Economic Transformation and Productivity in Thailand: Why Small is Beautiful for the Size of Agriculture?

Review of Integrative Business & Economics Research

Waleerat Suphannachart*
Faculty of Economics, Kasetsart University

Tittayatorn Boonkaew
Faculty of Economics, Kasetsart University

ABSTRACT

This paper provides empirical evidence on the effects that economic transformation has on productivity in Thailand. It has two main objectives. First, the descriptive analysis examines characteristics of economic transformation using the national level time series data for Thailand, covering the period 1970-2015. Second, the statistical analysis employs error correction methods to investigate the effects of economic transformation on total factor productivity (TFP). The results demonstrate that the economic transformation has occurred in terms of the decline of agriculture in GDP and total employment. However, the transformation process appears to have slowed down especially in the labor market. The statistical results confirm that the economic transformation has a positive and significant impact on the TFP. This means the smaller the relative size of agriculture the higher productivity the Thai economy can achieve. The findings suggest large potential aggregate productivity gains from the labor reallocation across sectors. It also raises a concern over agricultural subsidy policies that could slow down the transformation process and deteriorate an economy's long-term productivity.

Keywords: Economic transformation, Total factor productivity, Thailand.

Received 27 January 2018 | Revised 11 February 2018 | Accepted 27 May 2018.

1. INTRODUCTION

Economic transformation, also referred to as structural transformation, is a term used to describe the process of change in the production structure of an economy (World Bank Group, 2016a). It is a key driver of economic development consisting of a shift of sector proportions away from agriculture toward industry and services. This transformation process improves total factor productivity (TFP) by moving labor and other resources from lower- to higher-productivity sector thereby sustaining long-term growth and overall economic development. The concept of economic transformation

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

has well been established and proved by empirical evidence of various countries (Perkins et al., 2013; Norton et al., 2015). However, the concept has sometimes been forgotten by policy makers and academic in Thailand. The reverse trend of economic transformation had been observed recently when rising number of Thai workers had recently returned to the agricultural sector (Nation, 2017). This counter-transformation labor movement was in line with the agricultural subsidy policies that raised agricultural product prices above the market level (Jitsuchon, 2014). The media in Thailand also promotes the perception that young and educated people especially descendants of Thai farmers shall return to farms and help Thai agriculture. It is evident that the agricultural sector had attracted more educated youngsters particularly those descendants back to farms during 2002 to 2011 when the rice-pledging schemes were implemented (Siamwalla and Wachirakorn, 2013 cited in Jitsuchon, 2014).

The concern over changing age structure that may adversely affect agricultural production has in part led to policy recommendations to attract young workers to the agricultural sector (Saiyut et al., 2017). Nonetheless, Suphannachart (2017) and Wirotsattabut (2017) have tested empirically that the aging society, that has begun in Thailand since 2005, has had no significant impact on the agricultural labor productivity. The labor force, especially young workers aged 15-24 years old, has declined nationwide. The proportions of old labor, aged 60 years and over, have increased not only in the agricultural sector but also in industry and services. In fact, Thailand will soon become an aged society with 20 percent of total population aged 60 years and above in 2025. Drawing young workers to the agricultural sector which has the lowest labor productivity may not be a sustainable solution. This may even slow down the structural transformation and lower the TFP.

Moreover, the relative size of Thai agriculture was ranked third when compared with those developing countries in the middle-income group (World Bank Group, 2016b). Those agricultural workers accounting for 34 percent of the total workforce are attributable to only 7 percent of the country's GDP. This does not take into account the role of migrant workers that have become increasingly important. Attracting more workers to work for agriculture without any significant agricultural reforms may worsen the productivity and living standard. There are still rooms for improving efficiency through resource (especially labor) reallocation. In addition, Klyuev (2015) has shown that there exist large potential aggregate productivity gains from the labor reallocation across sectors in Thailand but the transformation process appears to have slowed down.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

This paper aims at depicting the overall pictures of economic transformation in Thailand during 1970-2015. It also tested empirically whether the economic transformation over the past decades had contributed to the TFP growth of the overall economy. If the empirical evidence conforms to the theoretical concept then the smaller size of the agricultural sector shall improve the aggregate productivity and sustain long-term growth of the overall economy. This study expects to show that a way of helping the aging agriculture is not necessary drawing more workers back to farms but rather concentrating on labor skills (quality issues) or innovating the sector to be small but smart. It is also expected to shed light on policy recommendation that could improve the total factor productivity. The policy implications could probably be applied in other developing countries.

The paper consists of five sections. First is the introduction. Second is the methodology and data. The third section describes briefly the economic transformation in Thailand. The fourth section provides empirical results using the statistical analysis on the linkage between the economic transformation and total factor productivity. The fifth section is conclusion and policy implications.

2. METHODOLOGY AND DATA

The empirical investigation of economic transformation impact on productivity employs the TFP determinants model in which major factors affecting TFP are taken into account along with the economic transformation. The determinants of TFP is based on the production function framework in which TFP growth is identified as a shift in the production function representing technical change. It is measured as that part of output growth not explained by growth of measured factor inputs (Solow 1957). It thus includes, but is not confined to, the effects of advances of knowledge or technological progress. Factors affecting TFP can be categorized into three main components: 1) pure technical change, which is identified with a shift in a production function. 2) efficiency gain, which is a movement toward the production function. 3) economies of scale, which refers to a movement along the production function toward the optimal scale where maximum productivity can be achieved (Coelli et al., 2005).

Our statistical analysis is based on a conceptual model in which the determinants of TFP include factors affecting the three main components of productivity gains explained above. Regarding the pure technical change, R&D expenditure is well recognized as a prime potential source of technical change that raises TFP while FDI flows represent

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

technology transfer from abroad that could as well shift the production function. The economic transformation is categorized under the efficiency gains as it refers to the process of resource reallocation allowing factors to move from lower (agriculture) to higher marginal productivity sectors (industry and services) thus raising TFP at the aggregate level. Education can be categorized under both technical change and efficiency gains as it is considered a close and obvious measure of human capital that helps bring about innovations in production technology (Romer, 1989). In particular, education is well recognized as a mean of improving labor quality. An improvement in labor skills can increase efficiency in the use of physical capital and adoption of technology. Better educated workers should therefore contribute positively to productivity. For trade openness, it helps in achieving economies of scale by expanding market size through export. Economies of scale bring about real cost reductions thereby increasing productivity. In addition, it enhances market competition through import and export. Competition influences technological development thereby increasing TFP growth. Altogether, there are five explanatory variables in the statistical model comprising economic transformation (ET), with-in country R&D (RD), net flows of FDI (FDI), education (EDU), and trade openness (TO). In stylized form, the model is:

$$TFP = f(ET, RD, FDI, EDU, TO) \qquad (1)$$

where *TFP* denotes total factor productivity of the Thai economy, ET denotes economic transformation (which is measured in terms of output and employment shares), RD denotes real research and development expenditure with-in the country, FDI denotes foreign direct investment, EDU denotes education, and TO denotes trade openness.

The employed data are time-series at an aggregate level, covering 45 years from 1970 to 2015. The data used for descriptive analysis of the economic transformation in Thailand are classified into three main economic sectors, that is, agriculture (crops, livestock, forestry, and fishing), industry (manufacturing, mining and quarrying), and services (both public and commercial services are included, for example, electricity, gas, water supply, healthcare, transportation, wholesale and retail trade, financial and insurance activities, accommodation, and all other activities not included in agriculture and industry). The data and sectoral classification are obtained from related government agencies. Summary of data sources and definition is shown in Table 1 and the descriptive statistics of the relevant variable are summarized in Table 2.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 1 Summary of variables and data sources, 1970-2015

Variables (notations)	Definitions	Data sources
1. Data used for the descriptive analysis		
Output (Y)	GDP (value added) at constant prices (million Baht)	National Income of Thailand, National Economic and Social Development Board
Labor (L)	Number of employed persons age 15 and above (persons)	Labor Force Survey, National Statistical Office
Export (X)	Values of exports (million Baht)	Office of Agricultural Economics and Ministry of Commerce
Total factor productivity (TFP)	TFP is measured as a residual of output growth that cannot be explained by labor and capital. TFP growth rates classified by sector are available only from 1981 onwards. TFP growth rates are converted into indexes using 1981 as base year.	National Economic and Social Development Board (1981-2015)
2. Data used for the statistical analysis		
Total factor productivity (TFP)	TFP is measured using the growth accounting method, in which TFP is a residual of output growth after subtracting labor and capital weighted by their respective factor income shares. The TFP growth rates are converted into indexes using 1971 as base year	Authors' calculation and National Economic and Social Development Board (1971-2015)
Economic transformation (ET)	ET is measured in two terms; - Output shares (ETY) measured as shares of agriculture in total GDP, and - Employment shares (ETL) measured as shares of agricultural labor in total	National Statistical Office and National Economic and Social Development Board

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

	labor force.	
R&D (RD)	Research and development expenditure in Thailand, comprising public and private funding, deflated by GDP deflators (million Baht)	Bureau of the budget and Office of the National Research Council of Thailand
Foreign direct investment (FDI)	Net flows of FDI, comprising equity capital with at least 10% of foreign shareholding, loans from affiliates, and reinvested earnings, deflated by GDP deflators (million Baht)	Bank of Thailand
Education (EDU)	Shares of labor force with upper secondary education level	Labor Force Survey, National Statistical Office
Trade openness (TO)	Share of total imports and exports in GDP	Ministry of Commerce and National Economic and Social Development Board

Table 2 Summary statistics of variables in the TFP determinant models, 1970-2015

	lnTFP	lnETY	lnETL	lnRD	lnFDI	lnEDU	lnTO
Mean	4.89	-2.23	-0.59	8.40	10.31	-2.81	-0.42
Median	4.88	-2.41	-0.56	8.41	10.85	-2.66	-0.43
Maximum	5.10	-1.61	-0.24	11.06	12.87	-1.61	0.20
Minimum	4.61	-2.66	-1.08	5.83	6.69	-4.61	-1.27
Std. Dev.	0.12	0.34	0.24	1.51	1.98	0.85	0.47
Jarque-Bera	0.84	4.31	3.72	1.68	4.39	2.70	3.93
Probability	0.66	0.12	0.16	0.43	0.11	0.26	0.14
Observations	45	45	45	45	45	45	45

Note: all variables are expressed in natural logs.

With regards to the estimation method, applying the standard OLS method to non-stationary data series can produce a spurious regression while first-differencing that ensures stationary data series can overlook some meaningful level information. To guard against the possibility of a spurious relationship while maintaining the level

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

information, two main approaches offer reasonable solutions. First is the co-integration approach pioneered by Engle and Granger (1987) and later improved by studies such as Johansen (1988) and Phillips and Hansen (1990). The Engle and Granger pioneering method is appropriate when dealing with non-stationary data that are integrated of the same order – that is, all data series are integrated processes of order 1. Second is the unrestricted error correction modeling (ECM) method developed by Hendry and his co-researchers (Davidson et al., 1978, Hendry et al., 1984, Hendry, 1995). Under the ECM, the long-run relationship is embedded within a detailed dynamic specification, including both lagged dependent and independent variables, which helps minimize the possibility of estimating a spurious regression. It has been argued that the ECM method developed by Hendry (1995) can legitimately be applied to data series that are integrated of different orders, provided the resulting specification makes economic sense.

The first step of the estimation process is to conduct standard unit root tests on each variable. The Augmented Dickey-Fuller (ADF) test is employed in this study to test the time-series properties of the data series. The ADF tests the null hypothesis of non-stationarity against the alternative of stationarity (Banerjee et al., 1993). The results in Table 3 shows the variables used in this study is a mixture of stationary series or I(0) and nonstationary series that are integrated of order 1 or I(1). Since the data series are integrated of different orders, the error correction modeling (ECM) procedure of Hendry (1995) is used in this study.

3. ECONOMIC TRANSFORMATION IN THAILAND

The concept of structural transformation has been proved empirically robust in many countries all over the world (Perkins et al., 2013, p.587). As economies grow, agriculture tends to account for a declining share of both GDP and employment. This is also true for the case of Thailand. As shown in Figure 1, over the period of 1970-2015, the output share of agriculture has declined relative to those of the non-agricultural sectors. The share of agricultural GDP has fallen from 20 percent in 1970 to 7 percent in 2015. In contrast, the GDP share of industry has risen from 16 percent in 1970 to 31 percent in 2015. However, the industrial sector has started losing its competitive advantage and its share has declined since 2011.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 3 Augmented Dickey-Fuller Test for Unit Roots, 1970-2015

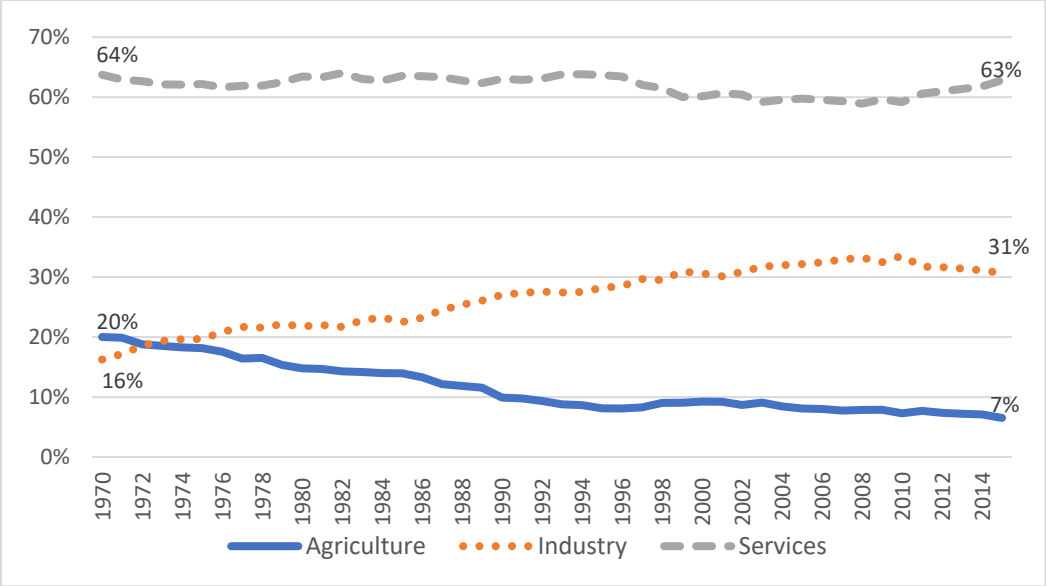
Variables	t-statistics for level without time trend	t-statistics for level with time trend	t-statistics for first difference without time trend	t-statistics for first difference with time trend	Order of integration
lnTFP	-1.421841	-2.742560	-5.014355*	-4.940422*	I(1)
lnETY	-0.494295	-3.059459	-8.424291*	-8.327454*	I(1)
lnETL	-1.508148	-2.067147	-10.00981*	-10.13064*	I(1)
lnRD	-0.231901	-3.121790	-4.563628*	-4.504998*	I(1)
lnFDI	-1.814654	1.623863	-9.141946*	-9.390971*	I(1)
lnEDU	-4.605418*	-2.838807	-8.155143*	-7.578773*	I(0)
lnTO	-1.058725	-2.004214	-7.307733	-7.267571*	I(1)

Notes: 1. All variables are measured in natural logarithms. 2. * denotes the rejection of the null hypothesis at the 5 percent level. 3. Numbers in parentheses indicate the order of augmentation selected on the basis of the Schwarz criterion.

The changing sectoral proportion of GDP in Thailand generally conforms to the broad concept of economic transformation. However, the initial share of GDP was not dominated by agriculture. Services, which include a broad range of activities, has dominated the share of GDP. Surprisingly, the share of services has remained roughly the same and even shrunk slightly (Figure 1). Although the service sector is expected to be Thailand's new engine of growth there has hardly been any changes in the its value added over four and a half decades. Lack of competition in many areas of services is believed to be one of the key factors impeding innovation and productivity growth of the service sector (Sujarittanonta and Kamsaeng, 2017). Competition is important for firms' decisions to invest in R&D which brings about new technology and innovation that drive productivity. Despite the government's efforts to promote innovation (through tax and non-tax incentives) low degree of competition in the service sector has hindered innovation. As a result, the role of services has remained stagnant.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Figure 1 Output Shares of Agriculture, Industry, and Services during 1970-2015



Source: Authors' calculation based on GDP (Value Added) data collected from the National Economic and Social Development Board (NESDB).

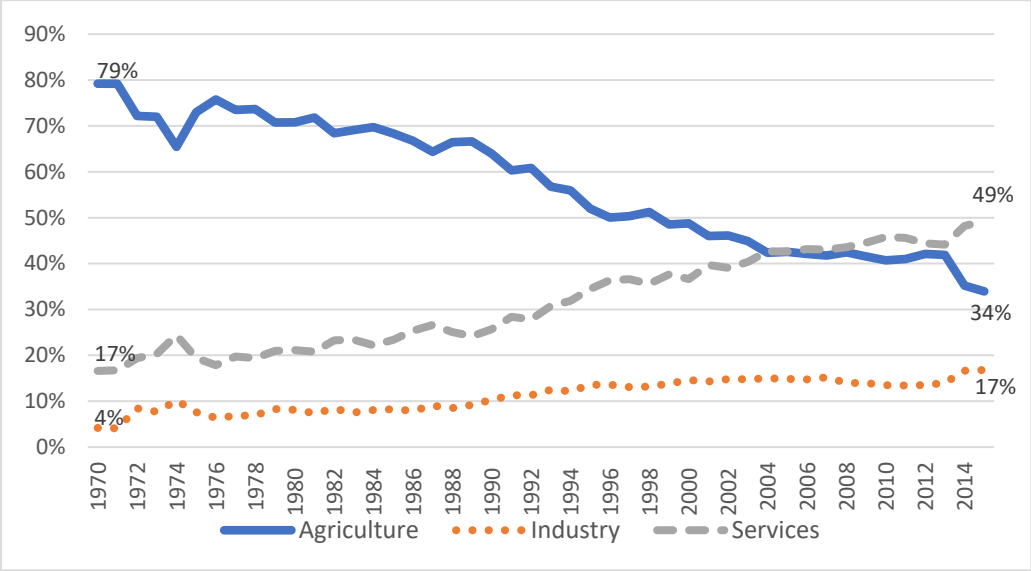
Regarding the labor market, agricultural employment accounted for more than half of total employment for almost three decades. However, since the early 1980s, the share of agricultural employment in total employment has declined continuously. This declining trend of agricultural employment is in line with the structural change of the Thai economy that has shifted from agricultural-based to industrialized, attracting agricultural labor towards industries and services. Figure 2 shows the shares of agricultural workers has declined while that of industry and services increased. The agricultural labor force has dropped from 79 percent in 1970 to 34 percent in 2015. Industry has accounted for the lowest share of employment, only 7 percent in 1970 and has risen to 17 percent in 2015. The service sector currently occupies the largest share of total employment, accounting for 49 percent in 2015.

The process of reallocating workers from less productive agriculture to more productive sectors (or structural transformation) had continuously proceeded since the industrial expansion of the 1980s but slightly reversed during the 1997-1998 financial crises when a number of industrial workers had moved back to the agricultural sector. After the crisis, structural transformation proceeds slowly. Since 2004 onwards the number of employment in agriculture started to pick up slightly notably during 2011-2012. This is partly due to the rise in agricultural product prices. However, the agricultural labor force has dropped since 2014 which is in line with the downward trend of agricultural

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

commodity prices.

Figure 2 Employment Shares of Agriculture, Industry, and Services during 1970-2015



Source: Authors' calculation based on data collected from Labor Force Survey (LFS), National Statistical Office (NSO).

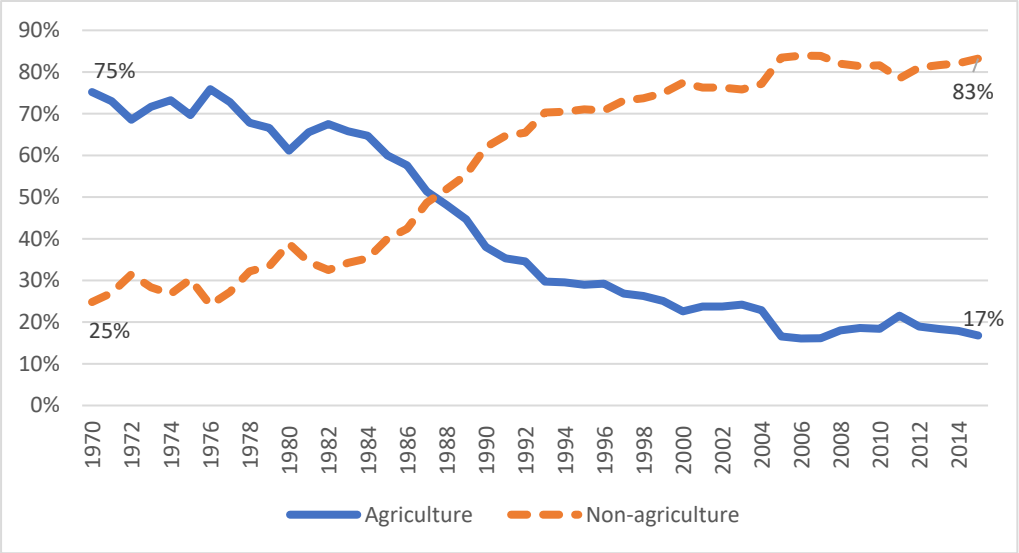
In addition to the traditional measures of economic transformation, Figure 3 shows changes in the export shares of agriculture and non-agriculture. It is obvious that the export share of agriculture has declined while that of non-agriculture increased. The point where the export share of non-agriculture exceeds that of agriculture lies in the mid-1980s in which the industrial expansion had occurred. The structural change of exports is in line with those of GDP and employment. At present, the majority of Thai exports come from industry and services, accounting for 83 percent in 2015, while agricultural exports accounted for only 17 percent.

With regards to labor productivity, which is measured as real annual output divided by number of employed workers, it is evident that the industrial sector has the highest labor productivity, followed by services and agriculture (Figure 4). As labor productivity reflects real income per worker, this implies an agricultural worker receives almost ten-fold less income than an industrial worker and almost seven-fold less than a worker in the service sector. However, labor productivity in the industry has declined distinctly in recent years. This is in line with the slowdown of export-oriented industrial growth. The industrial sector can no longer enjoys relatively cheap and abundant labor and raw materials as in the past. At the same time, the sector has still struggled to develop own

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

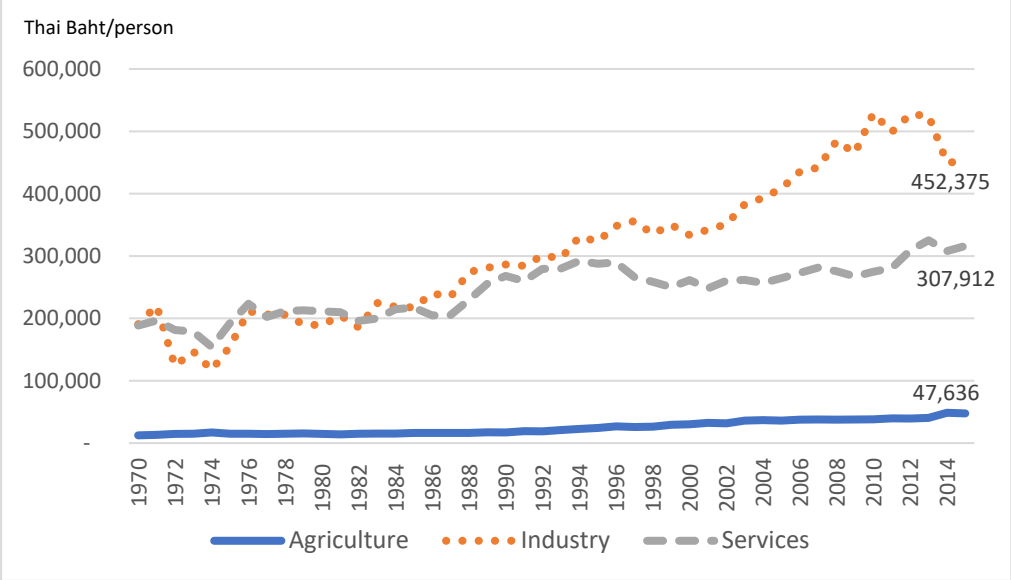
technology, innovation, and skills of workers in order to boost its competitiveness. In addition, the large dispersion of productivity across sectors in Thailand suggests large potential aggregate productivity gains from the labor reallocation across sectors but the transformation process appears to have slowed down (Klyuev, 2015).

Figure 3 Export Shares of Agriculture and Non-agriculture during 1970-2015



Source: Authors' calculation based on data collected from Office of Agricultural Economics and Ministry of Commerce.

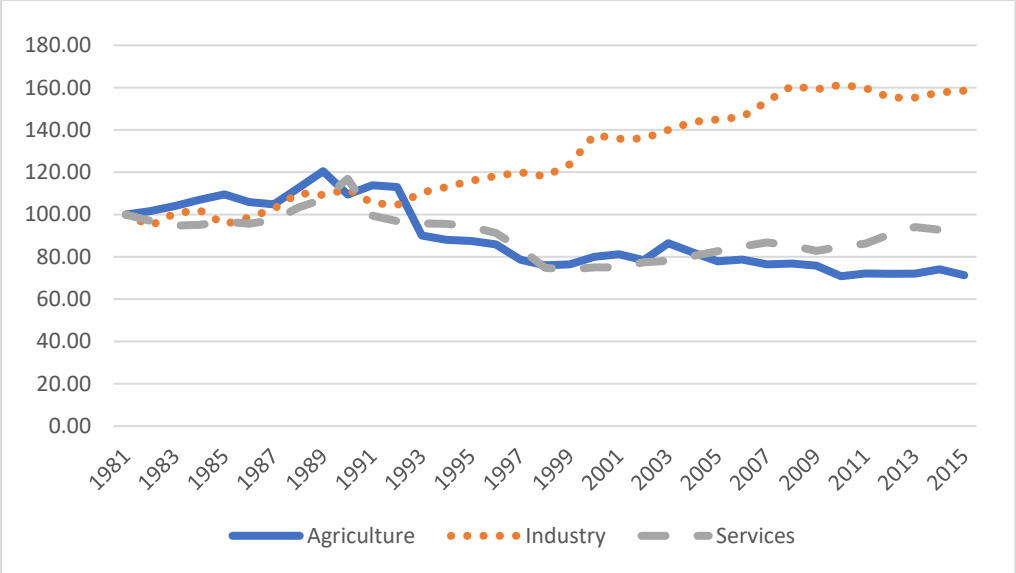
Figure 4 Labor Productivity in Thailand during 1970-2015



Source: Authors' calculation based on NESDB and NSO data.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Figure 5: Total Factor Productivity (1981 = 100) in Thailand during 1981-2015



Source: Authors' calculation based on TFP growth data collected from NESDB.

Moreover, the economic transformation can be explained in terms of technical change, often measured as changes in total factor productivity (TFP). As the Thai economy develops, TFP of industry and services had experienced upward trends (but slightly sluggish) while that of agriculture had gone downward, as shown in Figure 5. At the initial level (base year) agriculture had the highest TFP but dropped significantly at later periods. In 2015, the level of TFP for industry is the highest, followed by services and agriculture. The relatively low and downward trend of agricultural TFP can be explained by insufficient R&D investments (Suphannachart and Warr, 2011) despite the government efforts to promote 'smart farming' emphasizing on the role of R&D and innovation. The declining TFP also poses a significant threat for sustained agricultural development as TFP growth is a critical component of overall economic development. It might slow down the process of structural transformation if the research-based technical change in agriculture is still lagged behind (Perkins et al., 2013).

In overall, the structural change in the Thai economy has partly followed the process of economic transformation. In particular, it transitions from 'deagrarianization' in which the structure of Thai economy has shifted away from agriculture-based economy and gradually transitions to 'deindustrialization' in which the power of industrialization as an engine of growth has started losing its magic. However, the Thai economy has not yet developed to the stage of 'servicization' in which the growing importance of the service sector, notably high value services, determines further economic growth as observed in many high-income countries Gryczka (2016). There is still room for labor

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

reallocation across sectors and associated aggregate productivity gains in Thailand. In particular, the reallocation of workers in agriculture and services, in which the majority of Thai people resides and works, seems to benefit the overall economy. As the agricultural sector has the lowest labor productivity (income per worker) and 34 percent of agricultural workers is attributable to only 7 percent of GDP, reallocating workers to the higher productivity sector like services seems to be a promising solution. In doing so, Thailand needs to modernize the agricultural sector with helps of R&D so that less labor required in this sector and more non-farm jobs shall be generated. Tangkitvanich and Bisonyabut (2014) have projected a scenario called "modern farming and knowledge-based services" that this will help Thailand overcome the middle-income trap and aging society challenges while causing least effects on the environment.

4. EFFECTS OF ECONOMIC TRANSFORMATION ON TFP

From the estimation of the TFP determinant model using the ECM method developed by Hendry (1995), the TFP determinant equations are statistically significant at the 1% level in terms of the standard F test and perform well in terms of standard diagnostic tests for serial correlation (LM), functional form specification (RESET), normality (JBN), heteroskedasticity (ARCH) and stationarity of the residuals (ADF). The final parsimonious equations are shown in Table 4. The choice of dropping or keeping variables in the final models was statistical acceptance in terms of the joint variable deletion tests against the maintained hypothesis. Since all variables are measured in logarithms, the regression coefficients can be interpreted as elasticities and the size of the coefficients also indicate the magnitude of their relative influence. With regards to the effects of economic transformation on the TFP, the estimation results are divided into two cases in order to compare the results using different measures of the economic transformation. The first case measures the economic transformation in terms of agricultural output shares which had declined over time. The second case measures the economic transformation in terms of agricultural employment shares which had declined at a slower pace compared with those of output shares.

The results indicate that most of the variables have a long-run impact on TFP, as shown by the significance of the estimated coefficients in the level term. Searching for the determinants of TFP using only the first differenced or growth rate can miss out these level relationships. Major factors significantly influencing TFP are consistent with theory and priori expectations. The economic transformation measured in terms of agricultural output (ETY) and employment (ETL) shares is statistically confirmed to affect the productivity gains. Both ETY and ETL have expected negative signs (as

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

shares of agriculture decline TFP increases). This implies reallocating resources from agriculture to non-agricultural sectors improve the overall economic efficiency and hence raise TFP at the aggregate level. The long-run elasticities calculated from the steady-state solutions for ETY and ETL are -0.025 and -0.495, respectively. The size of the impact is larger when ET is measured in terms of agricultural employment shares rather than the output shares. This suggests large potential aggregate productivity gains from the labor reallocation across sectors in Thailand. However, the transformation process that appears to have slowed down as also indicated in the IMF study (Klyuev, 2015) can be a threat to the long-term productivity growth.

Other major factors influencing the TFP are R&D expenditure (RD), net flows of FDI (FDI), education (EDU), and trade openness (TO). All these variables have the expected positive signs and their respective long-run elasticities are statistically significant at the 1% level. Specifically, R&D investments improve TFP by generating new knowledge, technology and innovation that increase value added while reducing input uses. Thailand has long invested in R&D particularly in agricultural R&D (Suphannachart, 2015) and the R&D investments had also shown to have a significant impact on agricultural TFP (Suphannachart and Warr, 2011). The technology effect of FDI also contribute to TFP though at a relatively small magnitude of the impact. The significant positive impact of education implies that it improves labor quality and ability to process information and select, manage, and operate new technologies thereby raising agricultural productivity. Trade openness does prove to bring about scale economies thereby raising the productivity of the Thai economy during 1970-2015.

Table 4 Factors affecting TFP in Thailand, 1970-2015

Dependent variable: $\Delta \ln TFP_t$				
	ET in terms of output (ETY)		ET in terms of labor (ETL)	
	Estimated coefficients (t-ratios)	Long-run elasticity	Estimated coefficients (t-ratios)	Long-run elasticity
Constant	1.052 (3.328)***		1.165 (3.823)***	
$\Delta \ln ET_t$	-0.175 (-2.092)**		-0.031 (-0.361)	
$\ln ET_{t-1}$	-0.061 (-1.043)	-0.025 (-4.545)***	-0.156 (-1.972)**	-0.495 (-6.426)***

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

$\ln RD_{t-1}$	0.038 (3.964)***	0.156 (12.488)***	0.058 (3.196)***	0.184 (10.824)***
$\ln FDI_t$	0.009 (1.046)	0.037 (4.625)***	0.012 (1.165)	0.038 (5.429)***
$\ln EDU_t$	0.032 (2.245)**	0.131 (4.852)***	0.057 (3.099)***	0.181 (6.241)***
$\ln TO_t$	0.068 (2.699)***	0.279 (7.323)***	0.106 (2.215)**	0.337 (7.326)***
$\ln TFP_{t-1}$	-0.244 (-3.607)***		-0.315 (-4.989)***	
N (no. of observations)	44		44	
k (no. of parameters)	7		7	
Adjusted R^2	0.39		0.25	
F-statistic	4.86		3.08	
S.E. of regression	0.02		0.03	
Diagnostic tests:				
LM(1), *F*(1, *N*-*k*-1)	0.01 [*p* = 0.91]		0.04 [*p* = 0.85]	
LM(2), *F*(2, *N*-*k*-2)	0.13 [*p* = 0.88]		0.17 [*p* = 0.84]	
RESET, *F*(1, *N*-*k*-1)	0.43 [*p* = 0.51]		0.57 [*p* = 0.23]	
JBN, $\chi^2(2)$	0.35 [*p* = 0.84]		0.43 [*p* = 0.81]	
ARCH, *F*(1, *N*-2)	2.40 [*p* = 0.13]		0.85 [*p* = 0.36]	
ADF	-6.30 [*p* = 0.00]		-6.15 [*p* = 0.00]	

Notes: 1. The level of statistical significance is denoted as: * = 10 percent, ** = 5 percent and *** = 1 percent. 2. Long-run elasticities can be computed by dividing the estimated coefficients of the level terms by the positive value of the coefficient of the lagged dependent variable and respective standard errors derived using Wald test, imposing restrictions using the computed long-run coefficients. 3. Diagnostic tests are [numbers in square brackets are *p*-values of the test statistics]: *LM* is Breusch-Godfrey serial correlation LM test; *RESET* is Ramsey test for functional form mis-specification; *JBN* is Jarque-Bera test of normality of residual; *ARCH* is Engle's autoregressive conditional heteroskedasticity test; *ADF* is Augmented Dickey-Fuller test for residual stationarity.

5. CONCLUSION AND IMPLICATIONS

This paper reviews the economic transformation in Thailand during 1970-2015 as well as empirically tested its effect on the economy's total factor productivity. The empirical

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

evidence conforms to the theory that the economic transformation, defined as the decline of the relative size of agriculture in terms of output and employment, leads to aggregate productivity gains. Particularly, there still exists large potential aggregate productivity gains from the labor reallocation across sectors. Currently, approximately 34 percent of Thai labor force working in the agricultural sector which contributes to only 7 percent of the country's GDP (value added). The agricultural labor productivity is undoubtedly the lowest or about tenfold less than those of the industry and services. This value added per worker would be even lower if the contribution of migrant workers were taken into account. If the agricultural labor could be reallocated to earn more from jobs in the non-agricultural sector, then the overall TFP could improve significantly. This can be done if the agricultural sector could grow out of mechanization and innovation-driven factors rather than utilizing labor (especially low-skills). In other words, agricultural productivity shall be improved through more R&D and infrastructure investments (Suphannachart and Warr, 2011).

Since higher productivity implies more sustainable long-term growth, higher standard of living, and reduced poverty it is more than worthwhile speeding up the transformation process especially in the labor market. Agricultural price distortion policies, which was found impeding the transformation process -luring workers back to farms (Jitsuchon, 2014), shall be avoided. Policy focus shall no longer be relating to labor quantity but rather direct to skills, technology, and innovation. Specifically, policy measures that aim to attract young workers to work in the agricultural sector is not sustainable because Thai society has become aging since 2005, meaning that the proportion of old aged workers increases while that of young workers declines all over the country. Attracting young workers to farms implies less of them left for the non-agricultural sector that has much higher labor productivity, higher income per person, and hence deteriorating the aggregate productivity. Moreover, investments in R&D, education as well as opening up for more trade and foreign investment are found to have positive and significant impacts on the total factor productivity. The new development model for Thailand, and probably for other developing countries facing similar challenges, shall emphasize on investments in R&D (which is an input side of innovation), human capital (especially education), trade and investment liberalization that promote competition, technology transfer, and innovation.

REFERENCES

[1] Asian Development Bank. 2013. Agriculture and Structural Transformation in Developing Asia: Review and Outlook. ADB Economics Working Paper Series.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

[2] Boonkaew, T. 2017. Agriculture's Role in Economic Transformation and Its Effects on Productivity in Thailand. M.S. Thesis (in Thai). *Graduate School*. Bangkok, Kasetsart University.

[3] Chandrachai, A., Bangorn, T. and Chockpisansin, K. 2004. National Report: Thailand. Total Factor Productivity Growth: Survey Report. Tokyo, Asian Productivity Organization.

[4] Coelli, T. J., Rao, D. S. P., O'Donnell, C. J. & Battese, G. E. 2005. *An Introduction to Efficiency and Productivity Analysis,* New York, Springer.

[5] Davidson, J.E.H., Hendry, D.F., Srba, F. and Yeo, S. (1978). Econometric Modelling of the Aggregate Time-Series Relationship Between Consumers' Expenditure and Income in the United Kingdom, *The Economic Journal* 88, 661-692.

[6] Engle, R.F. and Granger, C.W.J. 1987. Co-Integration and Error Correction: Representation, Estimation, and Testing, *Econometrica* 55, 251-276.

[7] Gryczka, M. 2016. The changing role of the service sector in an innovation-oriented economy. *Folia Oeconomica Stetinensia (The Journal of University of Szczecin),* 16**,** 175-190.

[8] Hendry, D. F. 1995. *Dynamic Econometrics*, Oxford, Oxford University Press.

[9] Hendry, D.F., Pagan, A. and Sargan, J.D. 1984. Dynamic Specification. in Griliches, Z. and Intriligator, M.D. (eds.), *The Handbook of Econometrics Vol. II*. North-Holland, Amsterdam.

[10] Inder, B. 1993. Estimating Long-Run Relationships in Economics: A Comparison of Different Approaches, *Journal of Econometrics* 57, 53-68.

[11] Johansen, S. 1988. Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control* 12, 231-254.

[12] Klyuev, V. 2015. Structural Transformation - How does Thailand Compare? : International Monetary Fund, IMF Working Paper, WP/15/51.

[13] Nation. 2017. "NSO reveals agricultural labor increased by over 11 million". Nation TV News (May, 20). (Online). http://www.nationtv.tv/main/content/378548350/

[14] Norton, G., Alwang, J. & Masters, W. 2015. Economics of Agricultural Development: World Food Systems and Resource Use (3rd edition). New York: Routledge.

[15] Perkins, D., Radelet, S., Lindauer, D. & Block, S. 2013 .Economics of Development (7th edition). New York: W. W. Norton & Company.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

[16] Phillips, P.C.B. and Hansen, B.E. (1990). Statistical Inference in Instrumental Variables Regression with I(1) Processes, *Review of Economic Studies* 57, 99-125.

[17] Romer, P. M. 1989. Human Capital and Growth: Theory and Evidence. *NBER Working Papers No.3173***,** 1-41.

[18] Saiyut, P., Bunyasiri, I., Sirisupluxana, P., and Mahathanaseth, I. 2017. "Changing Age Strucure and Input Substitutability in the Thai Agricultural Sector", *Kasetsart Journal of Social Science*. 38, 259-263.

[19] Solow, R.M. 1957. Technical Change and Aggregate Production Function, *Review of Economics and Statistics* 39, 312-320.

[20] Sujarittanonta, P. and Kamseang, C. 2017. Competition: Missing Piece in Innovation Equation. Bank of Thailand Symposium 2017.

[21] Suphannachart, W. 2017. "What Drives Labour Productivity in the Ageing Agriculture of Thailand." Advances in Management and Applied Economics 7(1): 89-105.

[22] Suphannachart, W. 2015. "Agricultural Research System in Thailand: The Development, Policies, Institutions, Investment Patterns, and Impact Assessment." Review of Integrative Business and Economics Research 4(4): 63-89.

[23] Suphannachart, W. and P. Warr. 2011. "Research and Productivity in Thai Agriculture", *The Australian Journal of Agricultural and Resource Economics.* 55, 35-52.

[24] Tangkitvanich, S. & Bisonyabut, N. 2014. Towards Quality Growth: Challenges and Opportunities of Thailand in the Next Three Decades. . *2014 TDRI Year-End Conference on Positioning Thailand in the Next Three Decades: Four Challenges to Quality Growth.* Bangkok, 24 November, 2014 (in Thai).

[25] Tinakorn, P. and Sussangkarn, C. 1998. Total Factor Productivity Growth in Thailand: 1980-1995. Bangkok, Thailand Development Research Institute.

[26] Wirotsattabut, C. 2017. Impacts of Aging Society on Labor Productivity in the Agricultural Sector of Thailand. M.S. Thesis (in Thai). *Graduate School*. Bangkok, Kasetsart University.

[27] World Bank Group. 2016b. Thailand Systematic Country Diagnostic: Public Engagement (Online). www.worldbank.org/thailand.

[28] World Bank Group. 2016a. Structural Transformation of the Agricultural Sector: A Primer. Research Policy Briefs from the World Bank Malaysia Hub, No. 2 March 2016.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)