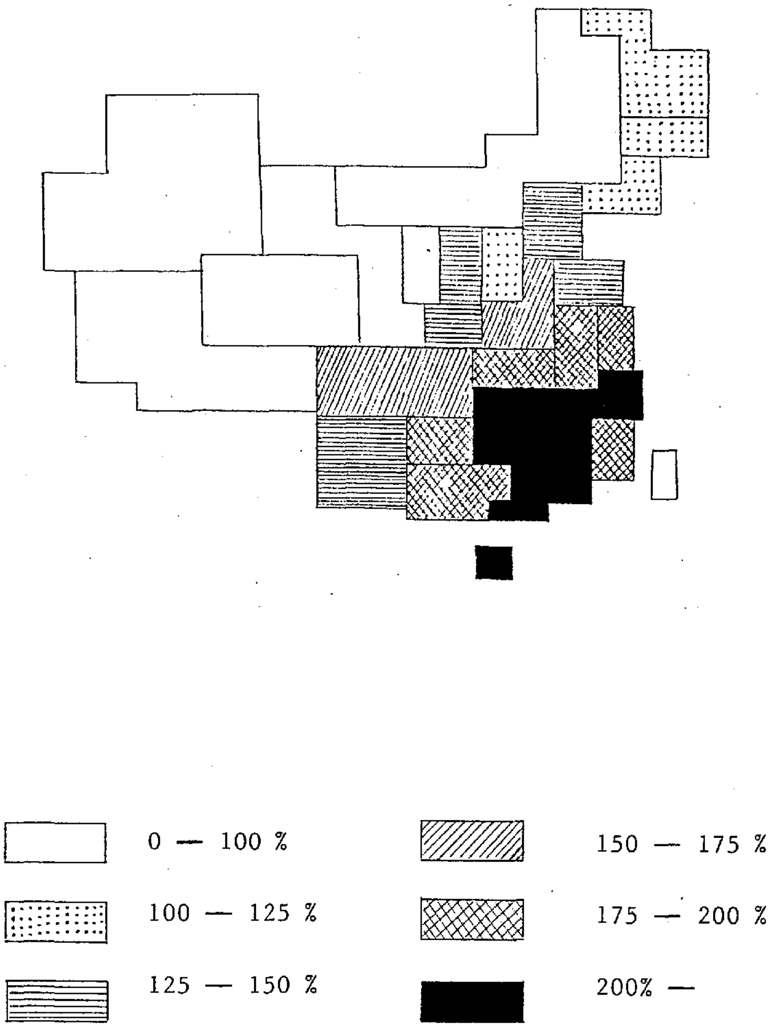


TABLE 1 presents the agricultural natural conditions in China. They are averaged for 21 years from 1959 to 1979 and observed on each provincial capital of China.

TAB.1 THE AGRICULTURAL NATURAL CONDITIONS OF CHINA

Regions	Elevation (m)	Temperature (c°)	Rainfall (mm)	Sunshine (%)	Frost-free season (days)
Beijing	31.2	11.5	653.6	63	177
Tianjin	3.3	12.3	573.9	62	201
Hebei	81.8	12.9	570.4	62	199
Shanxi	777.9	9.4	463.9	60	169
Neimenggu	1063.0	5.8	421.4	67	130
Liaoning	41.6	7.8	738.4	58	150
Jilin	236.8	4.9	592.6	60	147
Heilongjiang	171.7	3.6	520.6	60	140
Shanghai	4.5	15.7	1114.5	46	218
Jiangsu	8.9	15.4	1031.6	49	226
Zhejiang	7.2	16.2	1395.6	43	246
Anhui	23.6	15.7	984.1	49	226
Fujian	84.0	19.6	1352.1	42	325
Jiangxi	46.7	17.5	1588.3	43	227
Shandong	51.6	14.3	684.3	62	218
Henan	110.4	14.2	642.9	54	214
Hubei	23.3	16.3	1189.7	47	239
Hunan	44.9	17.2	1388.3	44	273
Guangdong	6.3	21.8	1701.1	43	342
Guangxi	72.2	21.6	1300.4	41	334
Sichuan	505.9	16.2	949.0	28	282
Guizhou	1071.2	15.3	1177.8	31	268
Yunnan	1891.4	14.7	1010.2	56	227
Xizang	3658.0	7.6	443.1	68	139
Shsnxi	396.9	13.4	582.5	46	207
Gansu	1517.2	9.1	332.4	59	167
Qinghai	2261.2	5.7	371.8	62	131
Ningxia	1111.5	8.5	206.4	68	169
Xinjiang	653.5	7.3	195.3	63	177

Source: The Agricultural Yearbook of China 1980 (9)

As seen in TABLE 1 the climate of the north is cold but that of the south is warm in China. Compared with the dry zone in the west, there are a lot of plains in the east, it is suitable for living and most of the people are concentrated here.

So far as grain crops are concerned, the only staple food crops have been wheat and rice. Other important crops are corn and barley. They also grow three other grain crops, these are the Kaoliang and millet and the sweet potato. Rice and barley is grown mainly in South China, wheat and Kaoliang and millet in North China. The Kaoliang and sweet potato are not only main crops, but are used for human consumption and livestock feeding.

In China, the population of the agricultural sector has been more than doubled since 1949. The land for farms has not increased very much. Today China's agriculture and agricultural products can be grown because of the improving structure of technical production in agriculture.

Since 1979, China has regularly begun to perform the Responsibility system of agriculture production. It has brought about productive activity in the countryside. China has put forward again the target to quadruple the production of industy and agriculture by 2000. In order to realize this aim the Chinese government pays more attention to the development of of agricultural production.

3. MODELS AND DATA

Agricultural production function indicates the technical relationship between the agricultural input resources and output returns. For the present time, the agricultural production function form is most widely used in the world, and among them the Cobb-Douglas production function has ben recognized as the one with universal significance. Agricultural production is quite different from that of industry or others since it is distinctly influenced by the external natural conditions. So the characteristics of agriculture production should also be taken into consideration in the study of the agricultural production function.

The model formulated in this paper, the most widely used production function for empirical estimation,is the Cobb-Douglas type. The forms are as follows:

MODELS 1 $\ln Y = \ln a + aL\ln L + aM\ln M + aN\ln N + aS\ln S$

MODELS 2 $\ln Y = \ln a + aL\ln L + aM\ln M + aA\ln A + aN\ln N + aS\ln S$

MODELS 3 $\ln Y = \ln a + aL\ln L + aK\ln K + aN\ln N + aS\ln S$

where

Y = gross agricultural production value in a hundred million yuan, measured in 1980 constant prices

L = measured in terms of the number of workers in agriculture in ten thousand men

M = horsepower of machinery for farm purposes in ten thousand hp.'s units

N = amount of chemical fertilizer used in agriculture calculated such that one unit equals ten thousand tons of nitrogen

A = measured in terms of the number of animals excluding domestic animals for farm purposes in units of ten thousand heads.

But the data for 1980 is data deficiencies, hence in this study estimated this as follows:

$$\text{Animal capital in 1980} = \text{Animal capital in 1979} \times \frac{\text{Number of large domestic animals in 1980}}{\text{Number of large domestic animals in 1979}}$$

K = M + A X 0.55 in ten thousand hp.'s units (8)

S = aggregate amount of sown land by crop in ten thousand hectares[1]

The a, aL, aM, aN, aS, aA, and aK are going to estimate parameters.

China's agriculture in a wide sense consists of farming i.e. agriculture in a narrow sense, forestry, animal husbandry, fishery, and the rural industry. The farming sector has played a significant role in the process of agricultural development in China. In 1982, their relative proportions in term of value were 62.8, 4.1, 15.5, 15.9, and 1.7 percent, respectively. But this paper estimated agricultural production functions is based on a narrow sense, and the main source of data (used in this analysis) is from the Agricultural Yearbook of China 1980 - 1983. When we formulate the specified production functions for analysis , we can not deny the possibility that our specification of production functions might have some bias. It could have been generated by the following three factors:

(1) we did not adopt simultaneous estimation methods.

(2) In the aggregate production function, data were not geometric

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1 The statistics on the sown land did not include the fact that there is a difference in land classes.

sums but arithmetical sums.

(3) In all twenty-nine regions of China, crop production figures show the total of all crops produced, the total for sown land includes the total of all arable land. Productivity of different land is not included.

4. THE RESULTS OF THE ESTIMATION OF PRODUCTION FUNCTION

TABLE 2,3,4 presents the results of the estimated agricultural production function in China by Cobb-Douglas function. The sample of data used was cross-section of data on twenty nine regions of China from 1979 to 1982 and the equation linear in logarithms are estimated by Ordinary Least Squares method. The figures in parentheses below the estimated pramaters are the t-values of the estimates, $\bar{R}^2$ is the coefficient of determination adjusted for the degrees of freedom.

Now we will explain briefly the results of the estimation of MODEL 1, MODEL 2, MODEL 3. In MODEL 1, agricultural production function are commonly used. The estimation of coefficient of correlation is very high and the parameter aL from 2.0 to 2.4 is in accordance with the theoretical and logical expectation specified in the formulation of the model. But the estimation of production elasticities of machinery is very small and not statistically significant. In MODEL 2 animal capital is added to the formula, all the estimated parameters aA are minus signs and the parameter aM is not statistically significant, since the theoretical sign condition is not satisfied. The estimated results of MODEL 3, all the estimated production elastisities are more satisfactory than that of MODEL 1 and MODEL 2 and all the estimated parameters, excluding parameter aK in 1980 its t-value are approximately significant at the 5 percent significance level. On the other hand, the sum of the production elasticities is approximately equal to one which implies constant returns to scale for China's agricultural production.

TABLE 2 THE RESULTS OF THE ESTIMATION OF AGRICULTURAL PRODUCTION FUNCTION BY MODEL 1

variable	model / parameter	Y = f (L , M , N , S) 1979	1980	1981	1982
	a	0.09675	0.1557	0.1175	0.1612
const.	lna	-2.3357	-1.8601	-2.1417	-1.8252
		(-6.322)	(-4.878)	(-4.819)	(-5.269)
lnL	aL	0.2465	0.2439	0.2409	0.1921
		(3.113)	(3.072)	(2.932)	(2.845)
lnM	aM	0.1748	0.0578	0.0992	0.0847
		(1.938)	(0.627)	(1.078)	(1.285)
lnN	aN	0.2547	0.2813	0.2189	0.3062
		(4.611)	(4.938)	(3.350)	(5.179)
lnS	aS	0.3961	0.4202	0.4646	0.4409
		(4.500)	(4.732)	(5.038)	(6.658)
$\bar{R}^2$		0.97986	0.97662	0.97719	0.98771
Σa		1.0721	1.00319	1.02359	1.02297

TABLE 3 THE RESULTS OF THE ESTIMATION OF AGRICULTURAL PRODUCTION FUNCTION BY MODEL 2

model		Y = f (L , M , A , N , S)			
variable	parameter	1979	1980	1981	1982
	a	0.09092	0.1545	0.1162	0.1416
const.	ln a	-2,3978	-1.8676	-2.1522	-1.9547
		(-6.618)	(4.788)	(-4.653)	(-5.887)
ln L	aL	0.2807	0.2516	0.2445	0.2477
		(3.491)	(2.923)	(2.743)	(3.581)
ln M	aM	0.1183	0.04477	0.09363	0.01514
		(1.263)	(0.421)	(0.891)	(0.213)
ln A	aA	-0.0875	-0.01685	-0.00733	-0.08128
		(-1.511)	(-0.262)	(-0.118)	(-2.030)
ln N	aN	0.2075	0.2728	0.2136	0.2403
		(3.336)	(4.096)	(2.665)	(3.730)
ln S	aS	0.5244	0.4453	0.4774	0.5819
		(4.346)	(3.365)	(3.320)	(6.239)
$\bar{R}$		0.98089	0.97568	0.97622	0.98913
Σ a		1.0434	0.99762	1.02180	1.00376

TABLE 4 THE RESULTS OF THE SETIMATION OF AGRICULTURAL PRODUCTION FUNCTION BY MODEL 3

model		Y = f (L , K , N , S)			
variable	parameter	1979	1980	1981	1982
	a	0.08881	0.1349	0.0949	0.1481
const.	lna	-2.4212	-2.0036	-2.3551	-1.9100
		(-6.236)	(-4.985)	(-5.526)	(-5.599)
ln L	aL	0.2078	0.2304	0.2123	0.1634
		(2.675)	(2.983)	(2.768)	(2.5080
ln K	aK	0.2270	0.1171	0.1991	0.1357
		(2.084)	(1.040)	(1.850)	(1.667)
ln N	aN	0.2790	0.2823	0.2308	0.3219
		(5.598)	(5.529)	(4.186)	(6.207)
ln S	aS	0.3791	0.3926	0.4127	0.4194
		(4.167)	(4.285)	(4.403)	(6.157)
$\bar{R}$		0.98015	0.97727	0.97907	0.98823
Σa		1.0929	1.0224	1.0549	1.0404

5. THE RESULTS OF THE ESTIMATION BY POOLED DATA

Now we make use of MODEL 3, by means of pooled data we carry on further determing again the production function, the data is calculated for 1979 and 1980; 1980 and 1981; 1981 and 1982; and from 1979 to 1982 respectively, at the same time, conducting Chow tests on these four combinations. It shows that they could coordinate. The determined results of production function of pooled data are as TABLE 5

Examining changes over regular periods, the production elasticity of agricultural labour force aL from 0.22164 falls gradually, on the other hand, the production elasticity of capital aK from 0.15925 rises to 0.17336, the elasticity of fertilizer aN is probably fixed at 0.27 or so, the elasticity of land area aS rises a little.

In the results we made use of pooled data from 1979 to 1982 determining: the production elasticity of labour is 0.2871; the production elasticity of capital is 0.17065; the elasticity of fertilizer is 0.27437; the sowing area is 0.39910, these are similar to the results of estimates made above, and the elasticity of land is the biggest at well.

TABLE 5 THE RESULTS OF THE ESTIMATION OF AGRICULTURAL PRODUCTION FUNCTION BY POOLED DATA

model		lnY = lna + aLlnL + aKlnK + aNlnN + aSlnS			
variable	parameter	1979,80	1980,81	1981,82	1979-1982
	a	0.1108	0.1136	0.1151	0.1118
const.	aL	-2.2001	-2.1747	-2.1619	-2.1963
		(-8.071)	(-7.831)	(-8.038)	(-11.805)
lnL	aL	0.22164	0.22100	0.19376	0.20871
		(4.147)	(4.251)	(3.882)	(5.847)
lnK	aK	0.15925	0.16293	0.17336	0.17065
		(2.103)	(2.200)	(2.610)	(3.534)
lnN	aN	0.27747	0.25849	0.27123	0.27473
		(7.989)	(7.266)	(7.269)	(11.143)
lnS	aS	0.39620	0.39607	0.41113	0.39910
		(6.349)	(6.378)	(7.265)	(9.964)
$\bar{R}^2$		0.97938	0.97955	0.98385	0.98226
a		1.05456	1.03849	1.04948	1.055319

6. THE MEASUREMENT OF TECHNICAL PROGRESS

Now, we will measure the rate of technical progress for every province, municipality or autonomous region by using the estimated result of production function as follows:

$$Y = a_t L_t^{aL,t} K_t^{aK,t} N_t^{aN,t} S_t^{aS,t}$$

$$Y^* = a_{t+1} L_t^{aL,t+1} K_t^{aK,t+1} N_t^{aN,t+1} S_t^{aS,t+1}$$

$$Q_{t-t+1} = Y^* / Y$$

Here Q makes known the index of technical progress. If Q is equal to 1, then the rate of technical progress is zero; if Q is bigger than one ($Q > 1$), it shows that technique makes progress; if Q is smaller than one ($Q < 1$), then the technical progress rate falls.

We carried on calculating from 1979 to 1980, from 1980 to 1981, from 1981 to 1982, and from 1979 to 1982 respectively, the results are as TABLE 6 and TABLE 7 (see page 16,17).

At first, the rate of technical progress from 1979 to 1980 fell, this was mainly caused by serious natural disasters China suffered in 1980. The rate of technical progress from 1979 to 1982 is 104.917, this is a considerable technical progress. The calculations for 1979 to 1982 used respectively 1979's data 1980's data to carry on calculating. The sixth table is the average of the fourth table and the fifth table. Looking from the total average, the rate of technical progress is 100.83 the yearly average is 0.27 percent, but there are only three years for which this article is observed, it included possibly the change of the natural condition.

TABLE 6 THE MEASUREMENT OF TECHNICAL PROGRESS OF CHINA'S AGRICULTURE (1)

model	lnY = lna + aLlnL + aKlnK + aNlnN +aSlnS		
region	1979-1980	1980-1981	1981-1982
Beijing	96.959	99.301	106.19
Tianjin	97.626	101.97	98.706
Hebei	88.226	104.76	103.62
Shanxi	93.145	102.87	103.62
Neimenggu	93.833	114.01	96.601
Liaoning	92.430	99.561	111.46
Jilin	95.082	101.19	110.89
Heilongjiang	90.944	106.35	104.89
Shanghai	99.874	94.471	109.50
Jiangsu	90.378	100.28	108.30
Zhejiang	95.927	97.164	108.01
Anhui	93.733	101.06	107.45
Fujian	101.42	94.234	111.68
Jiangxi	98.799	97.849	108.39
Shandong	88.487	101.95	107.27
Henan	89.193	104.54	102.84
Hubei	92.149	102.11	104.95
Hunan	95.289	97.727	108.46
Guangdong	93.791	98.601	107.51
Guangxi	96.854	98.741	106.39
Sichuan	95.267	97.604	107.86
Guizhou	102.59	96.041	106.00
Yunnan	97.449	99.583	102.37
Xizang	106.83	106.45	82.669
Shanxi	95.076	101.86	103.17
Gansu	95.410	104.09	99.556
Qinghai	106.55	96.883	104.23
Ningxia	105.83	97.985	106.46
Xinjiang	98.096	102.32	103.47
sample mean	96.111	100.743	104.917
std deviat.	5.0190	4.11931	5.59331

TABLE 7 THE MEASUREMENT OF TECHNICAL PROGRESS OF CHINA'S AGRICULTURE (2)

model / region	lnY = lna + aLlnL + aKlnK + aNlnA + aSlnS		
	1979-1982 (by 1979 data) (1)	1979-1982 (by 1982 data) (2)	$\frac{(1)+(2)}{2}$
Beijing	103.27	101.86	102.57
Tianjin	101.80	97.018	99.41
Hebei	95.704	94.866	95.29
Shanxi	100.08	98.148	99.11
Neimenggu	95.278	99.036	97.16
Liaoning	102.71	101.00	101.86
Jilin	106.56	105.13	105.85
Heilongjiang	102.43	101.45	101.94
Shanghai	105.19	103.10	104.15
Jiangsu	97.803	96.688	97.25
Zhejiang	100.85	99.121	99.99
Anhui	99.370	99.795	99.58
Fujian	106.30	104.38	105.34
Jiangxi	104.57	104.52	104.55
Shandong	96.269	94.724	95.50
Henan	94.873	94.456	94.66
Hubei	98.316	98.303	98.31
Hunan	101.21	99.515	100.36
Guangdong	99.368	97.323	98.35
Guangxi	101.01	100.53	100.77
Sichuan	99.612	98.453	99.03
Guizhou	103.99	102.70	103.35
Yunnan	99.995	99.167	99.58
Xizang	97.740	98.624	98.18
Shanxi	100.85	99.158	100.00
Gansu	99.682	98.628	99.16
Qinghai	108.82	108.81	108.82
Ningxia	111.47	108.89	110.18
Xinjiang	103.83	103.21	103.52
sample mean	101.343	100.296	100.83
std deviat.	3.98237	3.69271	

7. THE MEASUREMENT OF TOTAL PRODUCTIVITY

From a variation of MODEL 3, and take advantage of estimated value of parameters, we calculate the total productivities (TP) in 1979, 1980, 1981, and 1982 as follows:

$$TP_{1979} = \frac{Y}{L^{0.2078}\ K^{0.2270}\ N^{0.2790}\ S^{0.3791}}$$

$$TP_{1980} = \frac{Y}{L^{0.2304}\ K^{0.1171}\ N^{0.2823}\ S^{0.3926}}$$

$$TP_{1981} = \frac{Y}{L^{0.2123}\ K^{0.1991}\ N^{0.2308}\ S^{0.4127}}$$

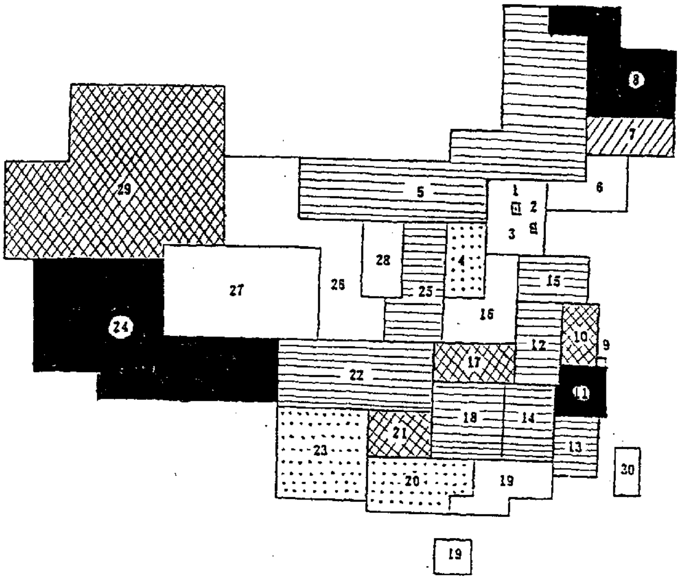
$$TP_{1982} = \frac{Y}{L^{0.1634}\ K^{0.1357}\ N^{0.3219}\ S^{0.4194}}$$

Here TP makes known the technological gaps between regions. Also, we can regard TP as the residual unexplained by inputs. TABLE 8 and FIG 3 represents the results of the measurement for total productivities.

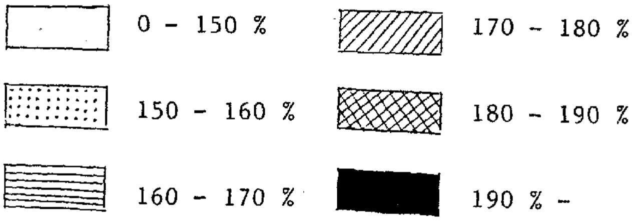
TABLE 8 THE RESULTS OF MEASUREMENT OF TOTAL PRODUCTIVITY

region	1979	1980	1981	1982
Beijing	104.86	153.52	102.82	154.40
Tianjin	89.996	132.28	87.199	164.28
Hebei	79.116	119.35	85.478	142.08
Shanxi	84.542	115.34	85.453	156.55
Neimenggu	111.63	139.07	92.033	160.47
Liaoning	107.98	168.38	118.11	161.11
Jilin	117.17	173.43	131.18	179.90
Heilongjiang	114.86	202.49	122.60	195.20
Shanghai	115.94	145.92	110.57	189.67
Jiangsu	110.88	166.03	121.78	184.05
Zhejiang	122.10	178.20	116.81	193.23
Anhui	96.049	142.18	120.30	176.45
Fujian	112.14	172.52	118.48	164.89
Jiangxi	114.60	173.37	114.76	167.80
Shandong	89.416	153.62	111.82	168.48
Henan	89.681	150.32	112.03	144.88
Hubei	121.63	166.43	121.29	189.50
Hunan	105.84	167.53	108.30	167.80
Guangdong	83.687	138.82	92.062	148.64
Guangxi	95.487	150.17	95.816	151.95
Sichuan	101.97	156.05	105.71	181.93
Guizhou	93.309	133.45	98.925	164.06
Yunnan	85.036	133.71	102.42	154.20
Xizang	120.45	206.29	148.43	202.08
Shanxi	95.076	118.56	87.854	161.68
Gansu	77.592	134.11	80.496	127.02
Qinghai	80.392	128.87	90.489	143.33
Ningxia	77.941	126.43	98.239	142.83
Xinjiang	100.63	160.28	118.40	185.35
sample mean	100.00	151.956	106.892	166.027
std deviat.	14.4492	23.2282	15.9957	18.6141

FIG.3 TOTAL PRODUCTIVITY OF CHINA'S AGRICULTURE (1982)



1. Beijing
2. Tianjin
3. Hebei
4. Shanxi
5. Inner Mongolia Autonomous Region
6. Liaoning
7. Jilin
8. Heilongjiang
9. Shanghai
10. Jiangsu
11. Zhejiang
12. Anhui
13. Fujan
14. Jianxi
15. Shandong
16. Henan



17. Hubei
18. Hunan
19. Guangdong
20. Guangxi Zhuang Autonomous Region
21. Guizhou
22. Sichuan
23. Yunnan
24. Tibet Autonomous Region
25. Shanxi
26. Gansu
27. Qinghai
28. Ningxia Hui Autonomous Region
29. Xinjiang Uygur Autonomous Region
30. Taiwan

8. THE REESTIMATION OF PRODUCTION FUNCTION

TABLE 7,8 presents the results of the reestimation of China's agricultural production function by Egaitsu-Shigeno type. The models are thus:

$$Y = \min (F (L,K) , G (N,S))$$

$$F = a L^{aL} K^{aK} \qquad (\text{M function})$$

$$G = b N^{aN} S^{aS} \qquad (\text{BC function})$$

In general, the procedure in agricultural production can be resolved into procedure in biological and chemical technology and in mechanical technology. In the procedure in agricultural production, the biological and chemical technology (the following calls BC technology) first consist of constant input means (N) such as fertilizers and pestcides and of land (S), while technogical procedure in mechanical engineering (the following is called M technology) consist of capital such as labor (L), agromachine (K) and draught animals, where N and S are considered as production factors which can replace each other, and are able to be combined into one group by the cooperation with changeable proportion, L and K can be combined into one group in the same way and the complement relation between two groups is assumed. Results of estimates of agricultural production function by Egaitsu-Shigeno type as follows:

TABLE 9 THE RESULTS OF THE ESTIMATION OF M FUNCTION

model		ln Y = ln a + aL lnL + aK lnK			
years		1979	1980	1981	1982
	a	0.0112	0.0165	0.0116	0.0190
const.	lna	-4.4950	-4.1073	-4.4605	-3.9634
		(-10.787)	(-9.672)	(-10.955)	(-11.678)
lnL	aL	0.5530	0.5617	0.5426	0.6416
		(5.533)	(5.653)	(5.718)	(7.711)
lnK	aK	0.6863	0.6079	0.6750	0.5182
		(5.120)	(4.580)	(5.412)	(5.185)
	$\bar{R}$	0.9439	0.9375	0.9449	0.9518
	Σa	1.2393	1.1696	1.2176	1.1598

TABLE 10 THE RESULTS OF THE ESTIMATION OF BC FUNCTION

model		ln Y = ln a + aN lnN + aS lnS			
years		1979	1980	1981	1982
	a	0.2495	0.2987	0.2829	0.3484
const.	lna	-1.389	-1.208	-1.263	-1.054
		(-5.387)	(-4.845)	(-4.432)	(-5.021)
lnN	aN	0.3715	0.3717	0.3278	0.4223
		(7.421)	(7.676)	(5.921)	(9.007)
lnS	aS	0.6307	0.5933	0.6329	0.5519
		(9.930)	(9.558)	(8.586)	(9.435)
	$\bar{R}$	0.9722	0.9699	0.9713	0.9846
	Σa	1.0022	0.9650	0.9607	0.9742

The first, the whole of the productive elasticity value of the model 2 was 1.2393 in 1979, it all greatly exceeded one in the other years, so the process of mechanics existed scale-up.

On the other hand, the whole of production elasticities of model 3 is slightly less than one. Here the t value of every elasticity value is very great, this is a very good determining result, making use of the above determining of this model, it is possessed of the advantage of little danger of multi-collinearity.

The resulta of measuremented technical progress by Egaitsu-Shigeno model are as TABLE 11 and TABLE 12.

TABLE 11 THE MEASUREMENT OF TECHNICAL PROGRESS BY EGAITSU-SHIGENO MODEL (1)

model	ln Y = ln a + aL lnL + aK lnK			
region	$Q_{1979-80}$	$Q_{1980-81}$	$Q_{1981-82}$	$Q_{1979-82}$
Beijing	98.493	92.969	109.90	103.54
Tianjin	99.159	92.969	110.57	104.49
Hebei	87.837	96.360	106.05	99.369
Shanxi	92.801	91.543	109.09	106.56
Neimenggu	93.935	88.609	109.23	109.38
Liaoning	92.272	91.244	108.48	105.55
Jilin	94.745	88.927	107.49	108.02
Heilongjiang	90.972	94.610	96.440	98.617
Shanghai	99.909	92.438	118.41	109.45
Jiangsu	89.188	97.720	110.57	101.04
Zhejiang	94.051	93.464	118.81	110.54
Anhui	91.950	90.658	115.12	111.82
Fujian	98.974	87.232	123.20	122.04
Jiangxi	96.237	85.223	120.35	122.83
Shandong	87.522	96.179	107.30	101.35
Henan	88.169	92.812	108.75	105.98
Hubei	90.899	92.168	112.01	108.03
Hunan	92.794	88.401	117.88	117.45
Guangdong	91.880	89.013	115.68	115.45
Guangxi	94.773	83.206	119.49	125.58
Sichuan	91.982	84.901	122.58	125.73
Guizhou	99.659	65.211	129.27	169.67
Yunnan	95.535	79.180	121.34	132.98
Xizang	108.11	61.053	124.02	175.08
Shanxi	93.870	89.587	114.09	111.91
Gansu	94.913	84.823	112.83	117.51
Qinghai	106.22	80.299	124.06	130.16
Ningxia	105.13	83.490	118.93	122.46
Xinjiang	97.287	84.190	113.13	119.16
sample mean	95.1408	87.5187	114.657	116.957
std deviat.				17.9691

TABLE 12 THE MEASUREMENT OF TECHNICAL PROGRESS BY EGAITSU-SHIGENO MODEL (2)

model	ln Y = ln a + aN lnN + aS lnS			
region	$Q_{1979-80}$	$Q_{1980-81}$	$Q_{1981-82}$	$Q_{1979-82}$
Beijing	102.43	100.48	109.37	112.40
Tianjin	102.36	103.43	100.30	108.77
Hebei	92.924	102.76	106.67	100.83
Shanxi	95.609	103.73	103.37	102.31
Neimenggu	95.117	114.41	91.469	90.909
Liaoning	95.907	100.13	112.50	106.75
Jilin	95.811	103.52	104.79	102.77
Heilongjiang	93.193	105.92	99.786	97.591
Shanghai	101.94	98.181	113.37	114.88
Jiangsu	93.227	100.11	112.58	103.90
Zhejiang	95.442	100.37	110.73	105.66
Anhui	93.420	103.34	107.52	100.40
Fujian	97.363	100.74	111.24	107.38
Jiangxi	94.607	103.07	104.03	101.09
Shandong	92.438	100.76	112.39	102.76
Henan	92.347	103.69	105.99	99.361
Hubei	93.521	102.85	105.93	100.71
Hunan	93.286	101.05	109.05	101.99
Guangdong	93.899	100.88	111.15	103.61
Guangxi	95.001	102.81	106.91	102.33
Sichuan	92.073	102.02	108.85	100.82
Guizhou	96.881	103.85	104.62	103.22
Yunnan	95.755	104.04	103.14	102.10
Xizang	106.72	113.07	82.552	102.21
Shanxi	94.988	104.55	101.86	100.80
Gansu	96.361	106.28	97.822	100.08
Qinghai	103.52	104.61	99.770	108.94
Ningxia	101.30	105.91	98.580	105.08
Xinjiang	96.864	106.24	98.282	100.45
sample mean	96.3549	103.545	104.642	103.106
std deviat.				4.55383

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