CHAPTER 6

THE EMPIRICAL RESULT

6.1 Labor Productivity

To estimate the value of labor productivity of Thailand, the partial productivity approach or the average productivity is applied as the following equation.

Labor Productivity = Q/L (3-2)

Q = the value of GDP of each sector (Baht)

L = the amount of employed persons in each Sector

To measure the changing value of labor productivity, the GDP at 1988 constant price, instead of commoditity price, is calculated.

First of all, the proportion of GDP and labor as the percentage to the whole economy is shown in the following table and graph:

Table 8 The share of GDP and labor classified by sector

	The agricultural sector		The industrial sector		The service sector	
	The Share in GDP1)	The Share of labor2)	The share in GDP1)	The share of labor2)	The share in GDP1)	The share of labor2)
1970	27.3	78.3	24.0	6.3	48.7	15.4
1971	27.2	76.7	24.9	6.9	47.9	16.4
1972	25.7	69.4	26.2	11.5	48.2	19.1
1973	25.3	69.7	26.6	10.7	48.1	19.6
1974	25.0	59.7	26.6	14.9	48.5	25.4
1975	24.8	58.6	26.7	15.1	48.5	26.4
1976	24.0	70.1	28.4	10.6	47.6	19.3
1977	22.4	67.9	29.8	11.5	47.7	20.5

	The agricultural sector		The industrial sector		The service sector	
	The Share in GDP[1)]	The Share of labor[2)]	The share in GDP[1)]	The share of labor[2)]	The share in GDP[1)]	The share of labor[2)]
1978	22.6	68.9	30.0	10.7	47.4	20.3
1979	21.0	64.9	30.4	13.5	48.6	21.6
1980	20.2	70.8	30.1	10.3	49.7	18.9
1981	20.1	64.2	30.5	12.8	49.5	23.0
1982	19.5	61.5	30.4	13.8	50.1	24.7
1983	19.4	63.1	31.8	13.0	48.8	23.8
1984	19.1	64.4	32.6	13.1	48.3	22.6
1985	19.1	63.5	31.6	13.0	49.4	23.5
1986	18.2	63.7	32.3	12.5	49.6	23.8
1987	16.6	59.8	33.7	14.3	49.8	25.9
1988	16.2	62.7	34.6	13.0	49.2	24.3
1989	15.8	61.1	36.2	14.4	48.0	24.5
1990	13.6	64.0	37.8	14.0	48.6	22.0
1991	13.4	54.0	39.0	19.2	47.6	26.8
1992	13.0	53.3	39.7	20.1	47.3	26.6
1993	11.7	53.0	40.5	19.5	47.8	27.4
1994	11.3	48.1	41.0	22.7	47.7	29.2
1995	10.7	46.7	41.8	23.0	47.6	30.3
1996	10.5	44.3	42.2	24.5	47.3	31.3
1997	10.5	43.7	42.0	23.9	47.4	32.4
1998	11.6	44.7	40.7	21.4	47.7	33.9
1999	11.3	45.3	42.9	20.3	45.8	34.4
2000	11.4	44.4	43.2	21.4	45.5	34.1
2001	10.1	42.2	44.3	23.3	45.6	34.5
2002	9.9	42.5	45.2	21.1	44.9	36.4
2003 Q(1-3)	9.4	40.6	46.3	21.9	44.3	37.6

Source: 1) National Economic and Social Development Board

2) Labor Force Survey

Roughly the view throughout 34 years of development is found that there are significant trends of labor and GDP share in each sector. "Thailand is the country of agiculture" is definitely true, but in the 30 years earlier when many of the thais, approximately 78% of employed person, sustains life by harvest. Presently, the percent of labor in agricultural sector falls to 40.6%. Labors have been moved into industrial and service sector. The amount of labor in industrial sector is shooting up by 15.6% and tends to continuous increase. Moreover, over 34 years, labor share grows 22.2% in the service sector.

As can be seen, the proportion of GDP in each sector to whole economy has also altered. A considerable decrease by 17.9% is in the agricultural sector. In contrast, the industrial sector performs the increasing proportion by 22.3%. The service sector has a tiny decline by 4.4 %.

Particularly considering each sector in Figure 9, we found that labor productivity of the agricultural sector is increased by the less decreasing share of labor than that of GDP. In the industrial sector, the slightly greater growth of GDP share comparing to labor share makes the continuously raising of labor productivity. A large diminishing trend of labor productivity of the service sector is due to the shooting up of labor share.

Figure 9 The share in GDP and the share of labor in each sector

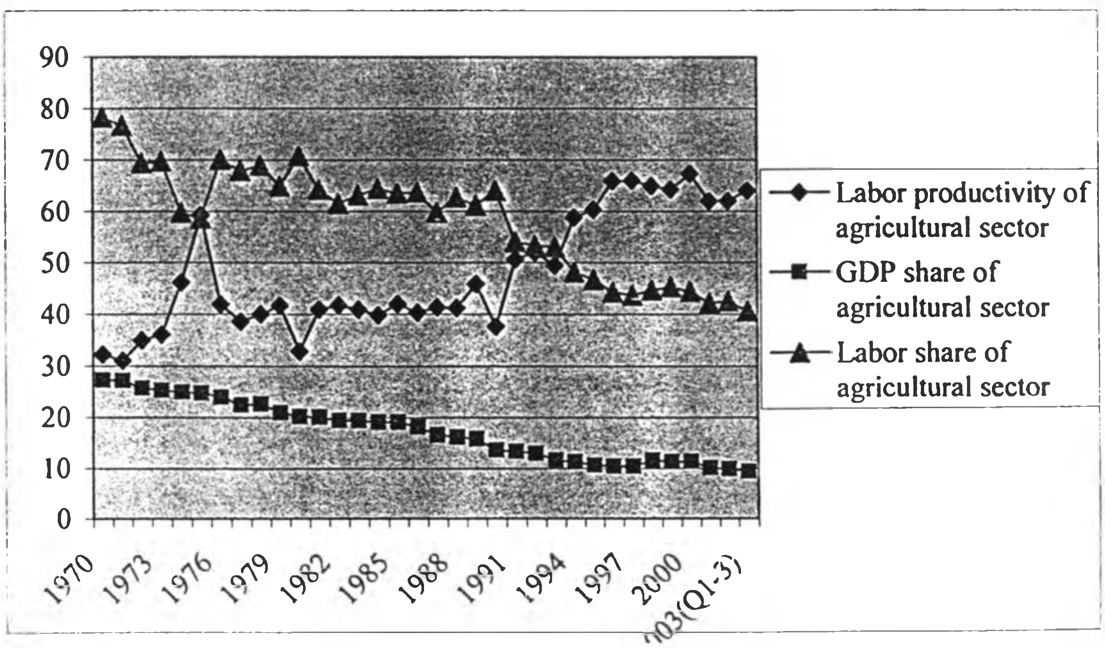


Figure 9A: The agricultural sector

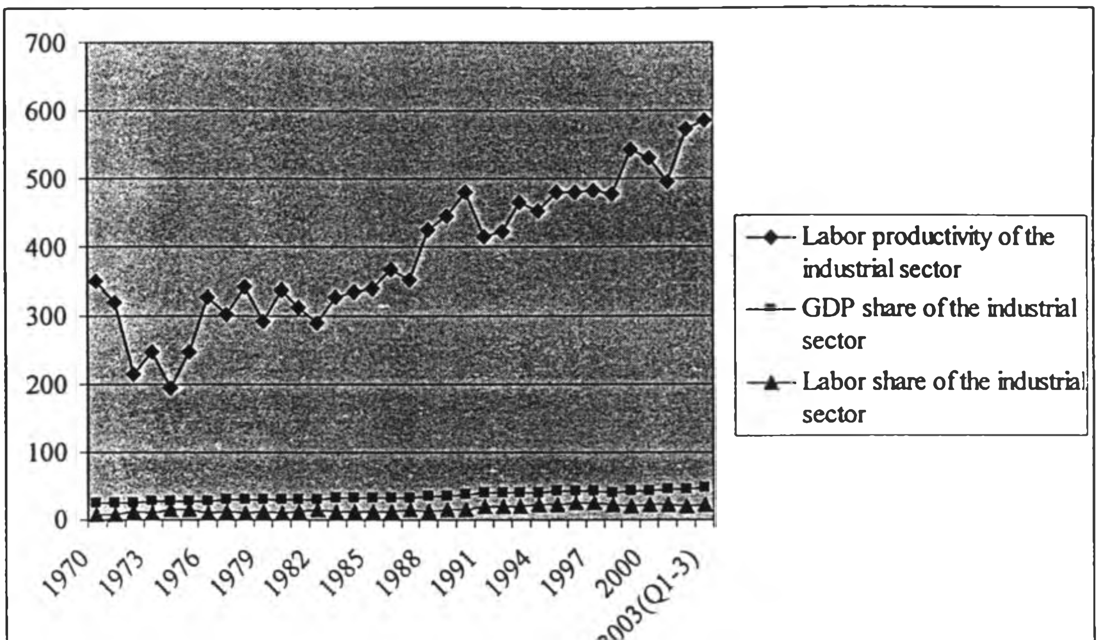


Figure 9B: The Industrial sector

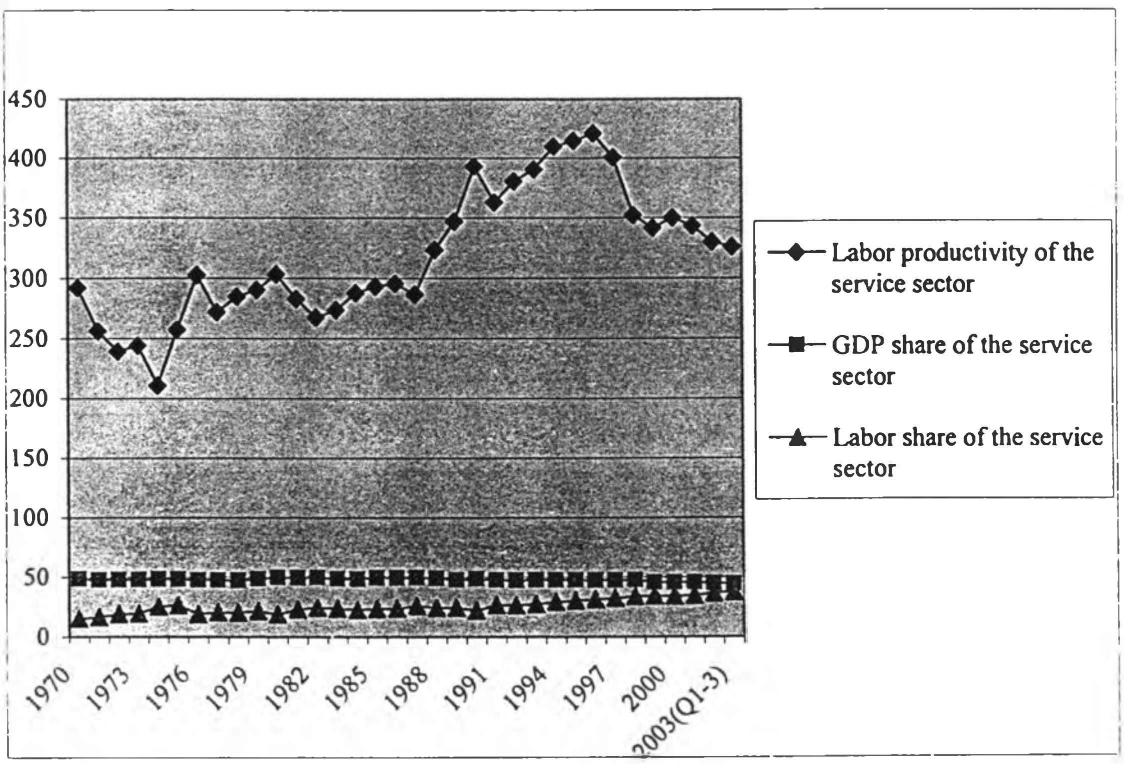


Figure 9C: The service sector

Remark: It should be remarked that the share of GDP and labor in each sector and labor productivity are calculated in a different unit, but these figures are interesting particularly on trend. The labor productivity in each sector is shown in Table 9.

As can be seen in Table 9, the productivities throughout 34 years of development of the agricultural, industrial, and service sector were 32.29, 350.41 and 292.18 baht per day at 1988 price, sequently. Considering among 3 sectors by simply subtract the beginning and end year, the labor productivity of the industrial sector has increased 234.25 baht, the labor productivity of service sector has increased 33.71 baht, and the least increment belongs to agricultural sector which is 31.73.

However, though 2 sectors contribute a tiny increase in value, the labor productivity increase of the whole economy is 183.79. It implies that the labor productivity of industrial sector has so increased that pushed the labor productivity of the whole economy up.

Table 9 Labor productivity classified by sector (Baht/Employed person)

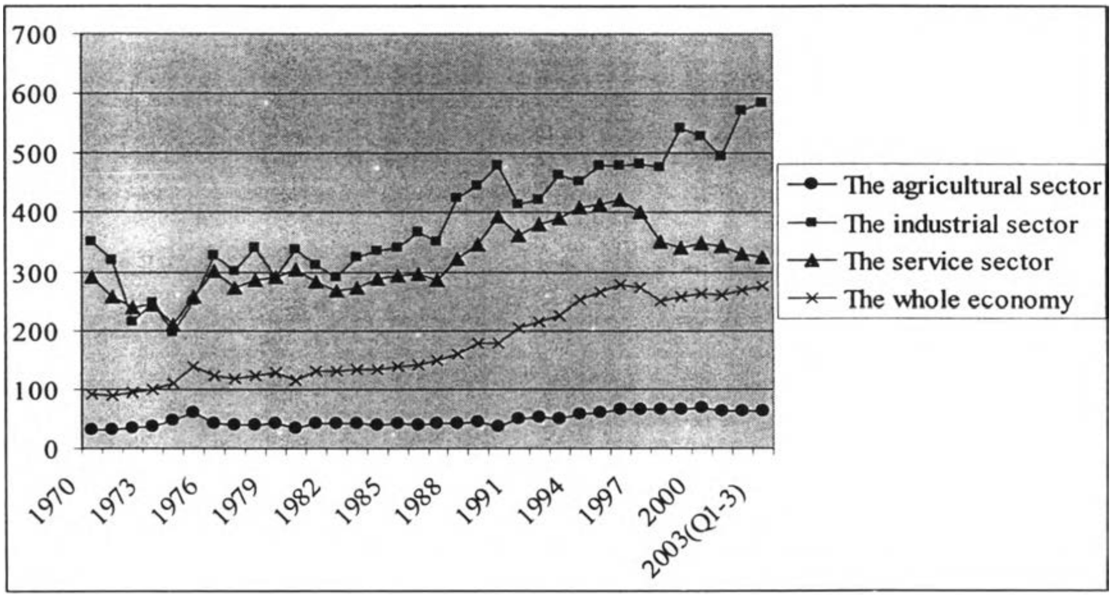
	Agricultural sector	**Industrial sector**	**Service sector**	**Whole economy**
1970	32.29	350.41	292.18	92.43
1971	31.11	319.88	256.15	87.86
1972	35.00	215.02	239.08	94.64
1973	36.09	246.48	243.80	99.39
1974	46.15	196.04	210.93	110.32
1975	59.20	248.04	257.14	139.87
1976	41.93	327.96	302.74	122.58
1977	38.61	302.64	272.08	117.02
1978	39.98	341.35	284.78	122.09
1979	41.68	291.96	290.35	129.09
1980	32.94	337.55	303.14	115.43
1981	40.96	311.45	282.85	131.18
1982	41.75	289.78	267.41	131.68
1983	40.95	326.39	273.59	133.59
1984	39.90	334.68	287.83	134.38
1985	42.01	340.44	293.06	139.79
1986	40.40	366.71	295.57	141.85
1987	41.38	352.19	286.69	149.26
1988	41.24	425.42	323.40	159.79

	Agricultural sector	Industrial sector	Service sector	Whole economy
1989	45.84	446.18	347.06	177.25
1990	37.70	480.05	392.82	177.92
1991	50.62	414.60	363.00	204.22
1992	52.00	422.51	380.52	213.72
1993	49.45	464.89	390.43	224.16
1994	58.79	452.57	409.67	250.79
1995	60.31	478.88	414.44	263.93
1996	65.91	479.49	420.91	278.10
1997	66.03	482.87	400.65	273.93
1998	64.95	476.80	352.03	250.35
1999	64.26	542.12	341.65	256.71
2000	67.35	528.84	349.93	262.80
2001	61.98	494.82	343.22	259.73
2002	62.00	572.63	329.84	267.26
2003(Q1-3)	64.02	584.66	325.89	276.22

Remark: 1.The labor productivity is calculated by GDP at the 1988 price divided by the average employed persons of the whole year.

2.The labor data earlier than 1997, having no periodical survey in harmony with the survey of GDP, are whole year averaged data.

Figure 10 Daily labor productivity classified by sector (1970-2003Q3)



The trend of labor productivity in industrial sector has significantly increased as shown in Figure 10. The agricultural has gradually increased. The labor productivity of service sector seems to be negatively affected by the economic crisis in 1997. This aspect must be carried on in the estimation.

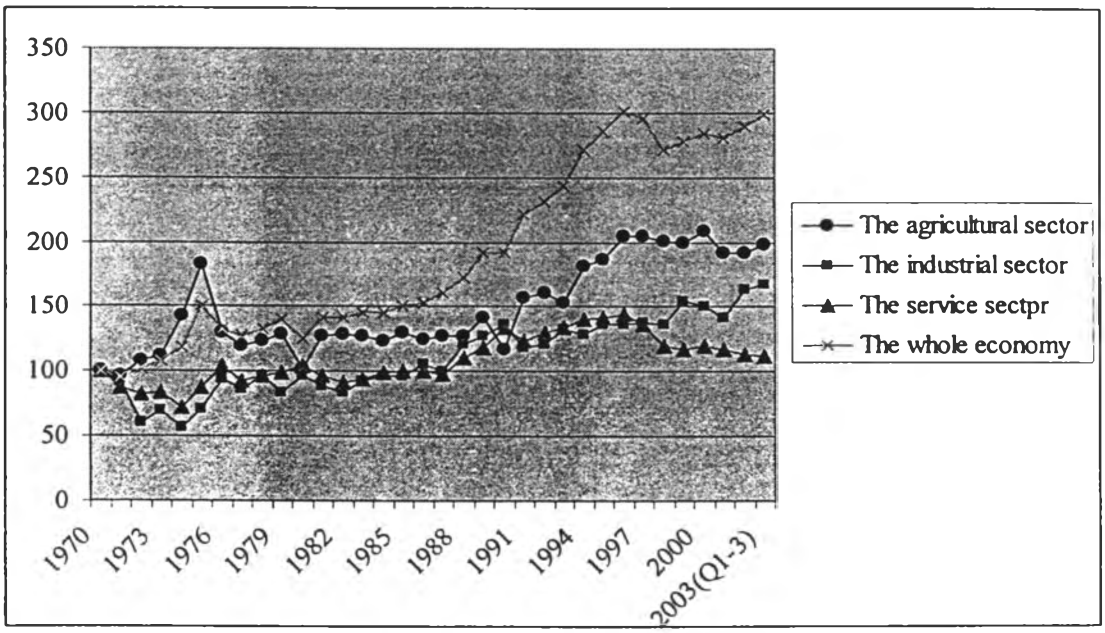
In order to demonstrate the increasing trend of labor productivity explicitly, the indexes are shown in the following table regarding 1970 as the based year.

Table 10 The index of labor productivity (1970=100)

	Agricultural sector	Industrial sector	Service sector	Whole economy
1970	100	100	100	100
1971	96	91	88	95
1972	108	61	82	102
1973	112	70	83	108
1974	143	56	72	119
1975	183	71	88	151
1976	130	94	104	133
1977	120	86	93	127
1978	124	97	97	132
1979	129	83	99	140
1980	102	96	104	125
1981	127	89	97	142
1982	129	83	92	142
1983	127	93	94	145
1984	124	96	99	145
1985	130	97	100	151
1986	125	105	101	153
1987	128	101	98	161
1988	128	121	111	173
1989	142	127	119	192
1990	117	137	134	192
1991	157	118	124	221

	Agricultural sector	Industrial sector	Service sector	Whole economy
1992	161	121	130	231
1993	153	133	134	243
1994	182	129	140	271
1995	187	137	142	286
1996	204	137	144	301
1997	205	138	137	296
1998	201	136	120	271
1999	199	155	117	278
2000	209	151	120	284
2001	192	141	117	281
2002	192	163	113	289
2003(Q1-3)	198	167	112	299

Figure 11 The index of labor productivity (1970=100)



The overall index shows that the labor productivity of the whole economy has been increased. The agricultural sector and industrial sector demonstrated its increasing trend, while service sector signifies its downward trend especially after the economic crisis.

Over 34 years, the index are found 98.27 percent increase in the agricultural sector which is the highest among sectors. It causes by the low initiative productivity; thus a small increase did make great proportion.

The fluctuations of labor productivity in each year demonstrate the ability to stabilize the productivity improvement of each sector. The labor productivity of the agricultural sector has highly fluctuated growth and has grown like the mirror of the industrial sector. The service sector has gradually increased, but not as much fluctuate as the others.

The following table shows the value and percentage increase and growth rate of the labor producitivity during 1970 – 2003 Q3. The growth rate of labor productivity is not only calculated by the mean of growth rate in each year.but also calculated as instantaneous(at the point of time) rate of growth and compound rate of growth. The formulas of instantaneous and comound rate of growth are demonstrated and explained in (5-3) to (5-9).

The growth rate of labor productivity of the whole economy is approximately 3.54 – 3.60. While the growth rate of agricultural, industrial, and service sector are well-nigh 2.1, 0.9, and 0.6. The instantaneous rate of growth shows the growth rate at the point of time, which are 2.08, 0.91, and 0.64 of agricultural, industrial, and service sector, sequently. Whereas, the growth rate over 34 years of each sector is 2.10, 0.91, and 0.64. Accoding to these 4 calculated indexes, the growth rate express in the same order. The most increasing sector is agricultural, followed by the industrial and service sector.

Table 11 Growth rate of labor productivity during 1970-2003 Q3

	Agricultural sector	**Industrial sector**	**Service sector**	**Whole economy**
Productivity increase(index increase)	1.98	1.67	1.12	2.99
Mean of growth rate in each year	2.17	0.97	0.68	3.54
Instantaneous rate of growth	2.08	0.91	0.64	3.54
Compound rate of growth	2.10	0.91	0.64	3.60

It should be noted that, from Table 11, the growth rate of labor productivity in industrial and secvice sector are quite low, approximately 0.91, and 0.64, sequently.

It is found that there has been the problem of scarcity of the skilled or technical employee, especially in science and engineering (For example, Puapongsakorn and Suzuki(1992), Panitchpakdi(2001:315-326)). The sectors which will be majorly effected are industry and service. Unfortunately, this problem will significantly increase its importance in the future.

The problems of skill promotion can be called as chronic problems. Those are reported by Ministry of Labor(1968) since 1968 that manpower supply was not relevant with the manpower demand, dropout rate was very high, the graduates did not utilize they had learnt, and most skills of the factory had unskilled and low educated labor. Moreover, the private company felt that the labor lack of interest and vocational concerns, which made them not interested in training employees.

The imposed solutions were to organize the Department of Skills Development, motivate the private sector to develop the labor productivity along with the public sector, change the bad attitude to vocational training to a better one, enhance the intense to teach of the professor and teacher by the appropriately appraisal system, open the skill training system and support the equipment to the present existed training center.

However, 26 years later, the problems have still persisted as the Board for Vocational Training and Skill Promotion(1994) reported the problem of developing labor skill:

- No national plan to develop the labor skill, making no direction of development and the irreverent of labor force and labor market
- Lack of cooperation to develop the labor skill and work-twice process.
- The skill training centers are centralized and very few
- The very few annum graduates
- The lack of local cooperation among public, private, and NGOs,
- No explicit system to encourage private to invest in labor development
- The unrecognized of labor standard importance through the National Occupational Skill Standards Committee establish are established in 1968.

There are some evidence from other studies that confirm the low and no significant increase of Thai's labor productivity compare to other countries such as Porter's study(2003) found that during 1995 – 2000, Thailand's labor productivity of the manufacturing sector is far behind leading Asian economies and productivity growth is lagging beyond others. Moreover, the general skill level of the Thai labor force is low and educational programs do not match company needs.

Some main industries are clarified as the sample clusters in his study such as tourism, automobile, and food processors. It is found that tourism has not been able to increase revenue per tourists over time. Even after the 1997 devaluation, revenues in terms of Thai Baht only remained stable, while tourists reduced their spending in terms of the US-Dollar. Automobile, another example, produced fewer cars per employee than the international benchmark countries and low labor cost allow Thai assembly plants to be cost competitive despite a much lower level of automation. Furthermore, thai food processors are trapped in a low-productivity, low-wage, low-skill system. Employees leave for more productive, better paying industries. Commonly, most companies compete on low input cost without paying attention to increase capability.

Thus, in conclusion, The result of the studies and other studies, even the Ministry of Labor of Thailand itself, are affirmed that Thailand has low labor productivity, and has slowly increased. The largest additional value of labor productivity is embodied in the industrial sector, but the highest growth of labor producitvity is generated in the agricultural sector. Throughout 34 years, the labor productivity of the whole economy has the growth rate well-nigh 3.60. The intererting sector is industrial and service sector due to its slow growth by 0.91 and 0.64, sequently.

6.2 The Effect of Public Capital and Private Capital to Labor Productivity

In order to investigate the impact of public capital to labor productivity and compare the role between public and private capital, or the second and third objective, the fit production function will be run and tested whether public capital and private capital are significant in each sector. The various specific of technological progress of Hicks, Harrod, and Solow augmenting are also added. Then, divided by L, the equations show the relation between labor productivity and public capital and private capital. The coefficients will identify the value of effect of public capital and private capital to the labor productivity. The working procedure of this section is described in 5.2.2.

Being noted that this study deals with time series data, the time trend and the nonstationary effect must be eliminated in order to prevent the spurious or nonsense regression.[1] After examining time trend in each sector, the variable embodied by time trend is detrended by subtracting the trend influence. The procedure of removing the trend is called detrending.

By taking the trended effect into account, it is found that most variables are under the influence of time trend represents in parabola relationship. It is so called a quadratic function or a second-degree polynomial in the trend as an exogenous variable, and may be written as:

$$X_i = c(1) + c(2)Trend + c(3)Trend^2 + u_i \qquad (6\text{-}1)$$

where X_i = the variable in sector i: *Y, K, G, L, Land* in each sector

After removed the trend effects, the equation remains only constant and residual, which equal to the variable deducted by trend effect [2]. Hence, the detrended variable will be employed into model.

6.2 .1 The Cobb-Douglas Production Function.

6.2.1.1 The Whole Economy

Necessary to mention, The whole Economy must be considered as an overview picture. The testing procedure is performed in 5.2.2. To briftly mention, the Wald test is brough to analyze by estimating and taking the test in (5-17) that β_A equals to zero. If it does equal, it implies to Hicks neutrality without *A(H)*. The estimation (5-61) is tested whether β_A equals to $\beta_K + \beta_G + \beta_L$.

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[1] This aspect is criticized by Munnell(1992) about the production functions estimated by aggregate time series data. However, mostly the criticized researches had done in US and Japanese region. Details in section 4.2

[2] The detrending equation of each variable demonstrates in the appendix II. The Augmented Dickey-Fuller test is used to test stationary of detrended variables. The hypothesis testing reject unit root at critical values 10%; thus,it can be decisively reject the null hypothesis of having unit root.

If it does equal, it is the Hicks neutrality. Similary, if it equals β_L, and $\beta_k + \beta_G$, it implies to be Harrod neutrality,and Solow neutrality, sequently.

Table 12 The result of coefficient test of the Cobb-Douglas Production Function of the whole economy

Techonological Approach	**Test coefficient of *A(H)* or β_A**	**Result**	**The acceptable technological progress**
Hicks neutrality ***Without A(H)*** ***Y =F(K,G,L)***	Equal to 0 (testing model (5-17))	Reject*	No
Hicks neutrality ***Y = A(H) F(K,G,L)***	Equal to $B_K + \beta_G + \beta_L$ (testing model (5-61))	Not reject	Yes
Harrod neutrality ***Y = F(K,G,A(H)L)***	Equal to β_L (testing model (5-61))	Not reject	Yes
Solow neutrality ***Y = F(AK,A(H)G,L)***	Equal to $B_K + \beta_G$ (testing model (5-61))	Reject*	No

Remark: * test at 99% significance

The Hicks and Harrod neutrality are the interesting functional forms for the whole economy as they do not reject the hypothesis. However, it is ambiguous to select one of them unless the estimated statistics are shown. Both of them must be considered its statistic value as well as the results of CES.

The rejection of the first test implies to the possibility to be Hicks neutrality with *A(H)* as a factor. The following table shows the results in various types of technical progress which also benefit us to determine the function of Hicks neutrality with *A(H)* as a factor and compare among functions. The acceptable functional forms, Hicks, Harrod neutrality and Hicks neutrality with *A(H)* as a factor, are bold and shown below.

Table 13 The estimations of Cobb-Douglas Production Function of the whole economy

	Hicks neutrality ***With A(H)*** **as a factor** ***Y =F(A(H),K,G,L)***	**Hicks neutrality** ***Without A(H)*** ***Y =F(K,G,L)***	**Hicks neutrality** ***Y=A(H) F(K,G,L)***	**Harrod neutrality** ***Y= F(K,G,AL)***	**Solow neutrality** ***Y= F(AK,AG,L)***
C(1)	**39,865,825.06 (2.075)****	21. 424 (0.394)	**386,176,362,602.846 (3.204)***	**3,227,810,885.561 (2.584)***	205,970.864 (1.192)
F	**-0.002 (-0.283)**	0.007 (0.801)			
LA	**-0.097 (-2.857)***				
LK	**1.081 (4.742)***	1.289 (5.185)*	**0.974 (4.005)***	**1.125 (4.814)***	0.988 (3.555)*
LG	**-0.456 (-2.267)***	-0.754 (-3.808)*	**-0.787 (-4.714)***	**-0.675 (-3.857)***	-1.002 (-5.856)*
LL	**0.113 (0.228)**	0.111 (0.194)	**-0.822 (-2.535)***	**-0.655 (-2.259)***	-0.048 (-0.085)
D_{crisis}	**0.172 (0.550)**	0.505 (1.516)	**0.181 (0.568)**	**0.249 (0.834)**	0.476 (1.386)
Adj R^2	**0.733**	0.646	**0.681**	**0.710**	0.592
DW	**1.579**	1.479	**1.434**	**1.630**	1.159
AK	**0.173**	0.430	**0.298**	**0.202**	0.544
SC	**0.506**	0.715	**0.536**	**0.440**	0.782

Remark: The values in parathesis are t statistics

* test at 99% significance

** test at 95% significance

Considering the first 2 estimated functions, it is found that the Hicks neutrality without *A(H)* is embodied by autocorrelation degree 2, which might imply to the spurious functional form. Moreover, it can be seen from the table that the Adjusted R^2 of the function that included *A(H)* is higher, excluding the significant coefficient of intercept. Thus, it is possible that *A(H)* works as a factor of production. It should be noted that the Hicks neutrality or *F* is not significant.

The function with Solow neutrality has the low Durbin-Watsan statistics while other's are not.It might imply to the spurious function. However, It is found that Hicks neutrality is inconclusive to be autocorrelation problem and other statistics are worse than the other 2 interesting function, Hicks with *A(H)* as an input and Harrod neutrality. Thus, there are 2 functional forms left to be considered.

Public and private capital do have effect on output as shown in every function, though in the diverse direction. Labor has an effect on output only when *A(H)* embodies with the labor, or in Harrod and Hicks neutrality.

6.2.1.2 The Agricultural Sector

Similar to the whole economy analysis, the Wald test and the same procedure is brought to analyze as stated in 5.2.2.1.

Table 14 The result of coefficient test of Cobb-Douglas Production Function of the agricultural sector

Techonological Approach	**Test coefficient of** ***A(H)*** **or** β_A	**Result**	**The acceptable technological progress**
Hicks neutrality ***Without A(H)*** ***Y =F(K,G,L,Land)***	Equal to 0 (testing model (5-17))	Reject**	No
Hicks neutrality ***Y = A(H) F(K,G,L,Land)***	Equal to $B_K + \beta_G + \beta_L$ (testing model (5-61))	Reject**	No
Harrod neutrality ***Y = F(K,G,A(H)L,Land)***	Equal to β_L (testing model (5-61))	Not reject	Yes
Solow neutrality ***Y = F(AK,A(H)G,L,Land)***	Equal to $B_K + \beta_G$ (testing model (5-61))	Reject*	No

Remark: * test at 99% significance
** test at 80% significance

The tests of this sector identify to Harrod neutrality, and Hicks neutrality with input *A(H)*. The following table shows the estimations of various technological approach and Hicks neutrality with *A(H)* as a factor as well.

Table 15 The estimations of Cobb-Douglas Production Function of the agricultural sector

	Hicks neutrality ***With A(H) as a factor Y =F(A(H),K, G,L)***	**Hicks neutrality** ***Without A(H) Y =F(K,G,L)***	**Hicks neutrality** ***Y = A(H) F(K,G,L)***	**Harrod neutrality** ***Y = F(K,G,AL)***	**Solow neutrality** ***Y = F(AK,AG,L)***
C(1)	**513.677** **(0.327)**	0.0001 (-0.517)	1,041,237.013 (7.363)*	**0.0001** **(-0.524)**	5,921,703,5 12.864 (1.351)
F	**0.006** **(1.843)****	0.001 (0.536)			
LA	**-0.080** **(-1.497)**				
LK	**0.246** **(1.001)**	0.537 (2.681)*	0.495 (3.808)*	**0.597** **(4.078)***	0.171 (2.874)*
LG	**-0.063** **(-1.580)**	-0.073 (-1.806)**	-0.103 (-2.795)*	**-0.081** **(-2.129)***	-0.141 (-3.427)*
LL	**0.005** **(0.062)**	0.015 (0.207)	0.012 (0.158)	**0.000** **(1.000)**	-0.069 (-0.842)
LLAND	**0.214** **(0.232)**	0.796 (0.925)	-0.398 (-2.149)*	**0.774** **(0.869)**	-0.602 (-0.654)
Dummy crisis	**-0.032** **(-0.297)**	0.112 (1.389)	0.1215 (2.326)*	**0.143** **(2.707)***	0.057 (1.071)
Adj R^2	**0.489**	0.432	0.410	**0.454**	0.220
DW	**2.080**	2.093	2.069	**2.179**	1.536
AK	**-2.807**	-2.761	-2.7107	**-2.787**	-2.431
SC	**-2.427**	-2.431	-2.425	**-2.501**	-2.146

Remark: The values in parathesis are t statistics

* test at 99% significance

** test at 90% significance

Almost all functions demonstrate the importance of private capital in a positive direction, and the public capital in a negative direction. The labor in every estimation exhibits the insignificance to output. Harrod neutreality shows that the economic crisis makes a positive effect in this sector

As can be seen from the table that though Hick neutrality with *A(H)* as a factor has higher value of Adj R^2 compared to Harrod neutrality, most of its variables are insignificant. However, we must carry on the result in a later analysis. Thus, in conclusion, there are the Hicks neutrality with *A(H)* and Harrod neutreality catching attention.

6.2.1.3 The Industrial Sector

The coefficient test which is described the working process in 5.2.2.1.6 is applied. The outcomes are shown in the following table.

Table 16 The result of coefficient test of Cobb-Douglas Production Function of the industrial sector

Techonological Approach	**Test coefficient of *A(H)* or β_A**	**Result**	**The acceptable technological progress**
Hicks neutrality *Without A(H)* *Y =F(K,G,L)*	Equal to 0 (testing model (5-17))	Reject**	No
Hicks neutrality *Y = A(H) F(K,G,L)*	Equal to $B_K + \beta_G + \beta_L$ (testing model (5-61))	Reject*	No
Harrod neutrality *Y = F(K,G,A(H)L)*	Equal to β_L (testing model (5-61))	Reject*	No
Solow neutrality *Y = F(A(H)K,A(H))*	Equal to $B_K + \beta_G$ (testing model (5-61))	Not reject	Yes

Remark: * test at 95% significance

** test at 85% significance

There are 2 interesting functional forms, Hicks neutrality with *A(H)* as an input and Solow neutrality. For the reason that they are not rejected the hypothesis. Interestingly shown in the following table, the yielded statistics of production function with *A(H)* as a factor behave the overall better value than those of others. The Adjusted R squared of Hicks neutrality with *A(H)* as a factor is higher than of Solow neutrality.

Table 17 The estimations of Cobb-Douglas Production Function of the industrial sector

	Hicks neutrality *With A(H) as a factor* *Y =F(A(H),K,G,L)*	**Hicks neutrality** *Without A(H)* *Y =F(K,G,L)*	**Hicks neutrality** *Y = A(H) F(K,G,L)*	**Harrod neutrality** *Y = F(K,G,AL)*	**Solow neutrality** *Y = F(AK,AG,L)*
C(1)	**5,949,810.927 (2.854)***	4,531.163 (4.041)*	24,597.990 (2.108)*	1,138.358 (2.237)*	**808,349.66 (2.779)***
F	**0.016 (1.863)****	0.012 (1.626)			
LA	**-0.590 (-1.780)****				
LK	**0.688 (2.168)***	0.626 (2.247)*	0.691 (1.910)*	1.027 (3.374)*	**0.453 (1.364)**
LG	**-0.549 (-2.742)***	-0.597 (-2.962)*	-0.831 (-4.012)*	-0.862 (-4.342)*	**-0.656 (-3.056)***
LL	**0.255 (1.435)**	0.294 (1.750)**	0.202 (1.030)	0.071 (0.425)	**0.382 (2.040)***
Dummy crisis	**-1.126 (-3.733)***	-0.897 (-3.038)*	-0.627 (-2.162)*	-0.641 (-2.205)*	**-0.689 (-2.545)***
Adj R^2	**0.792**	0.758	0.718	0.720	**0.750**
DW	**1.899**	1.803	1.614	1.667	**1.833**
AK	**0.596**	0.640	0.848	0.841	**0.726**
SC	**0.929**	0.920	1.086	1.079	**0.964**

Remark: The values in parathesis are t statistics

* test at 99% significance

** test at 90% significance

Every function points out that this sector has been effected by the crisis, causing a negative structural change. The public capital is significantly negative, but the private capital is significantly positive. There is an underlined characteristic of the industrial sector on the best value of Durbin-Watson stat among sectors and the whole economy, and no serial correlation shows in every equation. Those 2 functional forms, Hicks neutrality with *A(H)* as a factor and Solow neutrality must be analyzed to choose one of them associated with the CES's result and the additional test.

6.2.1.4 The Service Sector

The service sector encounters with the difficulty to collect or access the exact data in both public and private sector, especially the GDP and labor.

The reason is mainly stated as character of this sector, for example, in the private sector, the income or output of taxi drivers, waiters, or caddied are hard to calculate; moreover, they tend to inform smaller amount of income in order to avoid the tax collector. Hence, the figures are normally underestimate. In the other aspect, the government services are grouped in this sector; thus, some social value might possibly be neglected. (Kraipornsak,1995) However, the figures are universal applicable as it is the best data in the present existence.

The outcomes of the coefficient test working as the procedure described in 5.2.2.1.6 are shown below.

Table 18 The result of coefficient test of Cobb-Douglas Production Function of the service sector

Techonological Approach	Test coefficient of *A(H)*	Result	The acceptable technological progress
Hicks neutrality *Without A(H)* *Y =F(K,G,L)*	Equal to 0 (testing model (5-17))	Reject *	No
Hicks neutrality *Y = A(H) F(K,G,L)*	Equal to $B_K + \beta_G + \beta_L$ (testing model (5-61))	Reject*	No
Harrod neutrality *Y = F(K,G,A(H)L)*	Equal to β_L (testing model (5-61))	Reject *	No
Solow neutrality *Y = F(A(H) K,A(H))*	Equal to $B_K + \beta_G$ (testing model (5-61))	Reject*	No

Remark: * test at 99% significance

Every test rejects to hypothesis, which might indirectly be implied that the *A(H)* do has its effect or work as a factor instead of a technical approach proxy, or the testing estimated model does face a mathmetic problem, such as autocorrelation. Thus, in order to select a fit model, it must take every variables and statistic into account with deliberate considering. The following table shows the estimating results.

It is found that the estimation with *A(H)* as a factor is significant and has the highest adjusted R squared. However, the serial correlation degree one is shown at 95%. The other functional forms are facing the similar problem except Harrod neutrality. It is possible that the autocorrelation reflects the spurious production functions. Thus, the Harrod neutrality is the best functional form among the various technological progresses.

It must be noted that even the general implication, Hicks without *A(H)*, has such this kind of problem. The private capital is positively significant in every estimation. The public capital, excluding only in Hicks with *A(H)* as a factor, has a negative affect to output.

Table 19 The estimations of Cobb-Douglas Production Function of the service sector

	Hicks neutrality ***With A(H) as a factor*** ***Y =F(A(H),K,G,L)***	**Hicks neutrality** ***Without A(H)*** ***Y =F(K,G,L)***	**Hicks neutrality** ***Y = A(H) F(K,G,L)***	**Harrod neutrality** ***Y = F(K,G,AL)***	**Solow neutrality** ***Y = F(AK,AG,L)***
C(1)	53,102,257.530 (3.134)*	5.169 (0.332)	565,601,316.409 (2.799)*	**43,923,058.907 (2.791)***	386.896 (0.849)
F	0.146 (0.523)	0.002 (0.216)			
LA	-1.286 (-4.375)*				
LK	0.920 (5.206)*	1.188 (5.099)*	1.003 (4.096)*	**1.158 (5.836)***	0.834 (3.241)*
LG	-0.213 (-1.260)	-0.737 (-3.817)*	-0.582 (-2.792)*	**-0.337 (-1.892)****	-0.914 (-6.045)*
LL	0.515 (1.230)	0.402 (0.684)	-0.916 (-2.202)*	**-0.746 (-2.740)***	0.895 (1.485)
Dummy crisis	0.146 (0.523)	0.765 (2.142)**	0.499 (1.382)	**0.478 (1.577)**	0.581 (1.488)
Adj R-squared	0.812	0.607	0.634	**0.724**	0.595
DW	1.391	1.175	1.147	**1.459**	1.019
AK	-0.008	0.670	0.622	**0.341**	0.722
SC	0.342	0.950	0.860	**0.579**	0.960
AR(1) Test at 95%	yes	yes	yes	**no**	yes

Remark: The values in parathesis are t statistics

* test at 99% significance

** test at 95% significance

In conclusion, for Cobb Douglas Produciton Function some sectors have its unique character while some are undecisively identified. In the first stage analysis, the conclusion is performed in the table below and will be analyzed further with the results of CES Production Function.

Table 20 The selected technological progress of each sector and the whole economy of Cobb-Douglas Production Function

Techonological Approach	Whole economy	Agricutural sector	Industrial sector	Service sector
Hicks neutrality ***With A(H) as a factor*** ***Y =F(A(H),K,G,L)***	*	*	*	
Hicks neutrality ***Y = A(H) F(K,G,L)***				
Hicks neutrality ***Without A(H)*** ***Y =F(K,G,L)***				
Harrod neutrality ***Y = F(K,G,A(H)L)***	*	*		*
Solow neutrality ***Y = F(AK,A(H)G,L)***			*	

It should be noticed that the major technological approaches in production function are the Harrod neutrality with *A(H)* and the Harrod neutrality.

6.2.2 The Constant Elasticity of Substitution Production Function

The CES Production Function represents the production function with an unspecified constant elasticity of substitution. The results of the difference technological augmentations will be estimated as mentioned in 5.2.2.2.6 Then, labor productivity, private capital and public capital will be evaluated and compared the relationship among them by the coefficients and the other statistic values.

It must be noted that the estimations expressed in table 7 are used in this section. It will undoubtedly bring a great number of coefficients; thus, the mathematical method is used to calculate each coefficient. The results are displayed in the following tables:

6.2.2.1 The Whole Economy

Since the CES will be tested the coefficient whether it equals to a varius technical progress or not, the testing result are as below. The hypotheses as well as the tested estimations are performed in Table 21.

Table 21 The result of coefficient test of CES Production Function of the whole economy

Techonological Approach	**Test coefficient of log*A(H)***	**Result**	**The acceptable technological progress**
Hicks neutrality ***With A(H) as a factor*** ***Y =F(K,G,L)***	Equal to 0 (testing model(5-81))	Reject*	Yes
Hicks neutrality ***Y = A(H) F(K,G,L)***	Equal to v (testing model(5-104))	Not Reject	Yes
Harrod neutrality ***Y = F(K,G,A(H)L)***	Equal to δ_L (testing model(5-113))	Not Reject	Yes
Solow neutrality ***Y = F(A(H)K,A(H)G,L)***	Equal to $(\delta_K + \delta_G)$ (testing model(5-121))	Reject*	No

Remark: * test at 99% significance

The result of CES unites with the result of CD. However, the following table reflects the best functional form of the Hicks neutrality with factor *A(H)* by the better Adjusted R-squared. Besides, among three functional forms, only Hicks neutrality with factor *A(H)* shows no autocorrelation, while those 3 functions do not show this kind of problem in CD Production Function. Therefore, the Hicks neutrality with *A(H)* as a factor is the most interesting function and might decisively be chosen as the function for the whole economy.

Table 22 The estimations of CES Production Function of the whole economy

CES	Hicks neutrality *With A(H) as a factor* *Y =F(A(H),K,G,L)*	Hicks neutrality *Without A(H)* *Y =F(K,G,L)*	Hicks neutrality *Y = A(H) F(K,G,L)*	Harrod neutrality *Y = F(K,G,AL)*	Solow neutrality *Y = F(AK,AG,L)*
C	**13,988.852 (2.019)***	1,623.747 (1.077)	**202,319,765.2 (2.649)***	**8.875 (0.202)**	29,997.8203 (0.918)
υ	**0.002**	0.00007			
δ_K	**1.602**	2.231	**- 0.357**	**0.887**	0.551
δ_G	**-0.676**	-0.982	**0.202**	**0.115**	-0.496
δ_L	**0.043**	-0.249	**1.156**	**-0.001**	0.945
δ_A	**0.031**				
ν	**0.766**	0.285	**-0.381**	**1.560**	0.001
ρ	**-0.015**	0.165	**-0.224**	**2.688**	0.000
Dummy crisis	**0.108 (0.350)**	0.411 (1.336)	**0.329 (0.950)**	**0.302 (1.036)**	0.431 (1.141)
Adjusted R^2	**0.731**	0.663	**0.662**	**0.716**	0.584
DW	**1.472**	1.328	**1.024**	**0.736**	1.085
AK	**0.181**	0.381	**0.568**	**0.208**	0.591
SC	**0.514**	0.666	**0.853**	**0.494**	0.877
Elasticity of Substitution	**0.778**	0.245	**-0.491**	**0.423**	0.001

Remark: The values in parathesis are t statistics

* test at 99% significance

6.2.2.2 The Agricultural Sector

The coefficient tests of Agricultural sector are demonstrated below.

Table 23 The result of coefficient test of CES Production Function of the agricultural sector

Techonological Approach	Test coefficient of log*A(H)*	Result	The acceptable technological progress
Hicks neutrality *Witht A(H) as a factor* *Y =F(K,G,L,Land)*	Equal to 0 (testing model(5-81))	Reject*	Yes
Hicks neutrality *Y = A(H) F(K,G,L,Land)*	Equal to v (testing model(5-104))	Reject*	No
Harrod neutrality *Y = F(K,G,A(H)L,Land)*	Equal to δ_L (testing model(5-113))	Not reject	Yes
Solow neutrality *Y = F(A(H)K,A(H)G,Land)*	Equal to $(\delta_K + \delta_G)$ (testing model(5-121))	Not reject	Yes

Remark: * test at 80% significance

Hicks neutrality is ignored because it rejects the null hypothesis. Besides, Hick neutrality without *A(H)* are also abandoned according to the implication of the Hicks with input *A(H)*.

According to CD coefficient test, only Hicks neutrality without *A(H)* and Harrod neutrality are spotlighted, while this section indicates 3 interesting functions. As can be seen from the following table, Hicks neutrality with *A(H)* as a factor performs quite good result similar to the Harrod neutrality. But, its overall result is slightly worse than of the Harrod. Thus, the Harrod neutrality is selected as a functional form of CES of this sector. It should be observed the coefficients of Hicks neutrality with *A(H)* as an input factor in CD Production Function are mostly insignificant.

Table 24 The estimations of CES Production Function of the agricultural sector

CES	Hicks neutrality *With A(H) as a factor* *Y =F(A(H),K,G,L)*	Hicks neutrality *Without A(H)* *Y =F(K,G,L)*	Hicks neutrality *Y = A(H) F(K,G,L)*	Harrod neutrality *Y = F(K,G,AL)*	Solow neutrality *Y = F(AK,AG,L)*
C(1)	**0.000639 (-0.344)**	0.00026 (-0.449)	1.008 (0.044)	**0.00035 (-0.479)**	**782.182 (0.009)**
υ	**0.010**	0.003			
δ_K	**0.634**	0.860	0.723	**0.603**	**0.277**
δ_G	**0.024**	0.003	0.169	**0.075**	**- 0.245**
δ_L	**0.005**	0.128	- 0.089	**0.101**	**- 0.185**
δ_A	**0.053**				
δ_{LAND}	**0.284**	0.009	0.196	**0.221**	**153.025**
ν	**1.382**	- 1.103	0.008	**1.020**	**0.024**
ρ	**- 0.670**	0.564	0.003	**-0.158**	**- 0.020**
Dummy crisis	**0.143 (2.599)***	0.142 (2.703)*	0.118 (1.615)	**0.142 (2.653)***	**0.058 (0.782)**
Adjusted R-squared	**0.406**	0.434	0.386	**0.433**	**0.165**
DW	**2.183**	2.178	2.062	**2.161**	**1.467**
AK	**-2.656**	-2.762	-2.645	**-2.724**	**-2.338**
SC	**-2.275**	-2.432	-2.312	**-2.391**	**-2.005**
Elasticity of Substitution	**4.188**	- 0.705	0.008	**1.211**	**0.024**

Remark: The values in parathesis are t statistics

* test at 99% significance

6.2.2.3 The Industrial Sector

The hypothesis testing of coefficient is performed in Table 7 and carried on in this section. The following table confirms the results of CD that the Hicks neutrality without *A(H)* and Solow neutrality are the interesting cases.

Table 25 The result of coefficient test of CES Production Function of the industrial sector

Techonological Approach	Test coefficient of log*A(H)*	Result	The acceptable technological progress
Hicks neutrality ***With A(H) as a factor*** ***Y =F(K,G,L)***	Equal to 0 (testing model(5-81))	Reject*	Yes
Hicks neutrality ***Y = A(H) F(K,G,L)***	Equal to v (testing model(5-104))	Reject*	No
Harrod neutrality ***Y = F(K,G,A(H)L)***	Equal to δ_L (testing model(5-113))	Reject*	No
Solow neutrality ***Y = F(A(H)K,A(H)G,L)***	Equal to $(\delta_K + \delta_G)$ (testing model(5-121))	Not Reject	Yes

Remark: * test at 95% significance

In this sector the Hicks neutrality which is included the *A(H)* as a factor of production is our alternative as well as Solow neutrality. The following table indicates that Hicks neutrality without *A(H)* has the negative v value, which conflicts to the CES's property. Thus, only Hicks with *A(H)* as a factor, and Solow neutrality are left to analyze.

Being compared the general result of both 2 functions, the first one has a slightly better result as the greater Adjusted R squared. Therefore, this study will employ the Hicks neutrality with *A(H)* as a factor in the later analysis.

Table 26 The estimations of CES Production Function of the industrial sector

CES	Hicks neutrality *With A(H) as a factor* *Y =F(A(H),K,G,L)*	Hicks neutrality *Without A(H)* *Y =F(K,G,L)*	Hicks neutrality *Y = A(H) F(K,G,L)*	Harrod neutrality *Y = F(K,G,AL)*	Solow neutrality *Y = F(AK,AG,L)*
C(1)	**35,011,250.13 (0.260)**	**4,963.324 (2.974)***	24,516.46 (1.741)	795.450 (1.901)**	**911,566.658 (2.182)****
υ	**0.015**	**0.001**			
δ_K	**0.421**	**0.393**	0.513	0.289	**0.692**
δ_G	**0.315**	**0.221**	0.136	0.220	**0.194**
δ_L	**0.156**	**0.386**	0.350	0.492	**0.114**
δ_A	**0.107**				
ν	**0.582**	**-0.308**	0.061	-0.375	**0.182**
ρ	**0.053**	**0.040**	-0.0001	0.042	**0.004**
Dummy crisis	**-0.858 (-3.375)***	**-0.678 (-2.218)***	-0.627 (-1.909)**	-0.677 (-1.995)**	**-0.692 (-2.374)***
Adjusted R^2	**0.774**	**0.733**	0.705	0.709	**0.739**
DW	**1.821**	**1.801**	1.613	1.633	**1.827**
AK	**0.677**	**0.769**	0.919	0.905	**0.798**
SC	**1.010**	**1.019**	1.205	1.190	**1.083**
Elasticity of Substitution	**0.553**	**-0.296**	0.061	-0.360	**0.181**

Remark: The values in parathesis are t statistics

* test at 99% significance

** test at 95% significance

6.2.1.4 The Service Sector

According to the estimated result of CD which is decisively reject in every technical approach, the following process is tested to reaffirm the result.

Table 27 The result of coefficient test of CES Production Function of the service sector

Techonological Approach	Test coefficient of log*A(H)*	Result	The acceptable technological progress
Hicks neutrality ***WithA(H)as a factor*** ***Y =F(K,G,L)***	Equal to 0 (testing model(5-81))	Reject*	Yes
Hicks neutrality ***Y = A(H) F(K,G,L)***	Equal to v (testing model(5-104))	Reject*	No
Harrod neutrality ***Y = F(K,G,A(H)L)***	Equal to δ_L (testing model(5-113))	Reject*	No
Solow neutrality ***Y = F(A(H)K,A(H)G,L)***	Equal to $(\delta_K + \delta_G)$ (testing model(5-121))	Reject*	No

Remark: * test at 99% significance

The coefficient tests of CES is similar to those of CD, reject every hypothesis. It implies 2 implications: firstly, the tested equation is failed due to mathematic problem as the estimation of CD, or secondly, it is the Hicks neutrality with *A(H)* as a factor as the result of coefficient test.

Considering in the following various estimations, we found that Harrod neutrality gives us the most interesting result as well as its acceptable Durbin-Watson stat, while others are not. The autocorrelation degree 1 is found in every functional form except production function with Harrod neutrality. Despite the fact that adding autocorrelation in the estimation should improve the overall estimation, the outcome is converse. Thus, we can decisively select Harrod neutrality to practice in this sector.

Table 28 The estimations of the CES Production Function of the service sector

CES	Hicks neutrality *With A(H) as a factor Y =F(A(H),K,G,L)*	Hicks neutrality *Without A(H) Y=F(K,G,L)*	Hicks neutrality *Y = A(H) F(K,G,L)*	Harrod neutrality *Y = F(K,G,AL)*	Solow neutrality *Y =F(AK,AG,L)*
C(1)	69,490,457.57 (2.151)*	202,319,765.2 (2.649)*	8,213,740,000 (0.037)	**85.018 (0.792)**	21.654 (0.658)
υ	0.052	0.024			
δ_K	0.375	0.720	0.557	**0.554**	0.000
δ_G	0.080	-0.619	0.202	**0.164**	- 0.0002
δ_L	0.142	0.899	0.241	**0.282**	1.000
δ_A	0.403				
ν	0.008	0.141	-0.381	**0.462**	1.172
ρ	0.001	0.020	-0.224	**0.194**	- 0.719
Dummy crisis	0.136 (0.515)	0.643 (1.755)*	-0.381 (0.950)	**0.469 (1.515)**	0.551 (1.418)
Adj R'	0.814	0.621	0.662	**0.733**	0.617
DW	1.228	0.957	1.024	**1.408**	1.181
AK	-0.002	0.633	0.568	**0.335**	0.695
SC	0.331	0.914	0.854	**0.620**	0.980
Elasticity of Substitution	0.008	0.138	-0.491	**0.387**	4.171

Remark: The values in parathesis are t statistics

* test at 99% significance

At this point, the models were tested by coefficient and general estimation whether it is possible in various technological approaches in both CD and CES Production Function. The summary results of the selected technical progress of each sector including the whole economy are shown below.

Table 29 The selected technological progress of each sector and the whole economy of CES Production Function

	Approach
The Whole economy	Hicks neutrality with *A(H)* as a factor
The agricultural sector	Harrod neutrality
The industrial sector	Hicks neutrality with *A(H)* as a factor
The service sector	Harrod neutrality

The flags of the chosen model are lined on the path of testing; however, the solid determination of chosing the CD or CES in each sector cannot be concluded unless the results of CES Production Function are examined by testing the elasticity of substitution.

6.2.3 The Elasticity of Substitution Test

In order to determine whether it is the CD or CES, the elasticity of substitution is required. Relying on the fact that the CD always has elasticity of substitution equal to one and CES has constant elasticity at any value, The elasticity of substitution is tested as one can to determine the functional form. The hypothesis is established as the elasticity of substitutution equal to one by once more practicing the Wald test.The null hypothesis is defined by:

$$H_0: \sigma = \frac{V}{\rho+1} = 1 \qquad (6\text{-}2)$$

The results of testing hypothesis are shown in the following table:

Table 30 The result of elasticity of substitution test

	Approach	Result	The selected functional form
The Whole economy	Hicks neutrality with *A(H)* as a factor	Not reject	Cobb-Douglas Production Function
The agricultural sector	Harrod neutrality	Not reject	Cobb-Douglas Production Function
The industrial sector	Hicks neutrality with *A(H)* as a factor	Not reject	Cobb-Douglas Production Function
The service sector	Harrod neutrality	Not reject	Cobb-Douglas Production Function

Remark: Test at 95% significance
* marks the selected equation of each sector.

Every selected equation is not rejected the hypothesis that the elasticity of substitution equals to one; hence, its property signifies itself as Cobb-Douglas Production Function.

To conclude the result of the estimation and coefficient test, and the elasticity of substitution test, the following table is shown the most appropriate production function in each sector and the whole economy.

Table 31: The practical production function used in the study

	Production Function	Approach
The Whole economy	Cobb-Douglas	Hicks neutrality with *A(H)* as a factor
The agricultural sector	Cobb-Douglas	Harrod neutrality
The industrial sector	Cobb-Douglas	Hicks neutrality with *A(H)* as a factor
The service sector	Cobb-Douglas	Harrod neutrality

Since we have the fit production function for each sector, the labor productivity is analyzed the effect of public and private capital as clearified in section 6.2.4

6.2.4 The Result and Analysis

By working on section 6.2.1 to 6.2.3, the fit models in each sector are summarized in Table 32. The estimated models selected in will be transformed into labor productivity form to examine the relationship of labor productivity in each sector to evaluate the roles of public and private capital to labor productivity for the second and third objective of this study.

It is found that these selected models are embodied by the Hicks neutrality or Harrod neutrality. Harrod neutrality, the increase in technology holding labor decrease in the same proportion makes no change in output, was found to generate in agricultural and service sector. In this study, we assume that human capital with catch-up technology is embodied as the technological change. Thus, the increase in *A(H)* makes the multiple value with labor to output.

It should be noted that in order to increase the output growth or labor productivity by enhancing factor of production, the policy implication should spotlight on the flexible input, which is *A(H)*, and capital. Labor is quite constantly increase due to birth rate, death rate and labor movement rate within country. Remarkably, the growths of birth and death rates are tending to decrease owning to a good family plan, an advance in the technology of medical treatment, a better perception about health of people provided and supported by government, and a better education of people.

The flexible and applicable input is *A(H)* and capital. Whereas the *A(H)* can be increased by enhancing the internal educated people or quality of the labor, and so on; the capital, both public and private capital, could be enhanced by monetary or fiscal policy. However, the coefficient, which indicates the percentage change in labor productivity by the input, must be examined by each sector as the following results in 6.2.4.1 – 6.2.4.4.

In overall conclusion, the whole economy and the indutrial sector reflect their characteristics as Hicks neutrality with catch-up technology as an input factor, while the others affected by Harrod neutrality. The private capital has a positively effect on labor productivity, while the public capital is negative to labor productivity. According to the estimations, the public investment should be decreased. However, the government must increase the promotion and law to enhance the investment of private sector with no need to favor any particular input factor.

On the other hand, the agricultural sector and the service sector are produced by Harrod neutrality approach. This type of technological approach implies that emphasizing on human capital will make a large significant outcome to labor productivity. The coefficients reflect that the public sector should encourage the private sector to invest, especially in human capital and labor improvement.

6.2.4.1 The Labor Productivity of the Whole Economy.

As the production of the whole economy is the Hicks neutrality with *A(H)* as a factor, it is applied to analyze the effect of public capital and private capital to the labor productivity as shown below.

$$ln(Y/L)=17.501-0.002t+-0.972lnA(H)+1.081lnK-0.456lnG-0.887lnL+0.172D_{crisis} \quad (6\text{-}3)$$

(2.075)* (-0.283) (-2.857)* (4.742)*(-2.267)*(-1.784)** (0.550)

Adjusted R^2	0.733	Durbin-Watson stat	1.579
F-statistic	13.347	Prob(F-statistic)	0.000

* significance at 95% .

** significance at 90%

Remark: the definition of each variable is explained in (5-1) and section 1.4

The elasticities of labor productivity with respect to each input, human capital with catch-up technology, private capital, public capital, and labor, on the labor productivity are -0.972, 1.081, -0.456, and -0.887 sequently.

In other words, holding the other inputs constant, a 1 percentage increase in the private capital input leads on the average percentage change in labor productivity to about 1.081.

Similarly, holding the other input constant, the increase in public capital leads on the average about -0.456 percent increase in the labor productivity. On the other hand, about -0.887, and -0.972 percentage increase when a 1 percentage increase in the labor and human capital with catch-up technology, sequently.

It should be noticed that only the public capital that positively effects labor productivity. Besides, though it is the Hicks neutrality, the technological progress is not significant and very tiny. It might possibly imply to the inffectiveness of technological progress of the whole economy.

There is no significant effect of the economic crisis in 1997. However, in the sectoral analysis, the effect of structural changes by the economic crisis is found. It reflects the overall capability to absorb shock which is fairly effective.

6.2.4.2 The Labor Productivity of the Agricultural Sector

Harrod neutrality is found to be practical in this sector. The estimation is shown in (6-4).

$$ln(Y/L) = -8.517 + 0.966\, lnK + 0.057\, lnG - 0.288\, ln(A(H)L) + 1.690 lnLand + 0.185 D_{crisis} \quad (6\text{-}4)$$

(-0.881)(2.877)* (0.648) (-4.585)* (0.826) (1.522)**

Adjusted R-squared	0.580	Durbin-Watson stat	1.986
F-statistic	8.467	Prob(F-statistic)	0.000

* significance at 99% .

** significance at 85% .

Remark: the definition of each variable is explained in (5-1) and section 1.4

The elasticity of labor productivity with respect to public capital is 0.966. If we hold the other inputs constant, a 1 percentage increase in the private capital input enhance the average percentage change in labor productivity to about 0.966.

The percentage change of public capital is positive as it increases the percentage of labor productivity by 0.057; however, it is not significant. This variable is similar to the role of land to labor productivity which positively effect on its percentage change by 1.690, but signifies the insignificance.

Holding the other inputs constant, a 1 percentage increase in the labor, and human capital with the catch-up technology leads on the average percentage change in labor productivity to about -0.288. In the other words, adding human capital with catch-up technology or labor might decrease the labor productivity. It is possibly be explained that human capital, proxied in this study by educated people, is not effective; such as what they had learnt does not match the need in the agricultural career. In addition, the technological advance in this sector might not actually be transfered from a leading country, japan, to us.

The rainfall is also an augmented input factor of this sector; however, it is found to be insignificant to the model.[3] Puapongsakorn and Suzuki(1992:12) mentioned a possible cause that the influence of rainfall or seasonal affect has tended to decline owning to the increase of agricultural machines, and the advance knowledge about rotational cropping.

The crisis effect did a structural change to labor productivity at 85% significance and in the positive direction, it might possibly be explained that, before the crisis, the labor in this sector became mobilized to outside the sector, causing a higher wage; thus, the cost of production increase(International Consultancy Network to Office of Agricultural Economics in 1999). But after the crisis, some skilled labors, who were terminated, laid off, and voluntary retire from the industrial sector, have come back to the native land, which is mostly in agricultural sector; therefore, the productivity has become slightly improve by the economic crisis.

6.2.4.3 The Labor Productivity of the Industrial Sector

The Hicks neutrality with $A(H)$ as a factor is approached in this sector. All estimated coefficients were found significant. Similar to other sectors excluding the agricultural sector, the public capital plays a significantly negative role to output.

$$Ln(Y/L) = 15.599 + 0.016t - 0.590\log A(H) + 0.688\ln K - 0.549\ln G - 0.745\ln L - 1.126\,D_{crisis} \quad (6\text{-}5)$$

$$(2.854)^{*} \quad (1.863)^{**} (-1.780)^{**} \quad (2.168)^{*} (-2.742)^{*} (-4.183)^{*} (-3.733)^{*}$$

Adjusted R-squared	0.557	Durbin-Watson stat	1.887
F-statistic	6.660	Prob(F-statistic)	0.000

* significance at 95% .

** significance at 90% .

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[3] The agricultural production function with rainfall dummy are shown in the AppendixC.

Remark: the definition of each variable is explained in (5-1) and section 1.4

The elasticity of labor productivity with respect to private capital is 0.688. In other words, holding the other inputs constant, a 1 percentage increase in the private capital input leads on the average percentage change in labor productivity to about 0.688.

In contrast, a one percentage increase in public capital, labor and human capital with catch-up technology contribute to the average about 0.549, 0.745, and 0.590 percentage decrease in labor productivity, sequently.

The technological progress of the Hicks neutrality is 0.016; it shows an average increase in technological progress.

The economic crisis has made a strongly negative affect to output while the positive effect of economic crisis is found in the agricultural sector. It reaffirms the possible reason that it must have been mobilization of skilled and knowledgeable people from the industrial sector to the absorbing sector, agriculture.

6.2.4.4 The Labor Producitivity of the Service Sector

The service sector is approached by Harrod neutrality, the estimation is shown below.

$$ln(Y/L) = 17.095 + 1.023 lnK - 0.261 lnG - 1.023 ln(A(H)L) - 0.267\ D_{crisis} \quad (6\text{-}6)$$

(3.255)* (6.190)* (-1.572)** (-4.511)* (1.056)

Adjusted R-squared	0.801	Durbin-Watson stat	1.397
F-statistic	28.227	Prob(F-statistic)	0.000

Remark -* significance at 95% .

-** significance at 85% .

-No serial correlation at 90% and the definition of each variable is explained in (5-1) and section 1.4

As can be seen in (6-6), holding the other inputs constant, a 1 percentage increase in the private capital input enhance the percentage change in labor productivity by 1.023. On the other hand, the increase in public capital leads on the average about 0.261 percent decrease in the labor productivity.

About -1.023 percentage declines when a 1 percentage increase in the labor and human capital with catch-up technology.

The crisis makes an insignificant effect which might imply that this sector has not faced such a large influence by the economic crisis that labor productivity do change.

This sector includes the government services and public administration and defence. Thus, it might omit some values due to the difficulty of accurate measurement of output value in the government services and public administration such as social value or benefit(Kraipornsak, 1995). The lack of competition in government services and defence might be another reason that makes the public capital negatively effect to labor productivity.

6.2.4.5 Conclusion of the Estimations of Labor Productivity

In order to perform the conclusion and reason of the yield coefficients, the following table shows the summarized result of the labor productivity estimations in 6.2.4.1-6.2.4.4.

Table 32 The summary of the estimations of labor productivity

Sector	Agricutural sector	Industrial sector	Service sector	Whole economy
Functional form	Cobb-Douglas	Cobb-Douglas	Cobb-Douglas	Cobb-Douglas
Technical progress	Harrod neutrality	Hicks neutrality with *A(H)* as an input factor	Harrod neutrality	Hicks neutrality with *A(H)* as an input factor
Constant term	-11.513 (-0.881)	15.599 (2.854)*	17.095 (3.255)*	17.501 (2.075)*
F(Technological progress of Hicks)	-	0.016 (1.863) **	-	-0.002 (-0.283)
A(H)	-	-0.590 (-1.780)**	-	-0.972 (-2.857)*

Sector	Agricutural sector	Industrial sector	Service sector	Whole economy
K	0.966 (2.877)*	0.688 (2.168)*	1.023 (6.190)*	1.081 (4.742)*
G	0.057 (0.648)	-0.549 (-2.742)*	-0.261 (-1.572)**	-0.456 (-2.267)*
L	-0.288 (-4.585)*	-0.745 (-4.183)*	-1.023 (-4.511)*	-0.887 (-1.784)**
Land	1.690 (0.826)	-		-
D_{crisis}	0.185 (1.522)**	-1.126 (-3.733)*	0.267 (1.056)	0.172 (0.550)
Adjusted R^2	0.580	0.557	0.801	0.733
Durbin-Watson Stat	1.986	1.899	1.397	1.579
F-statistic	8.467	6.660	28.227	13.347
Prob (F-statistic)	0.000	0.000	0.000	0.000
Remark	*significance at 99% .	* significance at 95%	*significance at 95%	*significance at 95%
	** significance at 85%	** significance at 90%	** significance at 85%	** significance at 90%
			No serial correlation at 90%	
	(6-3)	(6-4)	(6-5)	(6-6)

In conclusion, the functional form of labor productivity of the whole economy is similar to of the industrial sector, the Hicks neutrality with *A(H)* as a factor. This might possibly be occurred by such the highest significant value of labor productivity in industrial sector that influences the functional form of the whole economy.

On the other hand, the agricultural sector and the service sector are embodied by Harrod neutrality. Hence, the general policy implication of sector produced by Harrod neutrality is to enhance *A(H)* which has a larger effect to output rather than that of the Hicks neutrality.

The public capital mostly signifies its negative effect which is in harmony with the study of Evans and Karras(1994) (describe in section 4.2). Their reason is the basic infrastucture might not be enough to activate the output. Another reason is Thai bureaucracy system that makes the ineffectiveness to the managing ability. This aspect is reaffirmed by Porter(2003) that Thai government bureaucracy and corruption create the significant cost to firms.

It is universally accepted from many empiricals that private capital effects in the positie way to labor productivity. For instance, Landue(1986), examining the government and economic growth in the developing countries during 1960-1980, reported that the private investment has a noticeable positive impact of economic growth, especially compared to pubic investment. Besides, the study of Suwanrada(1999) demonstrates that the effect of private capital to GDP was higher than that of public capital well nigh 0.2-0.3%. Both of them, as the examples, reaffirm with the result of this study that public capital is more significant than private capital.

The public capital of agricultural sector shows its positive effect to the labor productivity but insignificant. It might imply that the public capital effective to the output in the positive way as its unique character of this sector is not only particularly effect on the output, but also creates social value, such as a damn or a water supply system. However, the ineffectiveness of resources allocation and the objective, which the government usually focuses on, to distribute income might decrease the positive significance to labor productivity.

For the service sector, the public capital is also included the government services and public administration and defence. The lack of competition in government services and defence and the difficulty to measure an accurate value of output from the government services and public administration are possible claimed as the reasons for the negative effect to labor productivity.

Comparing between the effect of public capital and private capital to labor productivity, we found that private capital is significantly positive to labor productivity but public capital is vis-à-vis. Consequently, the private capital generates the average percentage change in labor productivity more than the public capital does. For the whole economy, holding the other input constant, a 1 percentage increase in the private capital makes 1.537 percentage change in labor productivity greater than public capital. The similar feature is found in the agricultural, industrial and service sector as 0.909, 1.237 and 1.284 sequently. Thus, it is affirmed that the government shall emphasize on encouraging private investment rather than invest by itself.

The human capital with catch-up technology is also negative to output, instead of complementary. It might imply that adding human capital with catch-up technology might decrease the labor productivity. It is similar to Landue(1986) who reported that the assumption that poorer developing countries ought to be growthing faster than the middle-income developing countries-or catch up effect- was rejected.

Besides, Wangudom(2001)'s result, tested whether human capital in Nelson and Phelps framework(1966), human capital is a source of technology progress composed of domestic innovation and techonology adoption, is significant to output growth. The outcome, tested by 3 different proxies of human capital, appeared to be not significantly different from zero at the five percent level. Therefore, he concluded that he did not find the evidence to support the idea that technology progress comes from adoptation and innovation.

The industrial sector is also found the negative effect of human capital to the labor productivity. The supporting evidences are found in the low technology utilized in the Thai industries, and the problem of transferring technology from leading country.

It is found that in manufacturing sector there were low levels of skilled labor by keeping them in labor intensive and old technology; thus, the low private capital has not effected on the labor productivity. Besides, thai-based producers have low incentives to adopt world-class technology to improve productivity, but perpetuate by low wages (Potter, 2003).

The major concern in the industrial sector is the technology transfers and technological level used to produce from Foreign Direct Investment. As Thailand has been one of the popular settlements for the multinational company, the knowledge and advance technology is intellectual property which belongs to the foreign owners so that thai people cannot develop themselves or have a slow development of productive process. The study of Busabokkeaw(1997) shows a different aspect that the foreign companies, Japanese and Germany firms in the automobile assembly, had been trying to transfer the technological knowledge, but the language skill and practical knowledge of their thai employees were not sufficient to take such the advance technology. Her study can be implied to the problem of human development entitled within thais through the learning process or the educational system.

This is similar to one of the conclusions of "The strategy to develop human for manufacturing and service of Thailand during 2003-2006", reported in 2002 by The Committee of Labor Development and Career Training Cooperation of Thailand that the human development was not relevant to industrial development, also labor structure was unrelated with the technological progress.

For the agricultural sector, the technological utilization by labor, one of the meaning behide the catch-up technology, is reported by International Consultance Network(1999) that the ineffectiveness of management and low technology make unproductive output. Particularly being noticed in this sector, the increase in land does not enhance the labor productivity. The capital and labor must enter to produce as well as extended land.

The crisis effect did a structural change to labor productivity in the industrial sector in the positive direction, but negative direction for the agricultural sector. It might possibly be explained that after the crisis labors have moved to the native land, which is mostly in agricultural sector. Therefore, the structural change of labor productivity of the whole economy has been absorbed.