

《論 文》

Economic Growth and Income Distribution: A Debate on Capital Accumulation in Thailand

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Abstract

The performance of the Thai economy after the financial crisis in 1997 has induced economists, and policymakers believe that Thailand was trapped in the middle-income range. This paper reviews the stylized facts. Here, we have constructed an economic chronology of Thailand to explain the past unstable growth path. It is an impact of the external shock of currency realignment in 1985, as well as financial crises in 1997 which may have implications of the capital deepening in Thailand.

We have surveyed the *theoretical as well as sought empirical evidence to explain* why Thailand has been falling into the trap. Firstly, we have applied an Input-Output Table of Thailand 1975-2010 which condensed the inter-industrial relationship into 5 disaggregate sectors. With calibrated capital stock, labor employment, we have statistically analyzed the path of economic growth, capital accumulation, and *factors* distribution of income in Thailand in the past decades 1970s-2000s. We have tried also to explain the growth and income distribution in Thailand from various theoretical perspectives, especially the debates on capital and distribution between the Neo-Classical and Post-Keynesian schools of thought.

In the long-run, if Thailand would aim to exit from the 'middle-income trap', she may have to emphasize the proper level of capital accumulation. With the Ramsey-Cass-Koopmans (RCK) model simulation, we try to forecast the long-term path of capital accumulation in Thailand. It is found that the steady-state growth path of capital accumulation and consumption would be still far from reached by our current effort in capital investment. The sacrifice of current consumption would be needed to increase the saving rate for capital accumulation and steady-state growth.

The Keynesian model of growth has proved to be well behaved in the case of Thailand. The profit rate was determined by the saving rate and the capital-output ratio. The profit-wage rate ratio determines the income distribution along with capital accumulation. It has been observed that Thailand had low productivity of capital and declining profit rate overtime. On the contrary, Thailand had real wage rate growth and an acceptable labor productivity record. Thus, the income distribution worked in favor of wage earners over time rather than the profit earner like capitalists or entrepreneurs. This is contradicting to the conventional belief that exploited labor surplus was a source of capital accumulation and growth. We, therefore, postulate that the Kuznets' Inverted U-Shape hypothesis may be realized in the case of the Thai economy i.e., Thailand has entered the phase of a reduction of poverty as well as income inequality in recent years. However, the result of the endogenously determined saving rate by the RCK model simulation has confirmed that the Thai economy is still far from reaching the steady-state level of economic growth and equitable income distribution as had been achieved by other predecessors.

Keywords: Growth and income distribution, capital controversy, RCK steady-state growth path

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1. Introduction

The macro-economic performance in Thailand has been subjected to a business cycle for several epochs. The growth record was quite impressive except during the Asian Financial Crisis in 1997-1998. The sources of growth from the supply side according to the growth accounting have shown that Thailand has reached the status of a middle-income country. The structural change in terms of value-added share has shifted from agriculture to the manufacturing and service sectors. The sources of growth were mainly from the capitalization deepening, rather owing to the growth of Total Factor Productivity (TFP). Since 1972, the contribution from labor numbers and land to economic growth has declined.

The objective of this paper is to apply the economic growth model to explain the Thai economy since the 1970s-2010s. We want to find out empirically why Thailand could not get out of the middle-income trap? Thailand has taken-off from subsistence since the early 1960s and has passed economic and financial crisis in 1997. It is hypothesized that Thailand should be able to reach a stable middle-high income country in the 2000s and onward. But this has never been achieved. What has been the obstruction to the capital accumulation and growth episode in Thailand?

To analyze the cause and trying to answer the above puzzle, we have first constructed a growth accounting on the supply side. We have compiled sources of growth from capital and labor inputs weighted by their value shares respectively. Besides, to factor inputs' contribution to the growth of output (represented by the Gross Domestic Product in constant prices), we have measured the source of growth from the technology named the 'Total Factor Productivity'.

Further, we would like to test the hypothesis that Thailand has had over capital accumulation before the Asian Financial Crisis (AFC) in 1997. It was pointed out by eminent economists especially Paul Krugman² that over capital deepening in East Asian economies including Thailand was inefficient. The sources of growth were biased by the inefficient capital input and caused low growth in TFP. To prove this, we have compiled a series of Input-Output accounting from the I-O Table of Thailand 1975-2020. This is to prove whether production function, capital intensity, and factor-price frontier (in constant price) are well-behaved as assumed by the Neoclassical Theory or not? In short, it is to prove that the growth of productivity of capital before AFC was low or inefficient and maybe a fundamental source of the economic and financial crisis that occurred in Thailand. The contagion effect was later spilled over to other East Asian Economies.

In the second attempt, we would like to debate concerning the path of economic growth and capitalization trend of Thailand after the AFC 1997. We hypothesize that Thailand was *undercapitalization*, as the capital stock was damaged by the crash in 1997. It was not restored to its sustainable level and induced the economic growth path lower than the growth potential. This may be one of the reasons why Thailand could not exit from the middle-income trap dilemma. Here, we have applied the 'Ramsey-Cass-Koopmans, RCK' model to analyze the long-term optimal growth path. Given heuristic assumption on model parameters and calibration, we simulate how Thailand can reach the long-run steady-state with an endogenous response of saving and capital accumulation.

It should be noted that the study on capital accumulation in Thailand was written by eminent economists before. The pioneering work was well written by Suehiro (1989)³. The study was fundamentally a historical record of the emergence of the capitalist class in Thailand from 1855-1985. The book was well informed with very impressive historical records. It was cited by most Thai study scholars. We have taken for granted that the book was a pioneering study from a historic point of analysis. In our study, we would rather choose to follow the economic approach from the philosophy of Classical, Neo-Classical, and Keynesian schools respectively. This study has chosen epoch of development of Thailand dating from 1975-2010 since we rely on the inter-industrial Input-Output accounts of Thailand. Our study, although it has a different academic path it may add on macroeconomic perspective to the previous study. We have further analyzed the income distribution in Thailand. We have applied the concept of factor incomes to lay the ground for further debates on the results.

² Krugman, P. (1994), "The myth of Asia's miracle", *Foreign Affairs*, Nov/Dec94, Vol. 73 Issue 6, p62, 17p, 1bw. Item Number: 9411180052. <http://www.gsid.nagoya-u.ac.jp/sotsubo/Krugman.pdf> accessed May 25, 2019; <http://documents.worldbank.org/curated/en/975081468244550798/pdf/multi-page.pdf> accessed May 25, 2019.

³ Suehiro, A. (1989), *Capital Accumulation in Thailand : 1855-1985*. The Centre for East Asian Cultural Studies, Japan.

2. The Capital Accumulation and Economic Development of Thailand since the 1960s

The economic growth episode of Thailand has taken-off since 1954 and continually expanded until 1960. Investment promotion policy had been the main thrust of the first National Economic and Social Development Plan. Under the plan, basic institutions were set up to facilitate planning and infrastructure development. Growth was interrupted after 1973 where major world currencies were floated and commodities boom flowed by the first oil crisis in 1973. Thailand was still benefited from this price hike as her agriculture prices were also lifted. She was truly affected by the second oil crisis in 1979. This time Thailand was suffered from a world recession after a high-interest rate thereby slow down world demand for Thai export and slowdown the domestic economy. Growth performance was quite moderate with 5 percent per year lower than her potential growth.

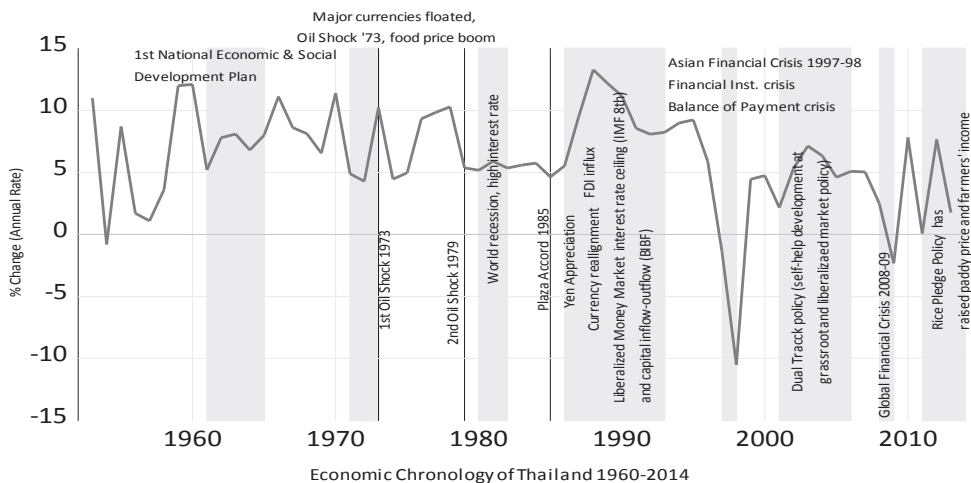


Figure 1: Economic Chronology of Thailand 1960-2014

Note: The economic chronology has not described the *domestic disruptions* from a series of *political unrests* in Thailand. We have treated them as *endogenous impulse responses to external shocks* e.g., *Vietnam War* and between imbalanced *class struggles* among the power bases. It is assumed to be non-economic Chronology as such.

The world's major developed countries led by the US had agreed with Japan to realign 'Yen' to its real value. The Japanese currency was appreciated from 220 Yen per US dollar to a much stronger position after the 'Plaza Accord' in 1985. This has led the Japanese foreign direct investment poured to other East and Southeast Asian countries. Thailand was one of the major recipients of FDI from Japan and other developed countries during the 1987-1990's. Thailand had an imbalance of the 'saving-investment' therefore decided to liberalize the money market to comply with IMF 8th article. This was to free the ceiling of *interest rate*, allowing a free flow of foreign capital under the 'Bangkok International Banking Facility' or BIBF scheme.

The liberalization of the money and the capital market had violated the open economy macroeconomic constraint. It is named the 'Impossibility Trinity' where the *fixed exchange rate regime* is operated to stabilized export earnings but allowing for *free capital flow*. The interest rate arbitrage would need to run a *high-interest policy* domestically. This will harm export as the cost of production of export will increase. Thus, the free capital inflow would be required to cushion the rising of domestic interest rates. The cheap capital and oversupply of money have caused any inflationary impact. To hedge against these inflationary, speculators would need to hoard *non-producing assets* rather than real investment goods.

This had resulted in the accumulation of '*non-tradable*' goods such as 'real estate'. Land price has boomed artificially. It helped to dress up the balance sheet of private banks and finance companies. The *Asian Financial Crisis* (AFC) had originated from Thailand in 1997, as the bubble busted, *banking crisis*, and *balance of payment crisis* thereafter. The Bank of Thailand was defeated by currency speculators or *hedged funds* in the currency war in February and May 1997.

The government after the AFC had managed to pay back the ‘rescue funds’ of 17.4 billion US dollars arrangement under the IMF’s balance of payment facilities. Thai currency was stabilized though much weaker than the pre-crisis level. The weak currency after the crisis had stimulated an export expansion in the world commodities market. The introduction of the ‘*dual-track*’ policy by the subsequent government has introduced a *self-help or grass-root* development in juxtaposition with *market-driven* policy and *deregulations*. The Thai economy had recovered and ready to take-off to another growth episode of competitiveness in *outward-oriented* export earning policy. Thai economy was not severely affected by the Global Financial Crisis in 2008-2009. The economy was further stimulated by the ‘Rice Pledge’ policy which had raised the paddy price and farmer’s income.

In short, Thailand started her economic development during 1950-1960 with growth in agriculture. It was dominated by primary products like paddy, timber, and tin, etc, for export earnings. During 1970’s she has earned foreign currency from four main cash crops like paddy, cassava, maize, sugar cane, and natural rubber. In the 1980s, Thailand has taken off to *light industrialization* in food production and others. After the ‘Plaza Accord’ and Japanese Yen appreciations after 1985, Thailand had received an influx of foreign direct investment from Japan and East Asian countries. This may be the beginning of light industrialization with labor-intensive and later shifting to *capital deepening* in her industries in the late 1990s.

2.1 Sources of Growth in Thailand

Ketsawa (2019)⁴ has pointed out that the *domestic demand expansion* mainly determined the *sources of industrial growth in Thailand* from the demand side as compared with *export expansion* and *import substitution*. The electronic and electrical machinery, transport equipment, rubber and plastic, and textile had contributed to manufacturing growth in Thailand. The growth of gross output of these industries was 17.4, 13, 9.4, and 8.6 percent, respectively. The transport equipment, chemical, electrical machinery, and other capital-intensive industries had their domestic demand and export as significant sources of industrial growth. Also, the industries had significant *backward linkage*.

The analysis of the *sources of growth from the supply-side* has found that the growth of real GDP was contributed by the growth of capital and labor inputs weighted by their value-share or factors’ prices and technology. The growth’s residual unaccounted by capital and labor in the growth accounting is nominated as the growth of technology. It is called ‘*Total Factor Productivity*’. Applying the ‘growth accounting’⁵ of Thailand, we have found that TFP growth was quite impressive during 1972-1991, 1999-2004, it may mean that TFP has contributed in line with human capital and physical capital growth contribution.

It was hypothesized that the TFP may have been higher if the *capital deepening process exhibited higher productivity and efficiency*. It was criticized by Krugman⁶ “if growth in East Asia has been primarily *input-driven*, and if the *capital piling up* there is beginning to yield *diminishing returns*. and there is *no sign* of such exceptional *efficiency growth*.” Thus, the ‘East Asian Growth Miracle’ including Thailand was heavily reliant on the growth of capital input. Moreover, it may mean that Thailand may have *over-invested* in capital deepening. That is, Thailand did not have a ‘quality growth’ with high TFP.

⁴ Ketsawa, W. (2019) “Industrial Growth and Development in Thailand 1980-2010: A Lesson Learned for CLMV”, *The Social Science Review: Special Issue on Mekong Economy*, No.156 March 2019, pp.51-70

⁵ GDP growth per year $\frac{d}{dt} \ln(Y) = [\text{growth of capital input } \frac{d}{dt} \ln(K) * \text{value share of capital } (r * K/Y)] + [\text{growth of Labor input } \frac{d}{dt} \ln(L) * \text{value share of labor } (w * L/Y)] + [\text{growth of land services } \frac{d}{dt} \ln(Land) * \text{value share of land } (rent * Land/Y)] + \text{Total Factor Productivity}$

⁶ Krugman, P. (1994), Ibid. a quotation is from his paper on pages 11-12.

See also World Bank (1993), *The East Asian Miracle: Economic Growth and Public Policy*, Oxford University Press <http://documents.worldbank.org/curated/en/975081468244550798/pdf/multi-page.pdf> accessed May 25, 2019.

Table 1: Sources of Growth from the Supply Side in Thailand 1972-1991
(Measured in Percentage per year)

Year	Avg. GDP growth	Labor growth	Land growth	Capital growth	TFP
1972-76	6.53	0.68	0.31	3.06	2.49
1977-81	7.23	1.52	0.26	4.60	0.85
1982-86	5.37	0.54	0.05	4.36	0.43
1987-91	10.94	0.87	0.00	7.26	2.82

(Measured in percentage per year)	1999	2000	2001	2002	2003	2004
GDP growth of which contributed by	4.4	4.8	2.2	5.32	7.14	6.34
- Total Factor Productivity, TFP (Unexplained Residual of growth determinants)	3.04	3.40	0.62	3.36	4.95	3.36
- Growth of Capital service	0.9	1.2	1.0	0.91	1.29	1.81
- Growth of Labor head	0.46	0.2	0.58	1.01	0.79	0.87
-Growth of land service	Na.	Na.	Na.	0.03	-0.02	
(in Percentage per year)	2005	2006	2007	2008	2009	2010
GDP growth of which contributed by	4.53	5.11	4.93	2.48	-2.33	7.8
- Total Factor Productivity, TFP (Unexplained Residual of growth determinants)	2.03	2.36	2.16	-0.28	-4.28	4.94
- Growth of Capital	1.96	2.31	2.28	1.99	1.40	2.53
- Growth of Labor (head count)	0.50	0.41	0.51	0.69	0.56	0.28
-Growth of land service	0.40	0.04	4.93	2.48	-2.33	0.04
(in Percentage per year)	2011	2012	2013	2014	2015	
GDP growth of which contributed by	0.1	6.5	2.87	0.71	2.8	
- Total Factor Productivity, TFP (Unexplained Residual of growth determinants)	-1.67	3.69	0.73	0.2	1.73	
- Growth of Capital	1.5	2.44	2.2	1.27	1.13	
- Growth of Labor (headcount)	0.33	0.34	0.36	-0.03	-0.76	

Note: real GDP, labor land, and Capital and TFP expressed in terms of percentage change per year.

Source: NESDB and own calculations

We have not estimated the sources of growth owing to human capital growth in our paper. If this is taken into account, the sources of growth may be somewhat changed on the labor headcount to be lower and replaced by the growth contribution from the human capital. The integration between growth contributions from the demand-supply side should be interpreted as follows: Firstly, the influx of foreign direct investment during 1987-1997 had given rise to rapid expansion on the demand side as had been pointed by Ketzawa (2019)⁷. Thus, the process of capital deepening applying low-wage labor in Thai manufacturing sectors was sources of growth from the supply side as well. This was pointed by Bowonthumrongchai (2019)⁸ that Thailand has passed the 'turning point' of several criteria proposed by

⁷ See Ketzawa, W. (2019) Ibid.,

⁸ Bowonthumrongchai, T. (2019) "Economic Development and Urbanization in Thailand 1960-2015: Implication for the Mekong", *The Social Science Review: Special Issue on Mekong Economy*, ???..

Minami (1968)⁹. Thus, there was an internal migration of unskilled labor with low-wage from the rural area (agriculture sector) to the urban area (manufacturing sector) in the Thai context. The capital deepening by the manufacturing and service sector without a proper plan for skills formation on the human resource had caused overcapitalization without matched skills. In an economic term, it may be described as unsustainable capital intensity (capital-labor ratio) growth path. The immediate response was a *decline in profit rates* of heavy industries as compared with light industries in the capital market. It was Krugman (1994)¹⁰ who firstly observed and warned about over capital accumulations in Thailand and other East Asian countries. Capital utilization was not efficient and may face *diminishing returns*. The macro-economic policy during 1994-1997 has proved to be imprudent as Thailand has complied with the IMF suggestion on the liberalization of the interest rates while allowing the free flow of foreign capital under the Bangkok International Banking Facilities. The declining rate of profit in the real sector has motivated investors and private funds to shift to invest in the non-performing loans i.e., real estates and non-tradable activities rather than R&D capital investment and human skills development.

After the AFC in 1997-1998, the foreclosure of non-performing financial assets had caused a decline in the physical capital of the real sector. Especially, the enterprises with Thai capitals were tragically declared bankruptcy and changing ownerships. Now the economic development of Thailand has turned into an episode of low-level capital accumulation opposite to what has happened before the AFC. Most of the private financial institutions were majorly owned by foreign capital. They were prudential on project loans for most of the firms. Thai firms had a hard time raising capital from the secondary capital market and debt market to finance their capital investment as well. Therefore, Thai firms in light industries and services, etc. that utilized labor-intensive, unskilled labor would seek to hire *foreign guest laborers* to reduce their production cost. The suppression of low-wage unskilled workers had prolonged the resumption of capital investment in most of the labor-intensive sectors. An exception may be only the foreign firms with their own capital could still make a capital investment. But, actual growth performance was lower than the potential growth after AFC 1997 until at least 2010. *Capital dilution* which was an opposite scenario of *capital deepening* was phenomena in Thailand after 2000 until the current date of 2020.

3. Review of Theoretical Models

We visualize that Thailand has been developed through stages of the 'Indicative Planning Model' drawn by the National Economic and Social Development Board, the Thai government. The National Economic and Social Development Plans since the early 1960s until now are altogether 12 plans. Most governments either elected under a democratic system and/or non-elected governments have mostly followed these indicative plans. Some democratic government has set her execution agendas according to these plans plus their own campaigned agendas. Thus, we may imagine that the execution agenda of each government was different in degree of dependency between indicative planning vis-à-vis market-oriented mechanism liberalization. It is postulated that Thailand may have applied some kind of planning process since the 1970s.

3.1 The Ramsey Model¹¹

Ramsey firstly asked the question of '*how much of income should a nation save?*'. He tried to apply the mathematical model to solve this puzzle. Ramsey's postulated that '*The rate of saving multiplied by the marginal utility of money should always be equal to the amount by which the total net rate of enjoyment of utility falls short of the maximum possible rate of enjoyment.*'¹² Ramsey described the maximum obtainable rate of enjoyment or utility and called it, for short, the '*Bliss*' which the community must save enough either to reach Bliss after a 'finite time', or at least to approximate to it indefinitely.

⁹ Minami R. (1968) "The Turning Point in the Japanese Economy", *The Quarterly Journal of Economics*, Volume 82, Issue 3, 1 August 1968, pages 380-402.

¹⁰ Krugman, P. (1994), *Ibid.*,

¹¹ Ramsey F.P. (1928), "A Mathematical Theory of Saving", *The Economic Journal*, Vol. 38, No. 152 (Dec. 1928), pp. 543-559, Published by Blackwell Publishing for the Royal Economic Society, Stable URL: <http://www.jstor.org/stable/2224098>, Accessed: 09/12/2010 04:55

¹² Italic is Ramsey's original, p 543.

Ramsey firstly started from the simple account identity that the savings plus consumption must equal income. Then, he defined the marginal rate of *utility* as a function of the frequency of consumption flow and the *disutility* of a rate of labor supply flow. The difference between the total rate of utility and disutility is '*net enjoyment*' which is *subjected to a given level of capital stock. The planner would aim to maximize net enjoyment over time. The maximal conceivable limit of net enjoyment is reached without further increase in either income or leisure by an increment of capital.* He called it the '*maximum obtainable rate of enjoyment*' or '*BLISS*' which strictly reach only at the limit. The more the nation 'save' (sacrifice of the enjoyment we have now) the feasible it can approach the bliss earlier. Ramsey has proved that the '*rate of saving multiplied by the marginal utility of consumption should always equal bliss minus the actual rate of utility enjoyed*'¹³

Ramsey model differed from the Solow-Swan model¹⁴ in crucial assumption on the *saving rate*. In Solow-Swan, the fraction of output is saved at a constant rate s , so that the saving is $sY(t)$. Solow assumes the production function is homogeneous of the first degree (leads to a constant return to scale of factors), thus, no scarce non-augmentable resource like the land that would lead to decreasing returns to scale in capital and labor and the model. The growth of the *labor force was exogenously given, as long as real income was positive, the positive net capital formation must result.* If savings fall to zero when income is positive, it becomes possible for *net investment to cease.*

Ramsey growth model was extended by Cass and Koopmans such that households explicitly optimize the choice of consumption at a point in time. Thus, the *model has an endogenous savings rate as a variable saving rate along with the transition to the long-run steady state.* It is also a Pareto optimal. Unlike the originally Ramsey which is a central planner's maximizing levels of consumption over successive generations, Cass and Koopmans's model describes a decentralized dynamic economy explaining long-run economic growth.

In a developing country like Thailand, it has been perturbed by the business cycle fluctuations with market imperfections and heterogeneity among households. It is interesting if the role of the government is considered as well.

3.2 The Indicative Planning Model à la Ramsey-Cass-Koopmans (RCK)

The production function is neoclassical Cobb-Douglas technology, $Y=K^\alpha L^{1-\alpha}$; $0<\alpha<1$, or $y=k^\alpha$ shown in per-capita terms. We omit technological progress in accordant with the stylized fact mentioned for Thailand and assume the population growth at a *constant rate*. The utility function is assumed as $u(c)=\frac{c^{1-\sigma}}{1-\sigma}$ where $\sigma>0$, the social welfare optimization is subjected to the economies' resource constraint given by $\dot{k}=y-c-(n+\delta)k$. The change in the capital (physical and human) is equal to the saving ($y-c$) minus by the depreciation plus population growth *rates* ($n+\delta$), all are in terms of per capita.

The social planner objective is to maximize welfare measured by the following:

$$\begin{aligned} \max_{c(t)} \int_0^\infty \frac{c^{1-\sigma}}{1-\sigma} e^{(n-\rho)t} dt & \quad (1) \\ \text{s.t. } \dot{k} = y - c - (n + \delta)k & \quad (2) \\ k(0) = k_0 & \end{aligned}$$

The current-value Hamiltonian

$$H = \frac{c^{1-\sigma}}{1-\sigma} + \lambda(k^\alpha - c - (n + \delta)k) \quad (3)$$

λ is the co-state variable, c is the *control* variable, and k is the *state* variable.

¹³ Italic is Ramsey's original, p 547.

¹⁴ Solow, Robert M. (1956). "A contribution to the theory of economic growth", *The Quarterly Journal of Economics*, Vol. 70, No. 1 (Feb. 1956), pp. 65-94, The MIT Press, doi:10.2307/1884513. Stable URL: <http://www.jstor.org/stable/1884513>. Swan, Trevor W. (November 1956). "Economic growth and capital accumulation" *Economic Record*. 32 (2): 334-361. doi:10.1111/j.1475-4932.1956.tb00434.x.

The first-order conditions are given by

$$H_c = 0 \leftrightarrow c^{-\sigma} = \lambda \quad (4)$$

$$H_k = \dot{k} \leftrightarrow \dot{k} = y - c - (n + \delta)k \quad (5)$$

$$H_\lambda + (n - \rho)\lambda = -\dot{\lambda} \leftrightarrow -\dot{\lambda} = (\alpha k^{\alpha-1} - (n + \delta))\lambda + (n - \rho)\lambda \quad (6)$$

The transversality condition

$$\lim_{t \rightarrow \infty} k(t) \lambda(t) = 0 \quad (7)$$

From (4), take a log and differentiating with respect to time yields

$$-\sigma \frac{\dot{c}}{c} = \frac{\dot{\lambda}}{\lambda} \quad (8)$$

Re-arrange (6), yields

$$\frac{\dot{\lambda}}{\lambda} = -\alpha k^{\alpha-1} + \delta + \rho \quad (9)$$

From (8) and (9) together, we get the Keynes-Ramsey rule. The equilibrium has saddle point property as can be observed in the usual phase diagram. By the Hartman–Grobman theorem the non-linear system is topologically equivalent to a linearization of the system about (\bar{k}, \bar{c}) by a first-order Taylor polynomial

$$\dot{c} = c \frac{\alpha k^{\alpha-1} + \delta + \rho}{\sigma} \quad (10)$$

$$\dot{k} = k^\alpha - c - (n + \delta)k \quad (11)$$

$$k(0) = k_0 \quad (12)$$

The transversality condition ensures convergence towards the interior *steady state*. The steady-state values are

$$k^* = \left(\frac{\alpha}{\delta + \rho} \right)^{\frac{1}{1-\alpha}} \quad (13)$$

$$c^* = k^{*\alpha} - (n + \delta)k^* \quad (14)$$

At steady state, the Jacobian matrix of the RCK¹⁵ is

$$J(k, c) = \begin{bmatrix} f_k - (n + \delta) & -1 \\ \frac{1}{\sigma} f_{kk}(k) \cdot c^* & \frac{1}{\sigma} [f_k(k) - \delta - \rho] \end{bmatrix}$$

become

$$J(k^*, c^*) = \begin{bmatrix} \rho - n & -1 \\ \frac{1}{\sigma} f_{kk}(k) \cdot c^* & 0 \end{bmatrix} \text{ has its determinant } |J(k^*, c^*)| = \frac{1}{\sigma} f_{kk}(k) \cdot c^* < 0.$$

Since c is always positive and σ is positive by assumption, the only $f_{kk}(k)$ is negative since f is *concave*. The determinant has one eigenvalue greater than zero and the other is opposite in sign. Besides, it is assumed that the inefficient over saving (non-Ponzi game or $\lim_{t \rightarrow \infty} k \cdot e^{\int_0^t (f_k - n - \delta) ds} \geq 0$) cannot occur in the optimizing framework. Thus, the equilibrium is a saddle point and there exists a unique stable arm or saddle path that converges on the equilibrium. The saddle path is stable or not depending on the property of the economic structure and the nature of the external shocks.

In Thailand, the government had implicitly followed these indicative planning rules which could work efficiently with the market mechanism. The RCK model with the government in a normal market economy is simply explained as follows:

The government has introduced proportional taxes on wage w, τ_w ; on the private return on asset a, τ_a ; and on the private consumption c, τ_c respectively. Thus the representative household's maximization problem is now simply to

¹⁵ Matrix of the partial derivatives of (10) and (11) with respect to (k, c) .

$$\max_{c(t)} \int_0^{\infty} \frac{c^{1-\sigma}}{1-\sigma} e^{(n-\rho)t} dt \quad (15)$$

$$\text{s.t. } \dot{a} = (1 - \tau_w)w + (1 - \tau_a)ra - (1 - \tau_c)c - na + T, \quad (16)$$

$$a(0) = a_0$$

whereas c denotes consumption per-capita, k the capital stock per-capita, T lump-sum transfers, w the wage rate, r the interest rate, σ the inverse of the intertemporal elasticity of substitution, and ρ the discount factor, respectively. The government is assumed to run a balanced budget. It means government revenue will be spent back to the economy via lump-sum transfer to households. The production function is neoclassical Cobb-Douglas technology

$$Y = K^\alpha L^{1-\alpha} \quad (17)$$

where, Y denotes the output, K the capital stock, L the amount of labor employed in production, and α the elasticity of capital in the final output production, respectively. Since perfect competition in factor markets is assumed, firms pay the factors according to their marginal product,

$$r = \alpha k^{\alpha-1} - \delta \quad (18)$$

$$w = (1 - \alpha)k^\alpha \quad (19)$$

Solving the household's optimization problem yields the Keynes-Ramsey rule

$$\frac{\dot{c}}{c} = \frac{(1-\tau_a)r-\rho}{\sigma}$$

Assuming capital market equilibrium k yields the system

$$\dot{k} = w + rk - c - nk \quad (20)$$

$$\frac{\dot{c}}{c} = \frac{(1-\tau_a)r-\rho}{\sigma} \quad (21)$$

with initial condition $k(0) = k_0$ equation (18) and (19) can be inserted into the system (20) and (21), or treated as algebraic equations for the *numerical simulation*. It should be noted that the optimal economic growth has been extended to incorporate the fiscal-monetary policy in an aggregative form by Uzawa H.(1998)¹⁶. The study has applied an exogenous income tax rate and growth rate of money supply such that an optimum rate of investment is attained through time. The economy produced public goods and private goods respectively. The former is regarded as consumption goods by Uzawa while private goods can either be consumed instantaneously or accumulated as capital. The study has explicit social welfare function which is defined as the discounted sum of the instantaneous utilities through time. It is however interesting that Uzawa has reformulated the problem of fiscal policy such that the public sector seeks optimal time-paths of factor and output allocations by choosing appropriate dynamic fiscal policy parameters i.e., tax rate and increases the rate of the money supply¹⁷. Cass (1965)¹⁸ proved the optimal growth model applying the calculus of variation and the 'Maximum Principle'. Cass acknowledged Koopmans (1963)¹⁹ who arrived at the same conclusion on the 'Keynes-Ramsey' rule with 'bliss' replaced by golden rule of individual welfare. Furthermore, Cass noted that the limiting optimum path is similar to those found by Srinivasan (1964)²⁰ and Uzawa (1964)²¹. However, they both assume that the utility index is simply consumption per capita, while in Cass's model he introduced a diminishing marginal rate

¹⁶ Uzawa, H. (1988), "Optimum fiscal policy in an aggregative model of economic growth", Chapter 18 of *Preference Production, and Capital: Selected Papers of Hirofumi Uzawa*, Cambridge University Press, pp.313-39

¹⁷ See Uzawa, H (1988) p.338.

¹⁸ Cass, D. (1965), "Optimum Growth in an Aggregate Model of Capital Accumulation", *Review of Economic Studies* No.32, pp. 233-240.

¹⁹ Koopmans T.C. (1963), "On the Concept of Optimal Economic Growth", *Cowles Foundation Discussion Paper*, December.

²⁰ Srinivasan, T. N. (1964), "Optimal Savings in a Two-Sector Model of Growth", *Econometrica*, No. 32 (1964), pp. 358-373.

²¹ Uzawa, H. (1964), "Optimal Growth in a Two-Sector Model of Capital Accumulation", *Review of Economic Studies*, 31 (1964), pp. 1-25.

of substitution between generations' welfare. Ohdoi R. (2016)²² has incorporated government intervention into the baseline RCK model. It is proved that the government spending crowds out private consumption. The consumption tax's *distortion is less* as long as the same rate applies to all goods and it is constant over time. Moreover, *capital income taxation harms the households' savings, thereby capital accumulation*. In consequence, *the capital stock in the steady-state decreases as the tax rate becomes higher*. By introducing the labor-augmenting technological change to the baseline model, all per capita variables (per capita GDP, capital, consumption...) become to grow at the same constant rate of technological progress in the long-run.

3.3 Debate on the Choice of Capital Accumulation

Inada, Sekiguchi, and Shoda (1992)²³ analyzed capitalization along the growth path of the 'Three-Sector model of economic growth'. The literature has drawn heavily to prove the growth of lower capital intensity towards the higher capital intensity sector empirically. The movement of low to high capital intensity is quite interesting and maybe point of discussion to explain the situation of contemporary Thailand 'why' we are not able to get out of the 'middle-income trap'. Inada's three-sector model had built up an *ex post*-theoretical model to explain how the economy e.g., pre modern-Japan which had limited resources allocate [*capital*] to nurture her industrialization away from the subsistence sector (the S-sector), passing the light industry sector (the X-sector), to the heavy and chemical industry sector (the Z-sector). The characteristic of S-sector is the same as Lewis²⁴, '*disguised unemployment*' and being the main supplier of low-wage labor to the X and Z-sector respectively. Noting in the case of Thailand, Bowonthumrongchai (2019)²⁵ has proved that Thailand has passed over a '*turning point*' using several criteria proposed by Minami (1968)²⁶.

The main hypothesis of Inada's 'three-sector model' are (1) if the amount of accumulated capital in the X-sector increases, the profit rate of the sector (R_X) declines, exhibiting constant return to scale of production and (2) As the Z-sector has increasing return to scale of production if the amount of accumulated capital in the Z-sector increases, *its profit rate (R_Z) rises*. It is assumed that the wage incomes in the S-, X-, and Z-sectors are spent entirely on consumption. The sum of investment in the X- and Z-sectors is equal to the sum of profits in the X- and Z-sectors. Thus, firms will optimally allocate their retained profit to invest in a sector that is the most profitable between X- and Z- sector. The Inada's model was a replica of what has been achieved in Japan and East Asian countries, in the early days of development. The model can be extended to cope with the open economy to have net capital inflow from abroad in terms of foreign aid (ODA). The model has its fundamental belief that heavy government intervention i.e., high import tariff to protect domestic infant industries, import of technology, heavy subsidy to the Z-sector would be *sufficient conditions to take-off*. This may or may not be true for most developing countries to replicate Japan.

The foregoing postulation is based on the neoclassical tradition. Especially, the smooth production functions with continuous substitution pioneered by von Neumann (1945-1946)²⁷ and Dorfman, Samuelson, and Solow (1958)²⁸, Morishima (1964)²⁹ respectively. Even though, Neuman had started with the finite array of linear technologies rather than continuous substitution and related core issues. It was later related to the issues of the factor price frontier, re-switching of production techniques by

²² Ryoji Ohdoi (2016), Ramsey-Cass-Koopmans Model (1) and (2) lecture notes, based on Acemoglu (2009), Blanchard and Fischer (1989) and Barro and Sala-i Martin (2004), Dept. of Industrial Engineering and Economics, Tokyo Tech. <https://www.google.com/search>

²³ Inada k., Sekiguchi, S. and Shoda, Y (1993), *Mechanism of Economic Development: Growth in the Japanese and East Asian Economies*. Oxford and New York: Clarendon Press, 1993.

²⁴ W A (1954) "Economic Development with Unlimited Supplies of Labor", *Manchester School of Economic and Social Studies*, Vol. 22, pp. 139-91.

²⁵ Bowonthumrongchai, T. (2019), "Economic Development and Urbanization in Thailand 1960-2015: Implication for the Mekong", *The Social Science Review: Special Issue on Mekong Economy*, ???..

²⁶ Minami R. (1968) "The Turning Point in the Japanese Economy", *The Quarterly Journal of Economics*, Volume 82, Issue 3, 1 August 1968, pp. 380-402.

²⁷ Von Neuman, John. (1945-46), "A Model of General Economic Equilibrium", *Reviews of Economic Studies*, Vol. 13, pp. 1-9.

²⁸ Dorfman, R., Samuelson, P. A., and Solow, R.M. (1958), *Linear Programming and Economic Analysis*, New York, McGraw-Hill.

²⁹ Morishima, M. (1964), *Equilibrium Stability and Growth: A Multi-Sectoral Analysis*, Oxford University Press.

(Pasinetti, and others)³⁰. It further leads to the debate between Classics, Post-Keynesian, and Neo-classical economists as noted by Marglin (1984, p.540)³¹ on multiple technologies and the re-switching.

'Reswitching was held to be important.....it is sufficient but not necessary condition.....the failure of the monotonicity in the correspondence between the capital intensity of production and the rate of profit....be understood as part of ...the larger debate....about the existence of the "well-behaved" capital aggregation in the multiple-good world.'

Burmeister and Dobell (1970)³² have applied Leontief model with Technique α and the corresponding matrix of input coefficient vector $[a_0 \dots a]'$ where $a_{0j} = \frac{L_j(t)}{Y_j(t+1)}$ and $a_{ij} = \frac{K_{ij}(t)}{Y_j(t+1)}$, ($i=1,2,\dots,n$; $j=0,1,\dots,n$) where L_j , K_j , Y_j is labor, capital inputs and output respectively. Given $W(t)=[W_0(t), W_1(t), \dots, W_n(t)]$ where $W_0(t)$ is the nominal wage rate paid at the end of the period t and $W_i(t)$ the gross rental rate for the i -th capital good paid at the end of period t . They defined the *equilibrium price* with *one technique matrix* as $P(t+1) = a_0 W_0(t) + P(t)\rho(t)a$ where $P_i(t)$, ($i=0,1,\dots,n$) the price of one unit of the i -th output at the beginning of period t and $P(t)=[P_0(t), P_1(t), \dots, P_n(t)]$.

They noted on page 231 further that $W_i(t)/P_i(t) \equiv p_i(t)$ is the gross own-rate of return for the i -th capital goods, ($i=1,\dots,n$) and the net own-rate of return for the i -th good $r_i(t) \equiv p_i - \delta_i$ where δ_i is depreciation rate and $r_0(t)$ is the money rate of interest or *the profit rate*. $[\theta + \delta]$ is a diagonal matrix with $(1, \theta + \delta_1, \dots, \theta + \delta_n)$ and $[\rho]$ is the diagonal matrix with $(1, \rho_1, \dots, \rho_n)$ on the diagonal and $[0]$ on the off-diagonal row-column. Hence, in matrix notation $p = a_0 + ppa$ where $p \equiv (\frac{p_1}{w_0}, \frac{p_1}{w_0}, \dots, \frac{p_n}{w_0})$ and $p = a_0 [I - \rho a]^{-1}$ where ρ is own-rate of return for the i -th capital good. If matrix $p \gg 0$ is strictly positive, the *net own-rate of return for the i -th capital good* r_i satisfy $r_i = 0$ for $i=1,\dots,n$. The scalar r_0 is called a feasible rate if the matrix ρ is feasible when $r_i = r_0, i=1,\dots,n$. Then it is proved $\frac{\partial p_i}{\partial \rho_j} \geq 0$, ($i=0,1,2,\dots,n$; $j=1,\dots,n$) if the j -th capital good is required, directly or indirectly for the production of good i . This implies a *non-negative relationship between gross own-rate of return and price of output*.

Burmeister and Dobell (1970) generalized his proof to an alternative set of technique matrices

$S_technique \equiv \{\alpha, \beta, \dots, \eta, \dots\}$ the given p is feasible such that the *equilibrium prices* $p_i(\eta)$, $i=1,\dots,n$, satisfy the inequality $p(\eta) \leq a_0(.) + p(\eta)\rho a(.)$ where $a(.)$ is a convex combination of technique matrices belong to S . *Equilibrium prices are functions of exogenous profit or interest rate r_0* . If $r_i(t) \equiv p_i - \delta_i = r_0 = 0$ for example then technique α is employed, it is feasible if and only if $r_0 < 1/\lambda_\alpha^* \equiv r_0^*(\alpha)$ where λ_α^* is the *dominant characteristic root* of the matrix $a(\alpha)[I - \delta a(\alpha)]^{-1}$.

The survey above gives the meaning for our study as follows: 1) The factor-price curve (FPC) where a horizontal axis of the interest rate or profit rate r_0 the plot against real wage $\frac{w_0}{p_i} \equiv \frac{1}{p_i}$ for Technique α that belongs to the set $S_technique$ is *downward sloping*. 2) With several techniques in S the FPC are *downward sloping* but can have any shape since their sign of the second derivative is ambiguous. However, their *outer envelope* or the economy's FPC can be derived. 3) The 're-switching' implies an entire technique in $S_technique$ recurs at a different profit or interest rates. This proof is to counter non-neoclassic tradition especially Sraffa (1960) and Passinetti (1966)³³ that it is *contradicting or paradoxical or perverse to the neoclassical setting*. Burmesiter and Dobell (1970) further responded that it is can occur even if the alternative technique matrices are all *indecomposable*. 4) They have finally proved that the re-switching of technique may occur but only *sufficient* but not necessary. It is *impossible* in the neoclassical multi-sector model without joint production³⁴.

³⁰ Pasinetti, Luigi L. (1966), "Changes in the Rate of Profit and Switches of Technique", *The Quarterly Journal of Economics*, pp.503-17; Samuelson, P., Modigliani (1966), "The Pasinetti Paradox in Neoclassical and More General Model", *Review of Economic Studies*, Vol.33, pp. 269-301; Morishima, M. (1966), "Refutation of the nonswitching theorem", *Quarterly Journal of Economics*, vol. 80, pp.520-525; The debate followed the pioneer paper by Sraffa, P. (1960), *Production of Commodities by Means of Commodities: Prelude to the Critique of Economic Theory*, Cambridge University Press.

³¹ Marglin S., A. (1984), *Growth, Distribution, and Prices*, Harvard University Press.

³² Burmeister, E. and Dobell A., R. (1970), "Leontief Models with Alternative Technique", Chapter 8 of *Mathematical Theories of Economic Growth*, Macmillan Publishing Co., Inc. New York., pp. 228-271

³³ See Sraffa (1960), Ibid.; Passinetti (1966), Ibid.; and Marglin S., A. (1984), Ibid.; See more detail in next section.

³⁴ Burmeister and Dobell (1970), See Theorem 5 page 297. *ibid.*; Burmeister, E. (1980), *Capital Theory and Dynamics Cambridge Survey of Economic Literature*, Cambridge University Press.

In *dynamic* Leontief models, Taylor (1979)³⁵ pointed out the **role of investment and capital accumulation**, let $b_{ji} = K_{ji}/X_i$ be capital-output ratio. Assuming that there is no substitution among capital types and some sectors only produce capital goods, the rest of the sectors have $b_{ji}=0$. If the economy is working at full capacity, then any increment in production is supported by *new capital stock* in place next year. The material balance equation is thus $X_i(t) = \sum_{j=1}^N a_{ij} X_j(t) + \sum_{j=1}^N b_{ij} [X_j(t+1) - X_j(t)] + F_i(t)$ and in matrix notation $X(t) = AX(t) + B[X(t+1)-X(t)] + F(t)$. If the economy grows at a constant rate g , or $X(t+1)-X(t)=gX(t)$. Then the homogenous equation $(I-A-gB)X(t)=0$ with no consumption when exogenous final demand $F(t)=0$. Then maximal growth of this economy is possible when surplus products are being invested. The maximal growth rate g^{bal} can be determined from the determinant $|(\frac{1}{g})I - B(I-A)^{-1}| = 0$ applying the Perron³⁶ a theorem that $B(I-A)^{-1}$ are nonnegative. There will be a positive growth rate g^{bal} with corresponding positive eigenvector X^{bal} at which steady growth is possible. The g^{bal} corresponds to the **largest (1/g)** that solves the above determinant. Investment demand in an open economy I-O may be related to capacity increments rather than output as $X(t)+M(t)=AX(t) + B[CAP(t+1)-CAP(t)]+F(t)$; with a restriction on $X(t) \leq CAP(t)$; and $M(t)[CAP(t+1)-X(t)]=0$ where $M(t)$ is import matrix (non-competitive type) which implying production in each sector cannot exceed its capacity and the competitive import is positive only if capacity is fully utilized to close the gap. Along the balanced growth path, all sectors are expanding at *the same rate*. The output vectors X^{bal} , g^{bal} satisfy the optimal growth path of output as *primal* solution while Sraffa's prices satisfy the optimal growth path of the price as a *dual* solution.

According to Taylor (1979, p. 192), the author relaxes the assumption on final demand $F(t) > 0$ grows at a rate of h under the growth path of a dynamic system $X(t) = (I-A-hB)^{-1} F(t)$ as long as the rate $h < g^{bal}$. *The aggregate saving rate and the capital-output ratio at Sraffa's prices can be determined as*

follows: Let $Z^T=[1,1,...,1]$ and savings rate $s = \left[\frac{\text{output net of intermediate sales} - \text{consumption}}{\text{Output net of intermediate sales}} \right]$ and $\kappa = \left[\frac{\text{total capital required for output net of intermediate sales}}{\text{output net of intermediate sales}} \right] = \frac{1}{g^{bal}}$ along the steady-state growth path. We observe $Z^T(I-A)^*X^* - Z^T X^* = hZ^T B^* X^*$ on the output side and $P_{Sraffa}^T(I-A)X - P_{Sraffa}^T F = hP_{Sraffa}^T B X$ on the cost per unit or price side so that saving equal investment.

We do not involve in such a debate between eminent economists in the last decades. What we are interested in is that what will be the behavior of correspondence between *the capital intensity of production and the rate of profit*, the factor-price frontier, the well-behaved production function, etc., in the case of Thailand during economic development. We wonder that the factor-price frontier of the production system exhibits a well-behaved manner or not. In short, is it possible that the capital deepening before the AFC was not well-behaved? The pre-AFC was deepening with an overcapitalization such that the slope of the FPC has perverse sign reflecting in an upward sloping demand for factor inputs i.e., the higher profit rate is perversely correspondent with higher capital-labor ratio. More importantly, we would like to know whether the real wage-profit rate or the factor price curve are well-behaved as a conjecture by the *neoclassical* model.

On the contrary, after AFC in 1977, capital accumulation was much under the sustainable level for the potential growth of the Thai economy. The production system in Thailand has chosen to bundle unskilled labor with cheap wages rather than to accumulate new capital with higher technology. The factor price frontier between profit rates and real wages may have another feature. In our paper, we have constructed the constant price dynamic I-O Tables of Thailand 1975-2010. We will explore the numerical evidence of these puzzles.

3.4 Growth and Income Distribution: Post Keynesian Approach

Luigi L. Pasinetti is an eminent economist of the post-Keynesian school the heir of the “Cambridge Keynesians” and a student of Sraffa and Kahn. He has also developed the theory of structural change and

³⁵ Taylor, L. (1979), Chapter 12 The dynamic Input-Output model and the Sraffa's price, in *Macro Models for Developing Countries*, Economics Handbook Series, McGraw-Hill Book Company.

³⁶ The singular matrix with 0 determinant, all element of I-O matrix A are non-negative such that each sector requires inputs from every other sector at least indirectly, the polynomial equation in will have positive root (Eigen root) larger in magnitude than any other Eigen value.

economic growth, structural economic dynamics and uneven sectoral development. Following Pasinetti (1974, Chapter IV)³⁷ section 5 on 'Long-run equilibrium conditions by Domar (1946)³⁸ as follows: Given the investment, influences *total* effective demand $(1/s) I = Y$, through $(1/\kappa) I = CAP/dt$, where I = new investment, CAP = productive capacity, κ = capital-output ratio, Y = net national income, s = savings to income ratio respectively. The *equilibrium between effective demands* Y **may not necessarily guarantee the full capacity utilization** CAP . Domar illustrated that given the initial condition where $CAP(0) = Y(0)$ at time=0. Then if the productive capacity over time $(dCAP/dt) = (dY/dt)$ the effective demand, after substitution, we obtain $(1/\kappa) I = (1/s) (dI/dt)$ from which $(s/\kappa) dt = (1/I)dI$.

By integration and the initial condition of $I(t) = I(0) e^{(s/\kappa)t}$. The ' e ' is the exponential rate, or the percentage rate of growth per period considered and the investments must expand at a percentage rate of growth g equal to s/κ or the '**warranted rate of growth**' $g = \frac{s}{\kappa}$. Harrod (1948)³⁹ defined it as the rate of growth at which the producers will be content with what they are doing. This can happen when net income, consumption, and the stock of capital will all grow at the same percentage rate g . The equilibrium may be violated in the long-run where full capacity utilization may not guarantee the 'full employment'. Harrod's contribution to the '**natural rate of growth**' may fill this gap. Given the labor force growth $L(t) = L(0)e^{(n)t}$ and average productivity of labor $y(t) = y(0)e^{(\lambda)t}$ where $L(t)$ =labor force at time t , and n = percentage rate of growth of labor force, $y(t) = Y(t)/L(t)$ and λ = percentage rate of growth of productivity. Thus, $g_n = n + \lambda$ is the 'natural rate of growth'. It is the maximum sustainable growth rate that technical condition makes available to the economic system as a whole. Then full employment of labor force and full utilization of productive capacity take place only if *the natural rate of growth and warranted rate of growth equal or* $g_n = g$ and thus $s = \kappa g_n$ the saving ratio (s) must be equal to the capital-output ratio multiplied by the natural rate of growth if equilibrium with full employment and full capacity utilization is maintained in the long run. The growth of investment emerges as a *solution* to keep full employment and full capacity utilization.

Pasinetti (1974) has further corrected the assumption of the Harrod-Domar model that treats s , κ , g_n as **constant** and making the equality between $s = \kappa g_n$ which is not always guaranteed. One parameter must be treated as a variable. This leads to the determination of **the rate of profit and income distribution to the rate of profit and economic growth**⁴⁰. The model starts with identity $P = P_c + P_w$ where P_c , P_w are profit which accrued to *capitalists* and *workers* respectively. The Equilibrium condition between

investment and saving is therefore: $I = s_w (W + P_w) + s_c P_c = s_w Y + (s_c - s_w) P_c$ and $\frac{P_c}{Y} = \frac{1}{s_c - s_w} \frac{I}{Y} - \frac{s_w}{s_c - s_w}$ and $\frac{P_c}{K} = \frac{1}{s_c - s_w} \frac{I}{K} - \frac{s_w}{s_c - s_w} \frac{Y}{K}$ and $\frac{P}{Y} = \frac{P_c}{Y} + \frac{P_w}{Y}$ and $\frac{P}{K} = \frac{P_c}{K} + \frac{P_w}{K}$ Finally, $P/K = (I/s_c) (I/K)$ and $P/Y = (I/s_c) (I/Y)$. It means that in the long run, the propensity to save influences the distribution of income of capitalists and workers. Given a neo-classical type of production function $Y = F(K, L)$ where labor force growth $L(t) = L(0)e^{(n)t}$ as usual, $s_c[F(K, L) - W] = I$ accordingly $\frac{dK}{dt} = k \frac{dL}{dt} + L \frac{dk}{dt} = knL + L \frac{dk}{dt}$ at steady-state $\frac{dk}{dt} = 0$ so that $I = knL$ substituting into the equality between saving and investment we obtain $s_c[F(K, L) - W] = \frac{K}{L} nL$ whence $P/K = (n/s_c)$. *The equilibrium rate of profit is determined by the natural rate of growth divided by the capitalists' propensity to save; independently of anything else in the model.*

The causality chain is as follows (see figure below): *the exogenously given rate of population growth and capitalists' propensity to save determine first of all the rate of profit. At this rate of profit, the optimum technique is chosen to satisfy the marginal productivity conditions. Then the optimum technique together with the rate of population growth uniquely determines the investment-income ratio. The technical relation in the production function simply determines the equilibrium amount of capital. Lastly, Euler's theory of distribution determines the factor of income distribution between capital and labor exhaustively. The wage rate and rate of profit are determined independently from the choice of technique (shape of production function) and marginal productivities.*

³⁷ Pasinetti, L. L. (1974) *Growth and Income Distribution: Essays in Economic Theory*, Cambridge University Press. Chapter IV. From Classical to Keynesian Dynamics, p.86.

³⁸ Domar, E., D. (1946), 'Capital Expansion, Rate of Growth and Employment,' *Econometrica*, pp. 137-147.

³⁹ Harrod, R. (1948), *Towards Economic Dynamics*, London.

⁴⁰ Pasinetti, L. L. (1974), *Ibid.*, p.111

According to *the Keynesian* view, the rate of interest has no importance in determining to save (unlike Solow Model of economic growth) but rather the *propensity to consume* thus *propensity to save* or saving rate out of income. In Pasinetti (1974, p. 127) the equilibrium relations $P/K = (g_n/s_c)$ determine the *rate of profit* first of all, simply from g_n (natural rate of growth) and s_c (saving rate of capitalist, assuming $s_w=0$) independent of anything else.

We would like to make another brief survey on how the factor income distribution is determined from the viewpoint of the Post Keynesian by Taylor (1979)⁴¹ as follows:

Let X, F be a column vector of the output X_i, F_i ($i=1, 2 \dots N$), and A the square $N \times N$ matrix. It is made up of the input-output coefficients a_{ij} , as a result, the material- balance equation $X_i = \sum_{j=1}^N a_{ij} X_j + F_i = \sum_{j=1}^N a_{ij} X_j + F_i$ is determined.

In compact form is $X = AX + F$ and $X = (I-A)^{-1}F$ where I is $N \times N$ identity matrix and $(I-A)^{-1}$ is *Leontief inverse*. The cost per unit output or cost-determined output price in sector i ., $P_i = \sum_{j=1}^N a_{ji} P_j + a_{Li}w + a_{Ki}r + a_{0i}P_0$ where w, r , and P_0 are the cost of labor, capital and noncompetitive imports (assumed to be equal for all sector) $a_{Li}w, a_{Ki}r, a_{0i}$ are coefficients for labor, capital, and imports respectively.

In the base year, all prices are set to *unity* $\sum_{j=1}^N a_{ji} + a_{Li}w + a_{Ki}r + a_{0i}P_0 = 1.00$. The solution (in matrix form) $P^T = (wa_L^T + ra_K^T + P_0 a_0^T)(I-A)^{-1}$ which implies that output price in each I-O sector is a summation of the direct and indirect primary factor costs in production.

We can view the income distribution struggle between wage earners and capitalist or between the traditional sector in the rural area e.g., agriculture with farmers – a modern sector in the urban area with entrepreneur and *rentier-capitalism* (landlord who control land and monopolist in the modern sector who control access to physical, financial, intellectuals, etc.,) by investigating empirically the wage-interest or wage-profit frontier.

It is the solution of the $wa_L^T [I-r(I-A)^{-1}A]^{-1} X = GDP = 1$. The extreme case where $wages=0$, or $wa_L^T=0$ the Sraffa's price can be found from $P^T \left[\frac{1}{1+r} I - A \right] = 0$; and $\left[\frac{1}{1+r} I - A \right] X = 0$. The solution of the polynomial equation in terms of $1/(1+r)$ associated with the 0 determinant of the matrix [...] have a positive root (eigenvalue) and r^{max} is maximal possible profit rate and **positive** left eigenvector in the economy P^{Tmax} and right eigenvector or standard commodity X^{max} respectively up to the imposition of the numeraire.

When the wage is positive scaling the employment as $a_L^T X^{max}=1$, we can obtain the income distribution as $GDP = P^T (I-A) X^{max} = r P^T A X^{max} + a_L^T X^{max} = r P^T A X^{max} + w$. By rearranging we arrive at $r = (1-w)/P^T A X^{max}$; $A X^{max} = (\frac{1}{r^{max}}) (I-A) X^{max}$ signifies the proportionality between intermediate and final sales of each component of the standard commodity. Finally, $P^T A X^{max} = (\frac{1}{r^{max}}) P^T (I-A) X^{max} = 1/r^{max}$. Thus, the wage-profit or wage-interest frontier in the Sraffa's economy is $r/r^{max} = 1 - w$. This implies that the wage w which is also labor share (after normalization) rises as profit rate ' r ' falls from its maximum r^{max} .

The Post Keynesian view is different from the Neo-classics in that the selection of production technique for all sectors, unlike Burmeister-Dobel (1970), this will lead to the highest possible r^{max} and a set of profit maximization techniques independent of the composition of final demand. It is known as the *non-substitution theorem* in I-O analysis.

⁴¹ Taylor, L. (1979), Chapter 12-4 on 'Wage and Profit Skirmishes in the Open Input-Output System', *Macro Models for Developing Countries*, Economics Handbook Series, McGraw-Hill Book Company.

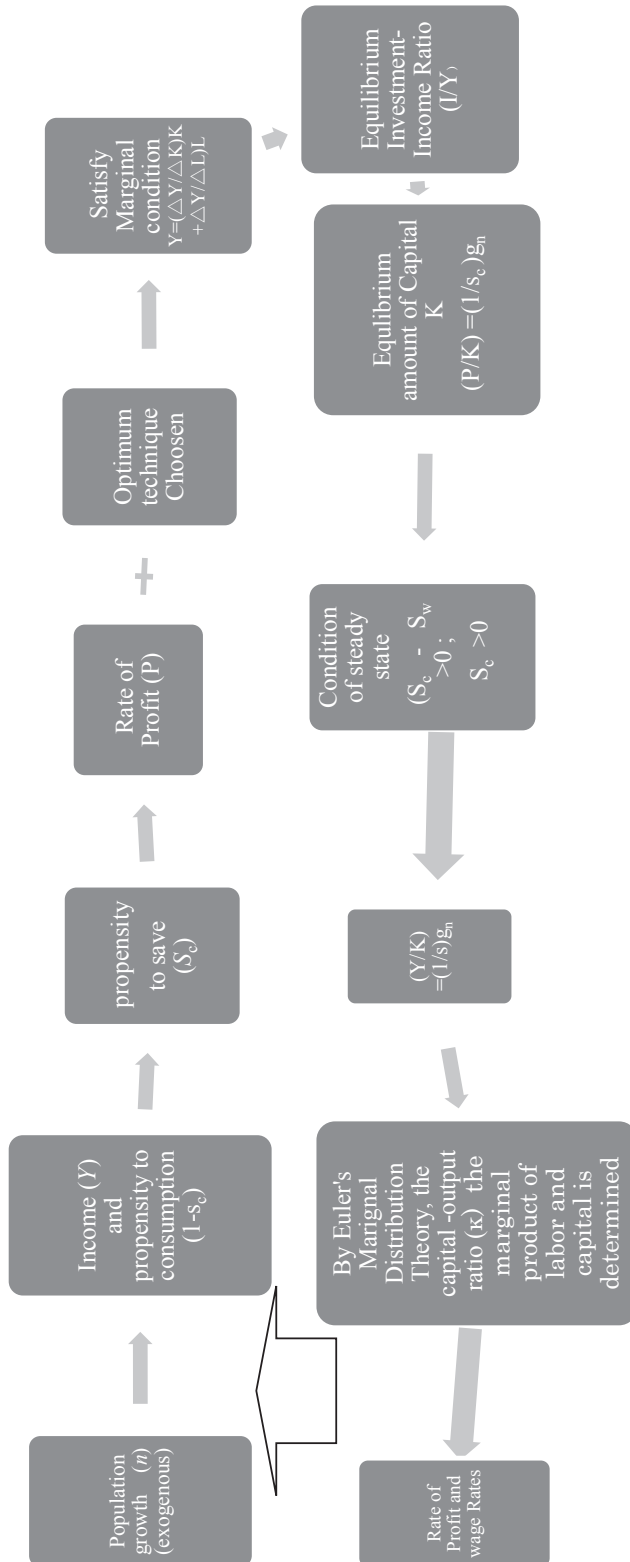


Figure 2: The Process of Capital Accumulation from View Point of the Post Keynesian.

In sum, we would like to test by applying the empirical study whether the factor price curve between the profit rate and the wage rate is downward sloping in either the Neo-classic or Post Keynesian that being pointed by our survey of literature above. Besides, the relationship between the capital-labor ratio and the profit rate- wage rate and saving rate would be also another point of investigation from the dynamic I-O of Thailand 1975-2010.

4. Empirical Analysis with Open Leontief Model

We formulate the planning model to maximize welfare function over the planning period (1975-2010). The model is subjected to constraints in the form of distribution relations, production functions, absorptive capacity functions, foreign exchange constraints, and initial and terminal capital stock and foreign debt constraints respectively. The model has four sub-sectors: (1) agriculture and mining, (2) heavy industry, (3) light industry, and (4) services. We rely on the ISIC classification under the 7 Input-Output Table of Thailand 1975-2010 respectively. We firstly estimate the capital stock which is consistent with the I-O structure in the planning period. We have applied the 'Perpetual Inventory Method following Berlemann and Wesselhoft (2014)⁴² to estimate the capital stock series.

It is assumed that the stock of inventory increases with capital formation (investments). That is the $K_t = (1-\delta) K_{t-1} + I_{t-1}$, where δ is the geometric depreciation rate. Repeatedly substituting this equation for the capital stock at the beginning of the period, leads to the capital stock in period t is a weighted sum of the history of capital stock investments $K_t = \sum_{i=0}^{\infty} (1-\delta)^i I_{t-(i+1)}$. Assuming the base year (origin of series) capital stock K , and the depreciation rate δ the capital stock series becomes $K_t = (1-\delta)^{t-1} K + \sum_{i=0}^{t-1} (1-\delta)^i I_{t-(i+1)}$. Berlemann and Wesselhoft have proposed the 'Steady State Approach' based on Harberger (1978). At the 'steady-state' output $gGDP$ grows at the same rate as the capital stock $gGDP = gK = \frac{K_t - K_{t-1}}{K_{t-1}} = \frac{I_t}{K_{t-1}} - \delta$. Thus, it is sufficient to calculate the capital stock in the initial period $K_{t-1} = \frac{I_t}{gGDP + \delta}$. If however, there is a short-term investment shock we may have to smooth the investment series using three-year moving averages to generate stable capital stock estimates.

The study has applied the regression analysis of investments on time variables to calculate the initial capital stock. The estimation result of the imputed depreciation rate is equal to $(1 - 0.9652) * 100 = 3.48$ percent per year on average for aggregate capital for national and assuming the rate for the manufacturing sector. The estimation of initial capital stock by sector for i = light industry, heavy industry $K_{i,t-1} = \frac{I_{i,t}}{gGDP_i + \delta}$ with $\sum_i K_{i,t} = K_t$ as the constraint or the summation of the capital stock of sub-sectors equal to the total capital stock in manufacturing. In short, the capital stock series are estimated from base year capital stock.⁴³

4.1 The Changing Trend of Economic Growth, and Productivity of Capital 1975-2010: Thailand under Asian (1997) and Global (2009) Financial Crisis

We have constructed stylized facts from the Thai I-O a 5-year interval account from 1975-2010. We have presented the related economic variables in both level form and terms of *the yearly* percentage change. Thai I-O was deflated with respective price indices to get a constant price I-O at 2000 prices as a basis. The graph of 5 sectors namely Agriculture, Light, Heavy, Service, and Public Utility is shown for illustration and analysis. Some aggregation is computed to arrive at the overall summary.

⁴² Berlemann, M. and Wesselhoft, J-E (2014), 'Estimating Aggregate Capital Stocks Using the Perpetual Inventory Method: A Survey of Previous Implementations and New Empirical Evidence for 103 Countries', *Review of Economics*, 65. pp. 1-34, ISSN 0948-5139.

⁴³ *Regression of $(K_t - I_{t-1}) = f(1-\delta) K_{t-1}$* , yields $\delta = 0.035$ with statistical significant P-Val=0.0, R² = 0.99 respectively.

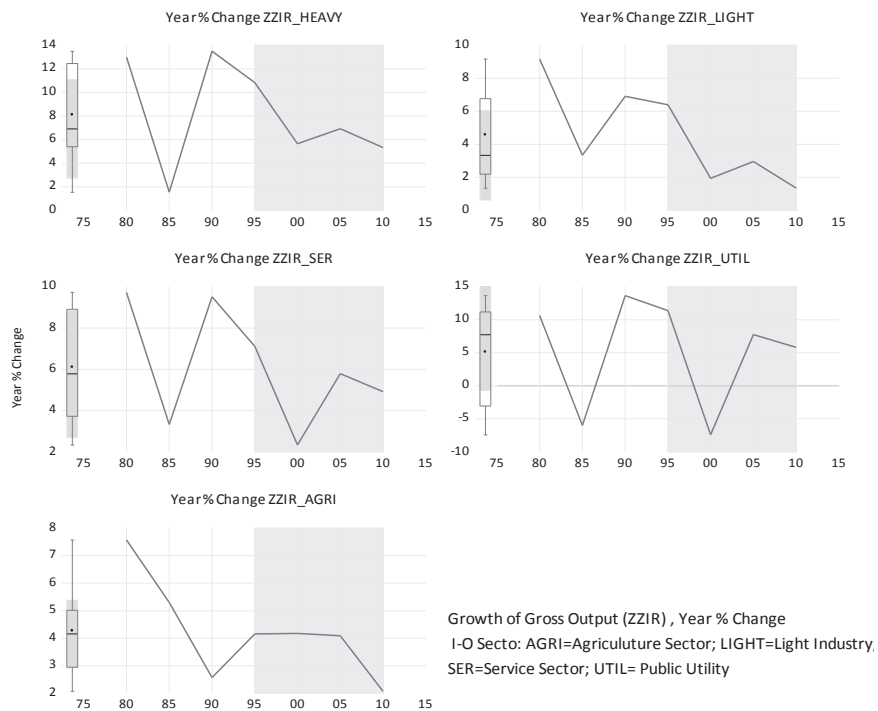


Figure 3: Growth Exposition of Gross Output by I-O Sector (measured in Year % Change)

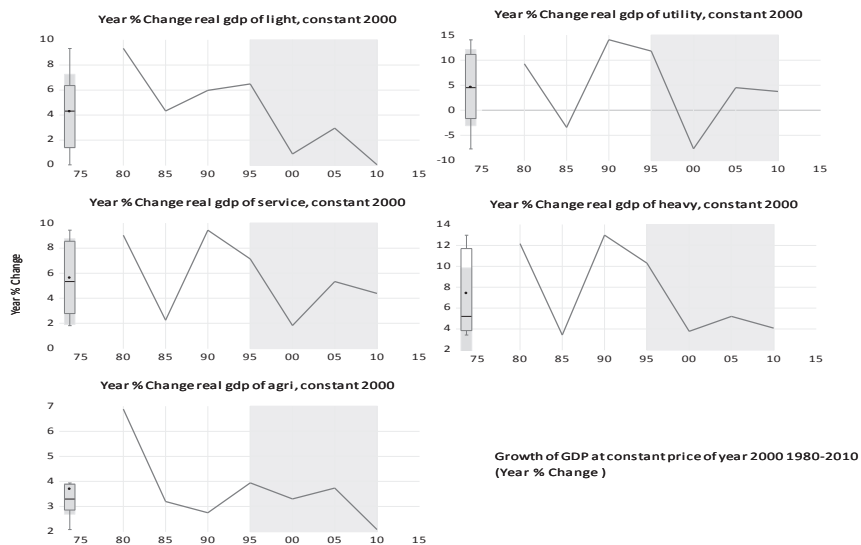


Figure 4: Growth Exposition of Gross Domestic Product by I-O Sector (measured in Year % Change)

We put shady strip to distinguish between pre-AFC (Asian Financial Crisis in 1997) and post adjustment of the economy. We mark 1975-1995 as the pre-AFC era and 1995-2010 as the post-AFC era.

Figures 3 and 4 have depicted a declining trend in the growth potential of the Thai economy after the crisis from its past trend. The agriculture and light industry sector behaved inferior to heavy and service sectors.

There are unstable growth rates in the Public Utility sector during the year 2000 but it could later recover to a small extent. Most of the sector has suffered from the GFC (global financial crisis) in 2000. This has accentuated the slowdown of Thai economic growth. It may be postulated that the Thai economy had suffered from two consecutive financial crises. However, Thailand has managed to recover quite well from GFC in 2000 as compared with AFC in 1997. Graphic from I-O has illustrated clearly that the AFC 1997 was a final outbreak but the Thai economy had chronic symptoms before the judgment day.

4.2 Thailand has over or under Capital Accumulation?

The overall labor employment has been rising to its peak of 3 percent growth in 1990. It has declined thereafter to 0% growth in the year 2000 as a result of GFC. The employment has further recovered in 2005 and declined thereafter. The agriculture employment has turned down since 1990 owing to rural-urban migration in Thailand. It has absorbed reversing 'u-turn' from urban to the rural area again after the AFC. It has been declining again after 2010. The service sector and heavy industrial sector has been a shock absorber of the Thai economy after the crises. The light industry is suffering from competitiveness and could not absorb employment and showing a declining trend since 1990. See Figure 5.



Figure 5: Growth Exposition of Labor and Employment t by I-O Sector (measured in Year % Change)

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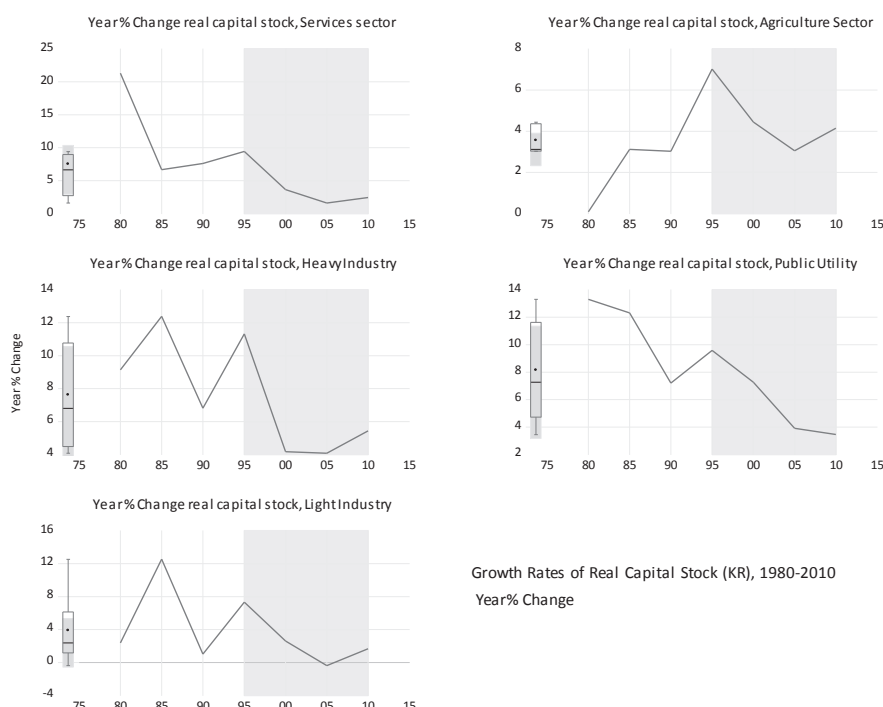


Figure 6: Growth Exposition of Capital Stock by I-O Sector (measured in Year % Change)

It is interesting to observe the growth of capital stock accumulation in the Agriculture sector during 1980-1995. As we have learned that rural-urban (agriculture – non-agriculture sector or manufacturing and service) migration has caused declining labor supply in the sector. Thus, there has been a process of mechanization in the agriculture sector. The period of slower accumulation has started during 1995-2010. The real capital stock growth was 3-4 percent per year.

All other sectors have shown a slowdown in the growth of capital stock as well. The growth rates are still normal but much lower than what they have shown in the past. This postulates that either pre-crisis Thailand was over accumulation or post-crisis we have un-sustainable growth of capital formation and capital accumulation to push the economy out of the 'Middle Income Syndrome'. See Figure 6.

The answer to this growth dwindles, unsustainable capital, and labor inputs growth can be observed from their productivity. The overall productivity of capital (Figure 7) has shown extraordinary negative productivity growth before 1990. It was not recovered that much thereafter except during the democratic government during 2000-2009, and 2010-2014. This has proved what Krugman (1994) has pointed out that over capital accumulation was the main source of GDP growth before AFC 1997 rather than the 'Total Factor Productivity' growth. Moreover, as productivity of capital has recovered during 2000-2005 and endured to 2010, it may be still lower than sustainable growth potential of the economy. We, however, refrain from testing the null-hypothesis of the relationship between capital productivity growth and the democratic process is refutable.

The productivity of capital in agriculture has behaved unimpressively since 1980-1995. It has been recovered from 1995-2005. During the same period, all other sector has shown an unsustainable capital accumulation. The productivity of labor (Figure 8), has shown a somewhat better shape except for the service sector and public utility. The service sector mostly hired unskilled labor with low productivity as a result of low education level and non-training employees. This is the choice of employment by an entrepreneur who chose low-wage unskilled labor. Likewise, the public utility which runs labor relation via strong labor union (in-house), the productivity growth of the public utility sector led by most of the state enterprises has stood still.

The overall labor productivity was corrected by the productivity growth of the private sector in heavy industry. Thai labor productivity growth was 4 percent on average after 1995 and 2-3 percent per year during 2000-2010.

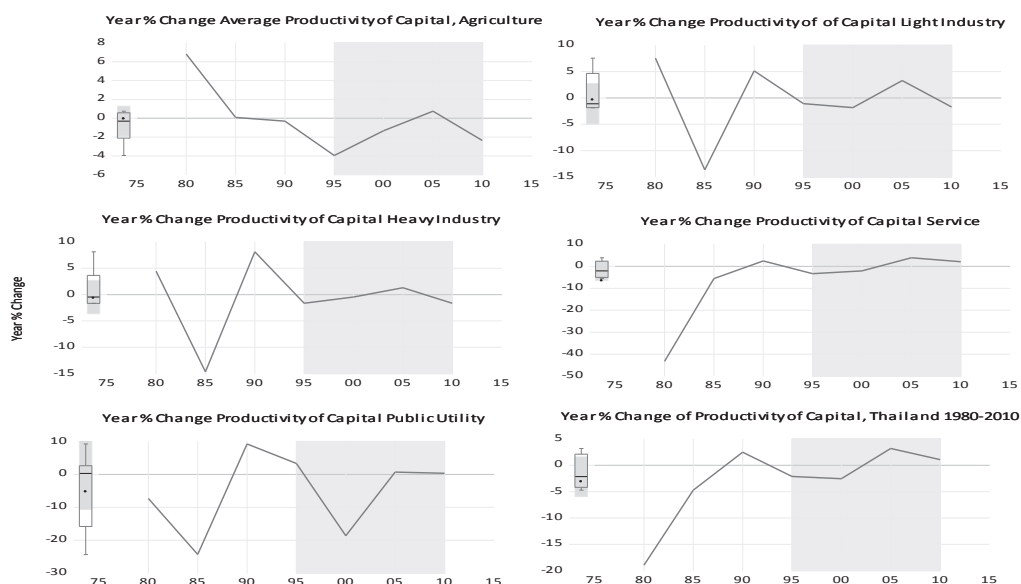


Figure 7: Productivity of Capital Stock by I-O Sector (measured in Year % Change of Real GDP per Employed Capital)

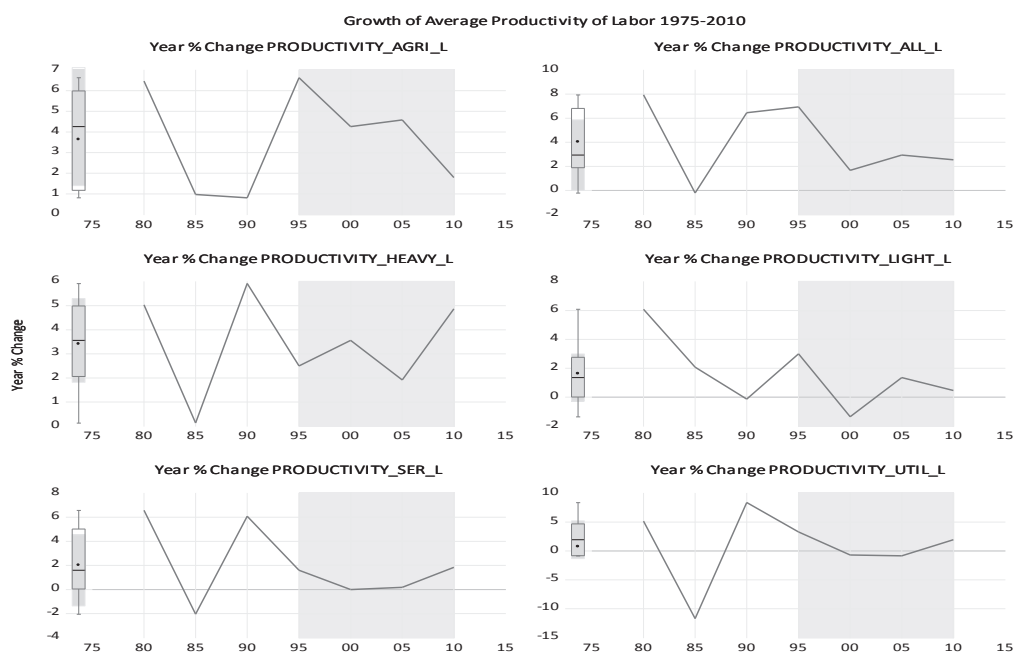


Figure 8: Productivity of Labor Input by I-O Sector (measured in Year % Change of Real GDP per Employed Labor)

Economic Growth and Income Distribution: A Debate on Capital Accumulation in Thailand

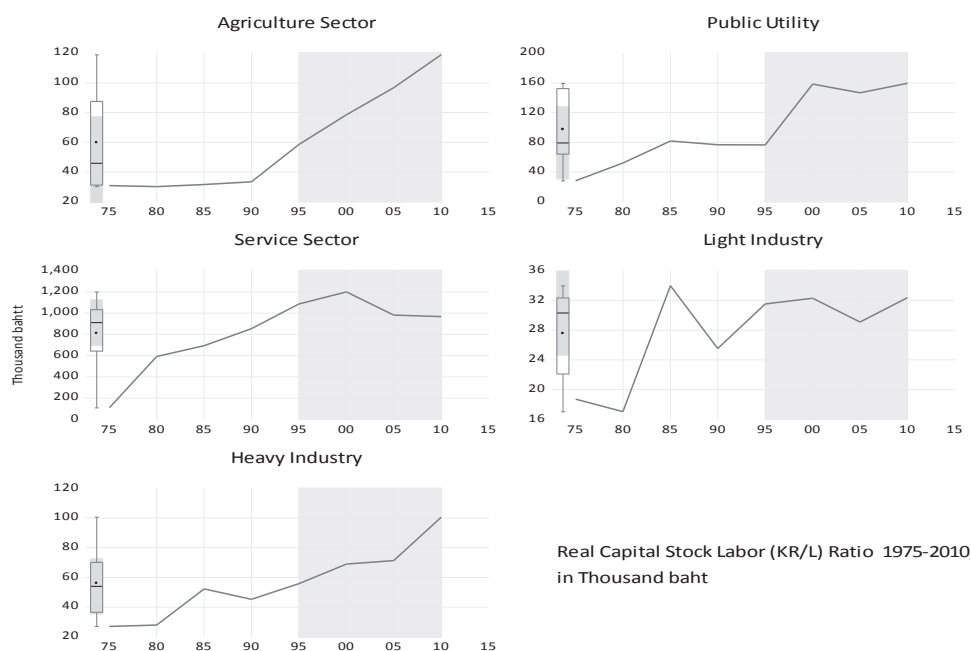


Figure 9: Capital Intensity Measured by Real Capital Stock – Employed Labor Ratio (in 1,000 baht)

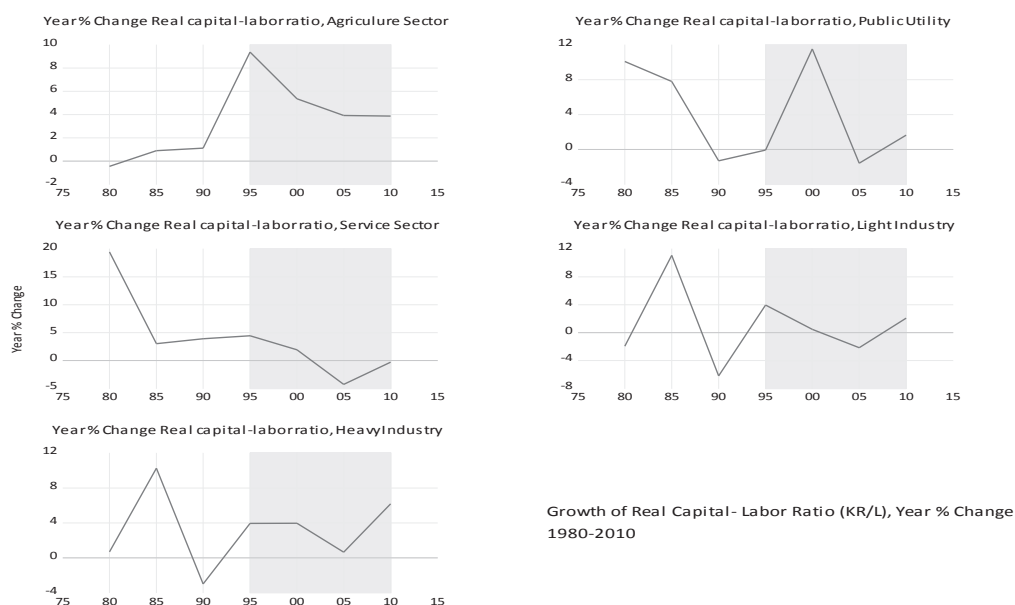


Figure 10: Growth of Capital Intensity Measured by Growth of Real Capital Stock – Employed Labor Ratio (Year % Change)

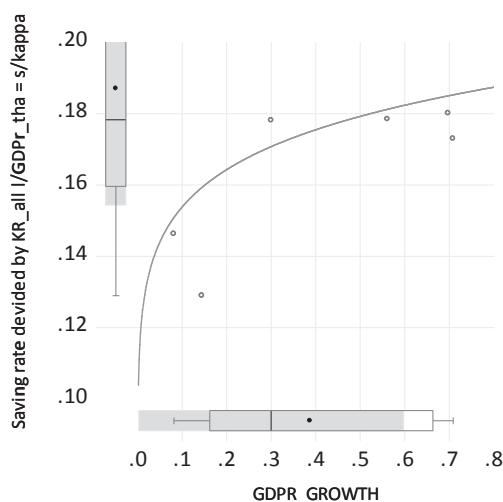
The 'capital deepening' indicated by the 'capital intensity' or 'capital stock over-employed labor ratio' in Figures 9 and 10 has interesting observation as well. Firstly, the subsector has clear capital intensity to be an impetus to sector and overall growth. Second, the growth rates of capital intensity in the agriculture sector have shown clear capital intensity owing to the process of mechanization before and after 1995. The heavy industry another sector that has accumulated capital after 1995 as well but all

other sectors like the light industry, service industry, and public utility have unimpressive capital intensity growth.

4.3 Growth Determination from Demand Side: The Post Keynesian Model

We have applied data from the I-O of Thailand and test the hypothesis of the Post Keynesian Model proposed by Harro-Domar and correction by Pasinetti mentioned earlier. The hypothesis is simple: The macro-economic growth in Thailand was driven from the demand side by the 'saving rate' (income minus consumption out of income) over the 'capital-income ratio'. The growth path is unstable in the short-run. We have shown a scattered plot between them and found positive relationships. Thus, it is implied that the Thai economy was *regular* and determined from the demand side regardless of the assumption on the technology of production and supply. Nevertheless, equality between aggregate-supply may *not be guaranteed*. In other words, growth was determined from the endogenous saving rate over the capital-output ratio.

Now, it is a wonder how capital is determined to form the Post Keynesian model. As we have depicted with a flow skeleton earlier, it is via the income distribution that the model will be solved. That is to say, capital stock is determined from a profit rate determination. The growth rate of output (real GDP) together with the saving rate will *simultaneously* determine the profit rate. According to Post Keynesian (e.g., Pasinetti and Harrod), *the natural rate of growth inclusive of the technological change will be proper variables for the 'growth rate' used above. The positive relationship between real profit rates is determined from the natural rate of growth (inclusive of technology increment) over saving ratio. The real profit rates would determine the capital income (operating surplus) and wage bill via the Sraffa's price equation* where real profit rate will shift up to the maximal rate of profit at the same time the return to labor would be declining (increasing) depending on the factor price frontier. Note that the technology set is given, what technology type of production will choose the capitalist will always find the maximized profit rate of return?



	(1) saving rate (real)	(2) saving rate (nominal)	(3) Real capital- GDP ratio	(4) saving rate/ (capital- Output Ratio)
1975	0.25	0.26	0.89	0.286
1980	0.33	0.29	1.94	0.173
1985	0.31	0.36	2.42	0.128
1990	0.38	0.39	2.13	0.180
1995	0.42	0.41	2.36	0.178
2000	0.39	0.39	2.67	0.146
2005	0.42	0.38	2.25	0.178
2010	0.48	0.46	2.13	0.225
(1) Saving rate = (1- PCER_all /GDPR_tha)				
(3) Real Capital -GDP ratio = KR_all / GDPR_tha)				
(4) saving rate / (capital-Output Ratio) = (3) / (KR_all/GDPR_tha)				

Figure 11: Growth Determination from Demand Side

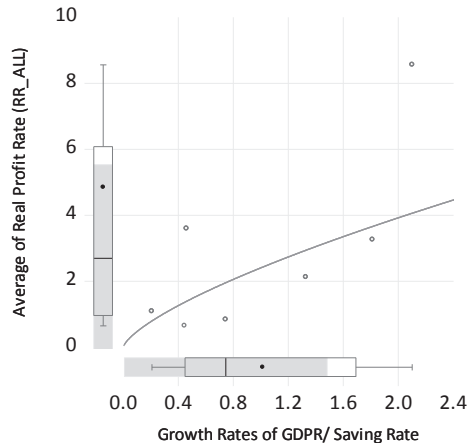


Figure 12: Profit Rate Determination

	(1) GDP/ growth rate, % p.a.	(2) saving rate	(3) (Growth Rates of GDP/ saving rates = (1)/ {(2)*100}	(4) Profit rate (average)
1975	-	0.25	-	-
1980	9.04	0.33	0.27	8.5
1985	2.59	0.31	0.08	3.6
1990	8.59	0.38	0.22	3.2
1995	7.74	0.42	0.18	2.1
2000	1.53	0.39	0.039	1.09
2005	4.83	0.42	0.11	0.84
2010	3.66	0.48	0.07	0.65

Note: (1) is a proxy for 'natural rate of growth' augmented with total factor productivity. Here GDP growth rate is just proxy. (2) saving of capitalist would be more appropriate to Post Keynesian Economy (3) profit rate is average of sectors' profit rate
See 3.4 above

4.4 Growth and Factor Income Distribution in Thailand

The return to capital input (Operating Surplus or Value of Profit) over the return to labor inputs (Wage bills) stands for a simple income distribution between wage earner vs. capitalist; between landowners or 'rentier' vs. entrepreneur in modern sector vs. wage earner in the traditional sector, in the sense of Ricardo of the classical economist and recalled by Kaldor (1955)⁴⁴. For Thailand, the light industry has shown a rising return on capital after 1995 while other sectors have the opposite direction. This can be explained as the growth of real wage rates of the light industry has significantly declined after 1995. The sector has entered a phase of negative real wage growth during 2000-2005. It is confirmed that the agriculture sector has reached its turning point with scarce labor supply and facing a rising real wage rate of 6-8 percent during 1995-2010 (See Figures 14, and 15). The real profit rate of all sectors has shown a declining trend from 1980 to 2010. This is a result of the deepening of real capital stock over time (See Figure 16). The rising wage rate and increasing of sizable return to employed labor inputs have further suppressed the growth rate of the real profit rate over the real wage ratio (See Figure 17).

The factor price frontier between the real wage and real profit rate has a negative slope as shown in Figure 18. This confirms our hypothesis of factor income distribution between the factors' owner of labor and capital inputs. *The return to wage earners will unavoidably reduce the profit of capitalists in Thailand during 1975-2010.* In other words, the Thai economy is well-behaved in a neoclassical economic sense and in Post Keynesian tradition (Sraffa and Pasinetti) who advocated the factor price frontier and income distribution. An entrepreneur will maximize their profit and switching along the non-linear factor price frontier. Figure 19 depicts the relationship between capital intensity and the factor price ratio. It is confirmed that the rising profit-wage ratio (in real term) has a *negative* relationship with capital intensity. We have applied the same set of data to estimate the elasticity of substitution in the tradition of neoclassical setting. We have found the elasticity of substitution is 0.41 for agriculture; 0.17 for light industry; 0.28 for heavy industry; 0.29 for service sector; and 0.34 for public utility respectively. This means the rising real wage- real profit ratio of 1% will induce the substitution of capital for labor input by a numerical value % point. Thus, the agriculture sector and public utility have exhibited the mechanization and capital deepening process as compared with other sub-sectors especially the light industry seems to be too retarded to change. This may be because of declining real wage growth in the light industry. Thus, capital deepening was not chosen. The employer still sticks to the traditional way of labor-intensive rather optionally change new capital investment.

⁴⁴ Kaldor, N. (1955), "Alternative Theory of Distribution," *Reviews of Economic Studies*, 23, pp.83-100



Figure 13: Operation Surplus (Return to Capital Inputs) and Wage Bill (Return to Labor Employed)

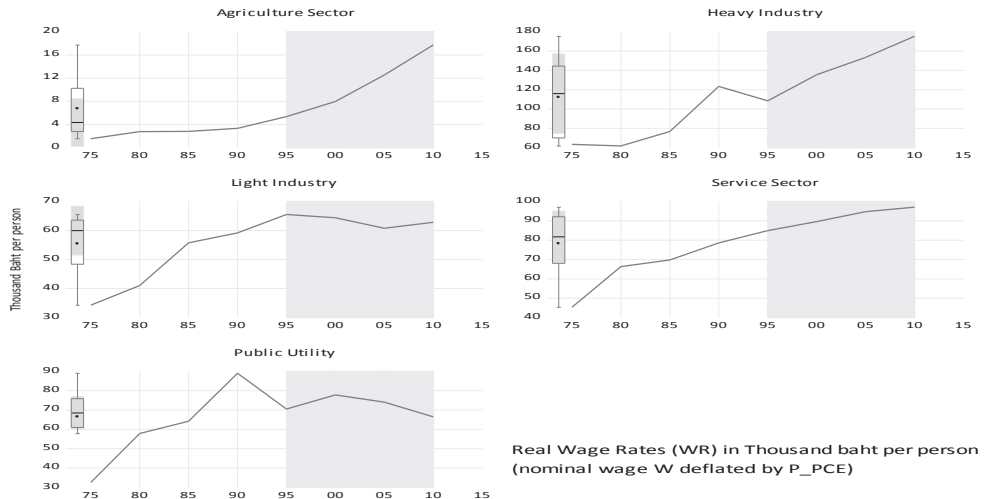


Figure 14: Real Wage Rates 1975-2010 (in 1,000 baht per person)

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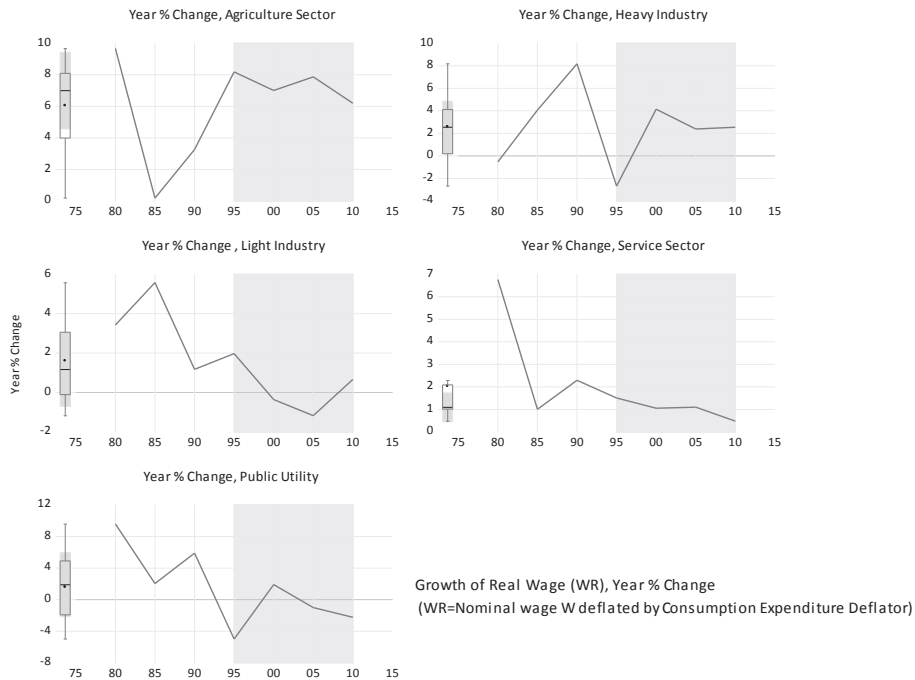


Figure 15: Growth of Real Wage Rates (Year % Change)

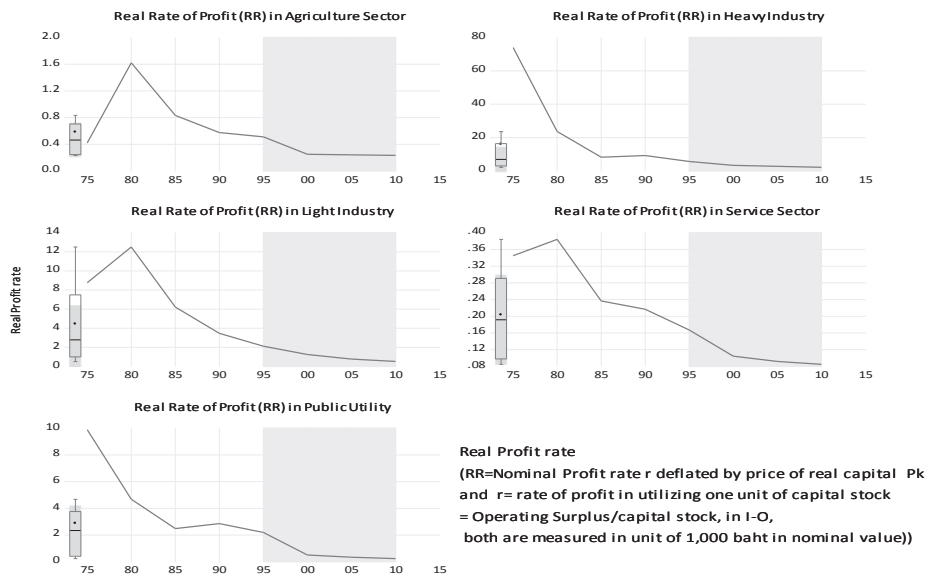


Figure 16: Real Profit Rates 1975-2010

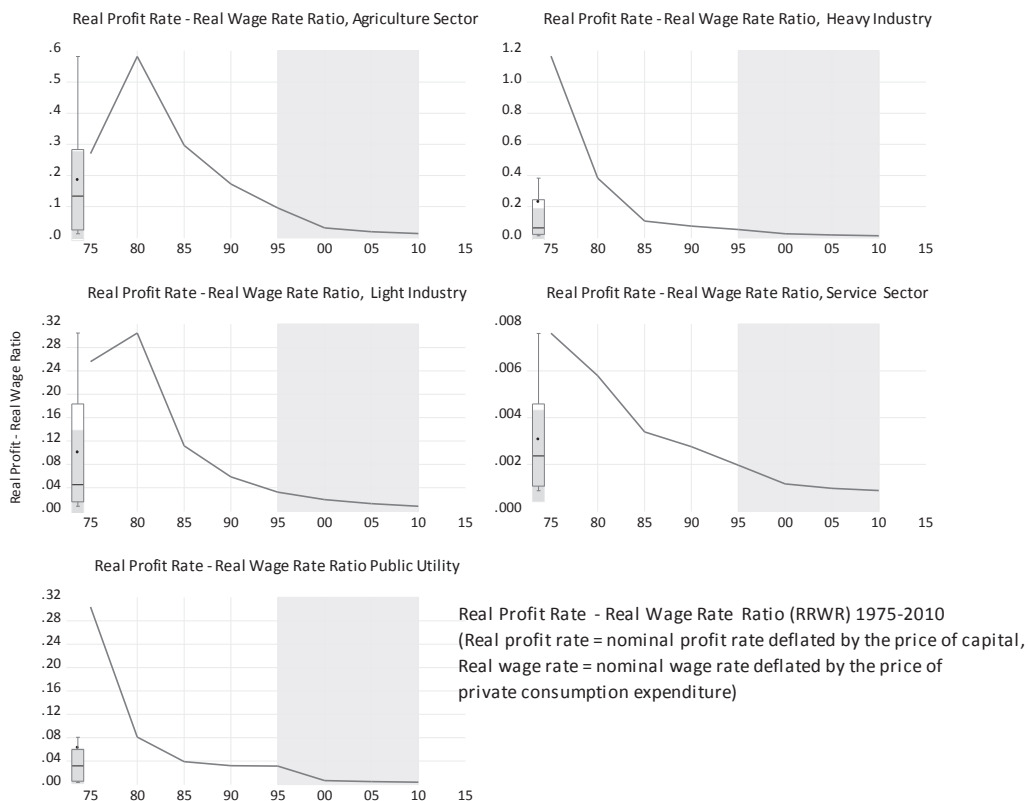


Figure 17: Real Profit Rates-Real Wage Rate Ratio 1975-2010

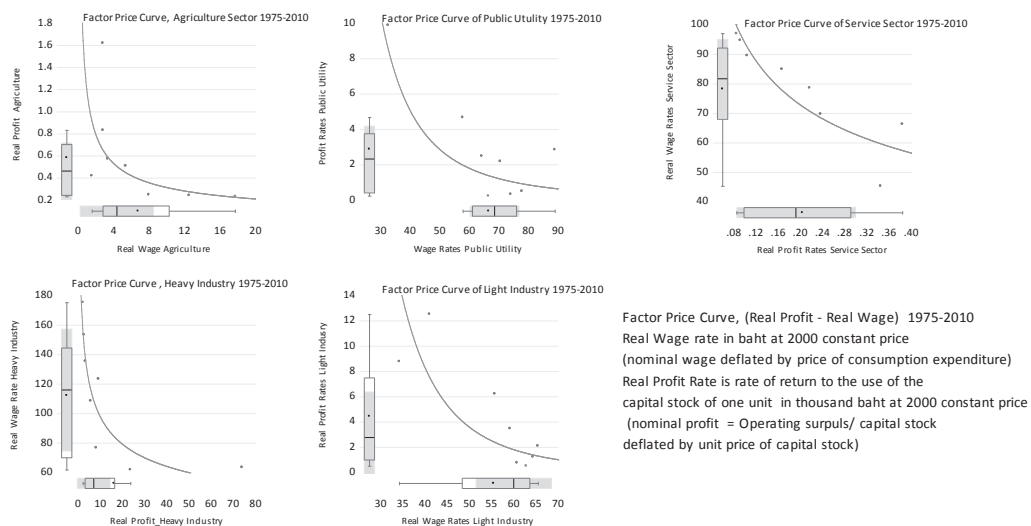


Figure 18: Factor Price Curve (Real Profit Rates-Real Wage Rate Ratio) 1975-2010

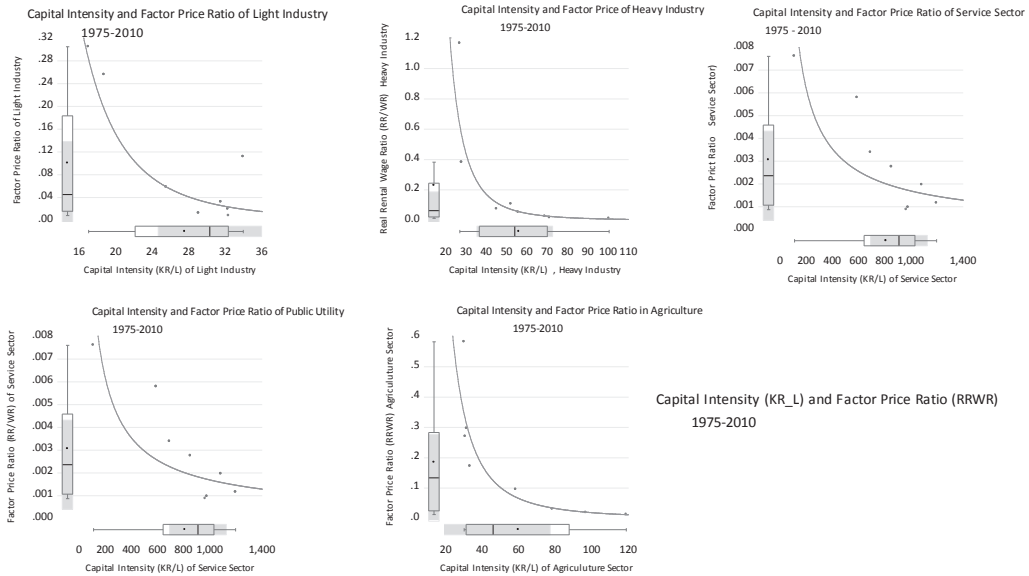


Figure 19: Capital Intensity (Real Capital – Labor Ratio) vs. Factor Price Ratio (Real Profit Rates- Real Wage Rate Ratio) 1975-2010

5 Capital Accumulation and Growth: The Numerical Approach (RCK Model)

We have a brief survey of the solution algorithm for the Ramsey model as follows: Chakravarty (1962)⁴⁵ had proposed to numerically solve the infinite program by considering plans extending over only a finite number of periods with the principle of successive approximation. The model had common characteristics of a finite time horizon with the existence of a single capital good with two goods, i.e., a consumer good and a capital good with a single utility function to be maximized by the assumed central planning authority. Kendrick and Taylor⁴⁶ (1970) had further proposed the numerical techniques for solving dynamic nonlinear multi-sector models. The study has applied a conjugate gradient and neighboring 'extremal methods' of the control theory to solve the nonlinear model with explicit nonlinear welfare, production, and investment functions. It was a development planning model. The study has tested the sensitivity of the elasticity of substitution parameters of production in the model.

In this paper, it is postulated that Thailand has desperately needed to increase capital investment to compensate for the capital dilution during AFC 1997/98. Would it be feasible and how long would it take to reach steady-state? Here, we solve the RCK model using MATLAB with Toolboxes⁴⁷. The syntax is provided by Afonso and Vasconcelos (2016)⁴⁸. It follows Chapter 2 of Barro and Sala-i-Martin (2004)⁴⁹.

The RCK model has a saving rate as *endogenously* determined by consumer optimization. The model conjectures on the role of capital accumulation in long-term economic growth, inter-temporal allocation of income i.e., consumption-saving dynamic allocation. Our parameters to compute the *transitional growth path* of *optimal* capital and consumption, as well as other variables overtime were shown in

⁴⁵ S. Chakravarty (1962), "Optimal Savings With Finite Planning Horizon", *International Economic Review*, Vol. 3, No. 3 (Sep. 1962), pp. 338-355, Wiley for the Economics Department of the University of Pennsylvania and Institute of Social and Economic Research, Osaka University, Stable URL: <https://www.jstor.org/stable/2525399>, Accessed: 26-04-2019 08:29 UTC

⁴⁶ Kendrick, D., Taylor, D. (1970), "Numerical Solution of Nonlinear Planning Models," *Econometrica*, Vol. 38, No. 3 (May 1970), pp. 453-467, The Econometric Society, Stable URL: <https://www.jstor.org/stable/1909551>, accessed: 26-04-2019 08:26 UTC

⁴⁷ MATLAB R2018b is licensed to Kitti Limskul

⁴⁸ Afonso, O. and Vasconcelos P.B.(2016), *Computational Economics: A Concise Introduction*, Routledge, New York. pp 253-255. See also Ken Deeley (2020), *Simulating the Ramsey-Cass-Koopmans Model Using MATLAB and Simulink*, <https://www.mathworks.com/matlabcentral/fileexchange/59422-simulating-the-ramsey-cass-koopmans-model-using-matlab-and-simulink>, MATLAB Central File Exchange. Retrieved January 20, 2020.

⁴⁹ Barro and Sala-i-Martin (2004), *Economic Growth*, Cambridge, MA: MIT Press.

Table 9 below. We have also estimated the *Inter-temporal elasticity of substitution* (σ) following Mao, C.S., (1989)⁵⁰ here $\sigma = 0.38$. The θ which is defined as $\theta = (\delta + \rho) / (\alpha^*(\delta + \eta + g) - g)$ where ρ is a *time preference rate* ($\rho = 0.025$); the *elasticity of capital in production* ($\alpha = 0.5 - 0.6$); the depreciation rate ($\delta = 0.035$); population growth rate ($\eta = 2.5$ % p.a.) respectively. Here the technology growth g following the TFP mentioned above is assumed to be 1.6 to 1.9 % p.a. respectively. Proper section of θ which is the *inverse inter-temporal elasticity of substitution* so that the saving rate (s) $s = 1/\theta$ is constant. Thus, theta $\theta = 1/0.38 = 0.26$ and saving rate or ratio (s) are 0.37~0.4 of output respectively. This is consistent with the rate of gross savings in Thailand after 1990. The hypothetical values of parameters are shown in Table 4 below.

Table 2: Macro-economic Variables

	1980	1985	1990	1995	2000	2005	2010
Net savings (Billion Baht)	100.1	151.5	530.1	990.8	673.7	966.1	1,610.6
-Private sector (Billion Baht)	88.7	140.4	305.5	590.7	574.4	597.2	1,354.9
Households	75.3	124.8	213.2	334.2	345.1	246.3	588.4
Corporations and cooperatives	13.5	15.6	92.4	256.5	229.3	350.9	766.5
-Public sector (Billion Baht)	11.4	11.1	224.6	400.1	99.4	368.9	255.7
General government	10.5	-3.3	182.7	331.7	38.2	237.0	67.5
Public corporations and government enterprises	0.9	14.5	41.9	68.4	61.2	131.9	188.2
Real interest rate ² (% p.a.)	3.1	13.6	8.2	7.1	6.4	-0.4	0.2
Deposit interest rate (% p.a.)	12.0	13.0	12.3	11.6	3.3	1.7	1.2
Lending interest rate (% p.a.)	16.1	16.1	14.4	13.3	7.8	4.7	4.3
Inflation (% per year)	19.7	2.4	5.9	5.8	1.6	4.5	3.2

Note: 1. Adjusted for the change in pension entitle, 2. the real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator.

Source: National Income, NESDB, and World Development Indicator, World Bank.

Table 3: Base Data for Model Simulation

	1975	1980	1985	1990	1995	2000	2005	2010
Population (million persons)	42.3	47	51.3	55.1	58.8	61.8	64.1	66.3
-Average growth per year, %		2.2	1.8	1.4	1.3	1.0	0.7	0.6
Labor (million persons)	18.8	22.8	26.6	31.4	32.8	33.5	36.6	38.8
-Average growth per year, %		4.2	3.3	3.6	0.9	0.4	1.8	1.2
Real capital stock, constant price of the year 2000, in trillion baht,	2.55	3.09	4.412	6.58	11.39	13.92	15.28	17.5
-Average growth, per year, %		4.2	8.5	9.8	14.6	4.4	1.9	2.9
Real capital-labor ratio, million baht per person	0.13	0.14	0.16	0.21	0.35	0.42	0.42	0.45
Gross output, trillion baht	0.62	1.34	1.99	4.53	8.76	11.69	18.51	27.51
-Average growth per year, %		23.1	9.7	25.4	18.6	6.6	11.6	9.7
Producer price index	0.42	0.67	0.58	0.7	0.84	1.00	1.26	1.65
Real gross output, trillion baht	1.48	2.00	3.44	6.47	10.43	11.69	14.69	16.67
-Average Growth per year, %		7.050	14.397	17.618	12.220	2.406	5.130	2.701
Real gross output per labor, million baht per person	0.033	0.059	0.075	0.144	0.267	0.348	0.506	0.708
-Average growth of real gross output per person, %		15.5	5.5	18.4	16.9	6.1	9.0	7.9
Private consumption expenditure, trillion baht	0.25	0.49	0.69	1.31	2.43	3.16	4.79	5.89
Consumer price index	0.26	0.37	0.53	0.64	0.81	1	1.12	1.29
Real Private consumption expenditure, trillion baht	0.98	1.34	1.30	2.05	3.00	3.16	4.28	4.56
-Average growth per year, %		7.3	-0.5	11.4	9.1	1.1	7.0	1.3
Private consumption per labor mill bath per person	0.05	0.06	0.05	0.06	0.09	0.09	0.12	0.12
-Average private consumption per capita per year, %		2.6	-3.3	6.6	7.9	0.6	4.8	0.1

⁵⁰ Mao, C.S., (1989), "Estimating Inter-temporal Elasticity of Substitution: The Case of Log-Linear Restrictions", *Economic Review*, November/December 1989.

	1975	1980	1985	1990	1995	2000	2005	2010
Value Added, trillion baht	0.35	0.70	1.02	2.19	4.16	5.22	7.78	11.08
GDP deflator	0.29	0.43	0.52	0.66	0.86	1.00	1.15	1.36
Real Value Added, trillion baht	1.20	1.63	1.95	3.31	4.83	5.22	6.76	8.15
-Average growth per year, %		7.2	3.9	13.9	9.2	1.6	5.9	4.1
Real Private Consumption Expenditure /Real Value Added ratio	0.82	0.82	0.67	0.62	0.62	0.61	0.63	0.56
Imputed Saving ratio	0.18	0.18	0.33	0.38	0.38	0.39	0.37	0.44

Source: Calibrated from the I-O Tables, the National Accounts, and data from the Bank of Thailand

Table 4: Calibrations of Parameters

calculated ² alpha α	estimated ¹ alpha α	depreciation delta δ	rate of time preference rho ρ	population growth eta η	technological change g	theta θ	gross saving ratio
0.523	0.46	0.035	0.02	0.020	0.016	2.60	0.385
0.543	0.46	0.035	0.02	0.020	0.019	2.60	0.385
0.583	0.50	0.035	0.03	0.025	0.019	2.40	0.417
0.668	0.60	0.035	0.03	0.015	0.019	2.40	0.417
0.688	0.75	0.030	0.03	0.015	0.019	2.40	0.417

Note: 1) estimated capital share or productivity embodied with human capital (1) $\log(y) = 1.056 + 0.756\log(k)^{***}$, $R^2=0.82$; estimated capital share without embodied human capital (2) $\log(Y) = 14.87^{**} + 0.46\log(K)^{***} + 0.70\log(H)^{***} - 0.17\log(L)^{***}$, $R^2=0.91$ where y = real output per effective labor; k =capital stock per effective labor; Y output; K =capital stock (real); H = human capital measured by labor by education-skills; L =labor body respectively. The ‘***’ signifies significant level at 99.0 percent.

2) The calculated ‘alpha α ’ or capital share is derived by $\alpha = \frac{(\delta + \rho)}{\theta + \rho + g}$

Given the initial value for capital: $k_0 = 32.825880$ the optimal path of capital and consumption at the steady-state: $k^* = 328.25$, $c^* = 30.399$ respectively in the far distance period. The path of capital, output, and consumption per effective labor over their optimal path is shown below. The time path of capital accumulation to steady state seems to be remote into a very far distant from the initial period as solved by the boundary value problem (bvp4c in MATLAB).

It depends on how the economy will have her capital deepening as shown by the capital share parameter ($\alpha = 0.68$ -0.75 see footnote 2 for calibration). The higher level of capitalization has resulted in slower consumption path growth. The saving rates (gross) behaved accordingly while the interest rate in the case of rapid capitalization (higher alpha) started with higher rate while the lower level of the capital deepening path (smaller α) would start with higher interest rate but declined rapidly towards the same rate in the long-term. The assumption of raising capital share also means a lower path of consumption per effective labor. The interest rate (cost of capital approximate the profit rate) declines to a very low level in the long-run (after capital deepening). It also approximates the declining rate of profit towards the steady-state. The saving share was not responsive to interest rate decline, stabilize, and later increase in the long horizon.

It should be noted that $\alpha = 0.68$ -0.75; $\delta = 0.03$; $\rho = 0.03$; $\eta = 0.015$; $g = 0.019$; $\theta = 2.4$ respectively. k^* = steady-state capital stock; c^* = steady state of consumption; s =gross saving rate transitional dynamics; r = interest rate $\times 100\%$; $k^{\wedge}/k^{\wedge*}$ = values per unit of effective labor of the capital stock; $c^{\wedge}/c^{\wedge*}$ = values per unit of effective labor of the consumption; $y^{\wedge}/y^{\wedge*}$ = values per unit of effective labor of the output; t = time path of model simulation to the steady-state. It can be in any time scale not necessary to be yearly. It may be regarded as an iteration of the model towards its steady-state.

The Thai economy behaves consistently with RCK conjecture. That is to say after AFC in 1997-1998, the vanishing of accumulated capital stock before this period had to be restarted again. It would take a much longer time to achieve a steady-state. As we are facing a decline in the population growth of the working-age, Thailand has no exogenous potentials to drive future economic growth. It is not sustainable to utilize an unskilled labor force just like in the past-present. The reliance on unskilled migrant guest labor would neither solve the problem. Besides, we have not invested in research and development

sufficiently. All these constraints sufficiently explain why we could not exit the middle-income trap. Even though the time to arrive at the steady-state depends on subjective assumptions and heuristic parameter calibrations, the endogenous response of saving share out of gross output seems to be unrealistic high close to 0.6 as compared with 0.44 at the starting period. That is to say, to arrive at a steady-state of capital accumulation and growth, we have to rely on foreign savings to add to domestic saving. Thus, we reject the null hypothesis that Thailand can exit from a middle-income trap in the short-medium term. *Thailand is on the path of unsustainable capital accumulation process if without sacrifice on conspicuous consumption to increase the savings as a financial source for gross fixed capital formation.* This means an urgent economic management plan would be desperately needed on the capital stock accumulation. Thailand has to rely on foreign savings as an additional source of finance inevitably condition for growth towards steady-state as the RCK model has predicted in our study.

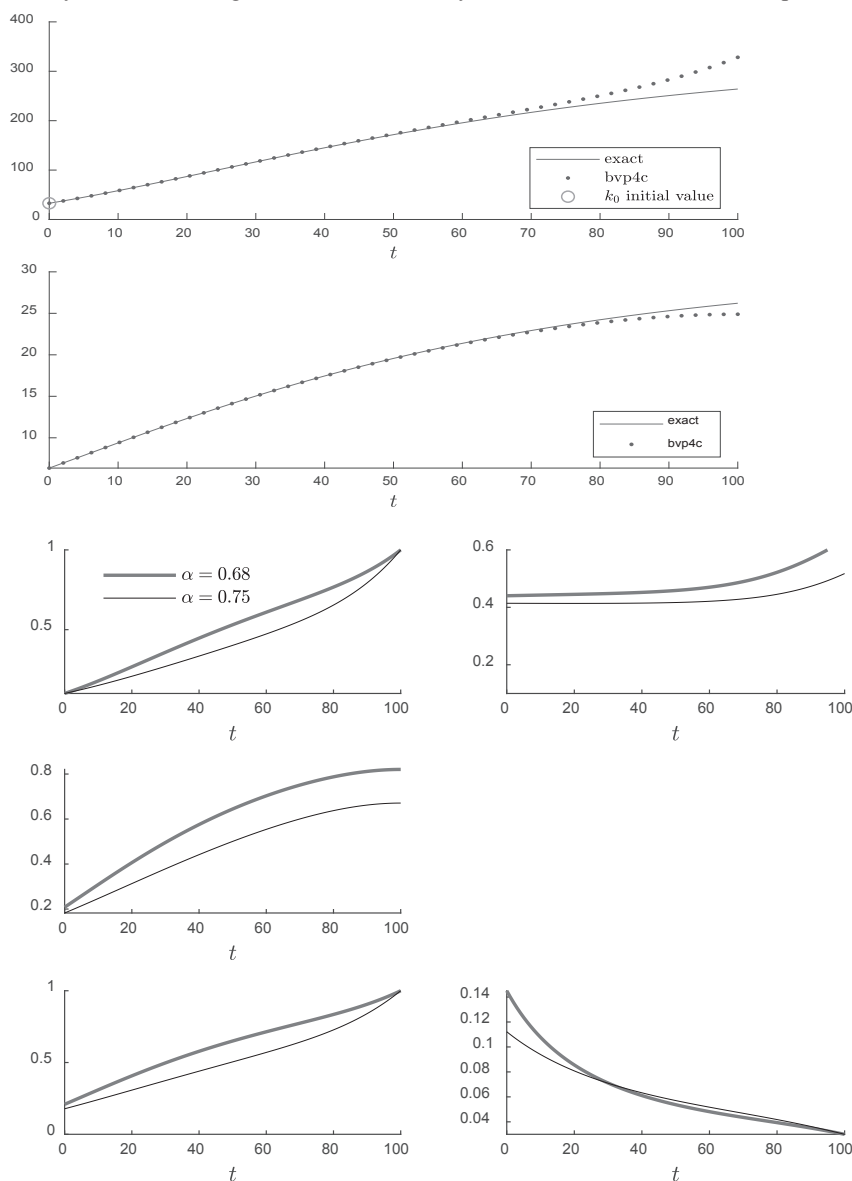


Figure 20: Transitional Dynamic Path of Optimal Ramsey-Cass-Koopmans model run (Million baht per person).

6 The debate on Capital Accumulation and Income Distribution in Thailand

6.1 On Capital Accumulation

In this paper, we have found an over capital accumulation in Thailand from 1985-1998. It was inefficient utilization of capital as was criticized rightly by Krugman (1994). This was a pre-condition to the AFC in 1997-1998. After the crisis, Thailand had lower *mean* economic growth rates as well as the low growth rates of gross fixed capital formation. The *overcapitalization* and inefficiency of capital accumulation that was criticized by Krugman had turned to be *under capitalization* during 2000-present. This is the main reason why Thailand could not phase-out of the 'Middle Income Trap' to join the league of high-income countries. We have tested the Krugman hypothesis by applying the dynamic I-O 1975-2010. It is confirmed that the productivity of capital was quite low as compared with that of labor inputs. This may be a reason to explain a low TFP in the economic development of Thailand.

To analyze the possibility to exit from the 'Middle-income trap', we have applied the Ramsey-Cass-Koopmans model to simulate the path of capital accumulation, consumption, and saving endogenously over a long time. We have found that the transitional dynamic of capital and consumption (and saving) will hypothetically need a longer time to reach the 'steady-state' level. The saving ratio has to be hypothetically as high as 0.60 by the end of the horizon.

This is because Thailand has entered slower population growth and lower total factor productivity (TFP) the gross saving rate would have to adjust endogenously *high enough* to reach the steady-state. The interest rate which approximates the cost of capital and rate of profit would adjust down to the steady-state to let the smooth capital accumulation and growth.

Since the saving ratio of 0.6 is artificially high, this may mean we have to sacrifice the consumption by both private and government for saving and investment. Besides, in the short-medium term, we may need to raise external funds either by borrowing or rise the competitiveness of export to earn foreign currency to finance our capital accumulation inevitably. This not shown in our closed economy model under the RCK but it is worth pursuing this line of research in the future.

We explain the reason for under capital accumulation as an insufficient gross saving rate in a wide margin. (1) The exodus of Thai capital (domestic saving) from Thailand investing abroad has exhibited the response to a declining rate of return to capital (profit rate) proved in our study. It had delayed capital accumulation in Thailand in recent years. (2) The 'turning point' between rural-urban migrations induced the overall wage rate increase. The capitalist has responded with substitution of a migrant with national labor in most of the labor-intensive sector e.g., agriculture, fishery, construction, and light manufacturing as well as the service sector. (3) This has caused another round of under capital accumulation. Especially, the Thai economy has a difficulty of capital investment in times of technological disruption. Finally, the Thai economy may not find her ways out of the 'middle-income trap' and maybe the last country that is still struggling in the middle-income countries league as pointed by Suehiro (2020)⁵¹.

6.2 On Income Distribution

We have postulated that the factor income distribution in Thailand during the period of study 1975-2010 be determined by the factor price frontier or relationship between the profit and wage rate. The Thai economy is well behaved as asserted by the normal factor price frontier. Capitalist optimizes investment and capital accumulation by selecting the highest possible profit rate regardless of any given technology of production. The equilibrium between investment and saving and the natural rate of growth augmented by technological change can determine the profit rate. The Euler's distribution of factor income gives a clue to the determination of return to labor after profit maximization.

⁵¹ This is consistent with Prof. Akira Suehiro, Faculty of International Social Sciences, Gakushuin University, Japan. He also raised question on the bias of labor productivity calculation by the official statistics. His presentation however based on wage-bill over Gross National Income (at current market prices). Our calculation was differently based on the Input-Output Table. Here, the nominal profit-wage ratio is 'Operating Surplus' over the Wage-bill. The average productivity of labor is measured as ratio of the Gross Domestic Product at Factor Cost (GDP at market price net of the indirect taxes and depreciation) over the wage rate, measured at constant price of 2000. The author would like to thank Prof. Akira Suehiro, for his comment on the occasion of the Final Lecture by Dr. Kitti Limskul at the Faculty of Economics, Saitama University, Japan February 28th, 2020.

It is astonishing to find that the *income distribution in Thailand tends to favor wages rather than profit earners* over the time of the study. In other words, the income inequality between wage-profit earners has been improved significantly over the study period 1975-2010. Especially, the policies during democratic governments in Thailand during 2000-2010 have been proved to favor wage earners in urban (SMEs) and rural areas (farmers) with several effectively implementable policies. The policy named a 'dual-track' and self-help rural development policy (OTOP) under pro-poor government policy, rice price support and income insurance policy of another democratic government would surely induce the poverty reduction and rural inequality.

We have applied the data from NESDB, the National Statistical Office and the World Bank to test the 'Kuznets' Inverted U-shape Hypothesis'. It is found that Thailand has reached her maximum inequality in terms of the mean income at the level of ~3,000 US dollars per head in 1992. Gini's coefficient was as high as 0.535 accordingly. The Gini's coefficients were mostly higher than 0.5 during 1993-2006. They were lower than 0.5 points since 2007-2017 respectively. It could be explained that after the influx of foreign capital after 1987 (owing to the Plaza Accord in 1985), income inequality has risen substantially. It was over 0.5 from 1990 to 1997.

The liberalization of interest rate in 1994 and liberalize the foreign capital inflow-outflow in the name of BIBF (Bangkok International Banking Facilities) had been starting as a period of the income inequality reduction in Thailand. The economic turmoil was triggered by the current account deterioration substantially during the period and followed by Financial Crisis in 1997. Two subsequent periods of democratic government had witnessed the rapid declining trend of income inequalities.

In our view, there are explanations of these phenomena. (1) There is insufficient data of the mean income in the upper tail e.g. deciles 9th and 10th of the income class while reports of middle income and lower-income were well recorded. The Gini's coefficient may be biased downward.



Figure 21: GINI's Coefficients of Thailand 1960-2018

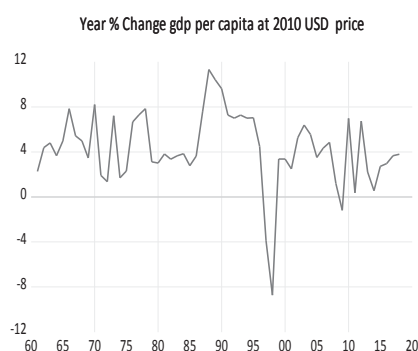


Figure 22: Growth of Per Capita Income

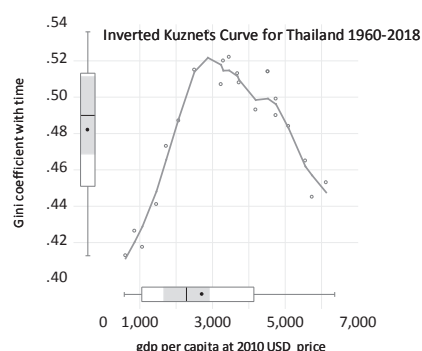


Figure 23: Inverted Kuznets' Curve

As a result of rapid growth during 1985-1995, both the profit earners and wage earners had both gained fruits of economic upswings. However, it was rational to postulate that gains of wage earners would be lagging behind those of the profit earners. Thus, this would cause a rapid rise of the Gini's coefficients during the booming period 1987-1995. (2) The financial crash in 1997 had probably damaged the wealth and real capital of the upper-income classes but left the middle and lower-income deciles with lesser economic effects. Some wage earners in the urban areas may move back to a rural area as reversed migration. This would result in the lower Gini's coefficients after the AFC 1997. (3) In our views, the true impetus of the declines of income inequality in Thailand was from the policies of those democratic governments (2001-2005 and 2008-2014) despite several political interruptions. The democratic government had launched several 'Pro-Poor' development policies. This may be the main reason for the decline of income inequalities in Thailand during those periods. The inequality coefficient (Gini) was recorded at 0.445 in 2015. However, this is still higher than the level of developed countries which should rather be significantly lower.

Our hypothesis is, therefore, if those democratic governments and their policies could be continued, Thailand may be able to materialize the more equitable income distribution. Unfortunately, the political interruption since 2014 had the inconsistent direction of policy. It had been pointed out by Veerayooth, K. (2020)⁵² that Thailand had an evolution of power struggles which induced the state-business relations and growth regimes in the 1980s-2010s. The interesting remark is on the recent economic tied up between the small groups of Sino-Thai conglomerates with the military regime on various occasions since the 1960s. The so-called economic 'Spearhead' had been seeking 'lucrative' business sectors with a monopolistic rate of profit.

We would like to add further that before the economic boom 1987-1995 the major business had concentrated in natural resource exploitation as well as agriculture. It had diversified into the light industry like rice mill, sawmill, textiles and apparel, furniture, and services during the democratic movement after 1975-1985. Thereafter larger industries such as large textiles factory, transportation equipment, electrical and electronics industry, chemical, etc., had emerged with foreign direct investment. The relationship between Sino-Thai conglomerated with foreign capital was prominent.

The small group of the Sino-Thai and military regime was intertwined during 2014-2020. The representative of the business group presents in the cabinet circle from time to time to mobilize the main government policy platform so-called 'Pracharat' which means 'People- State' relationship. But this time unlike the pro-poor policy of the former democratic governments the 'People' now consists more of conglomerate private business and less with small business and non-government organization. According to Veerayooth, the spearhead model of these Sino-Thai conglomerate aims at '*Mega-project-driven*'

⁵² The author would like to thank Prof. Veerayooth Kanchoochat, Professor of Political Economy at the National Graduate Institute for Policy Studies (GRIPS), Tokyo and Prof. Yasuhito Asami, Professor of Political Science at the Hosei University, Tokyo, Prof. Masaharu Nagashima, Faculty of Economics, Saitama University, Saitama for their valuable comments and notes on the occasion of the Final Lecture by Dr. Kitt Limskul at the Faculty of Economics, Saitama University, Japan February 28th 2020.

with ‘...hierarchical and unequal. A regime change in the 2020s would pose a serious threat to wealth accumulation.... to a much higher degree than regime changes in the 1990s and the 2000s.’

In our context, the declining profit rates (and rising real wage rates) had forced the profit earners to optimize their capital investment. One option is to move their wealth to invest in higher profit or higher rate of return of capital. The second option is to acquire the ‘Mega-project-driven’ and earn a long-term profit or rate of return in Thailand. This is clearly to seek a monopolistic power over the business by reaping the close relationship with the current ‘State’ - who continues its power from the military regime 2014-2019.

The theoretical question by Asami, Y. (2020)² whether our prediction of options mentioned above can be generalized to another economy as well. That is to say, if the Thailand industry would exhibit a profitable trend then foreign capital would freely flow into Thailand. This was valid in the pre-financial crisis where Thailand has had higher profit and low wage rates which were favorable to foreign capital inflow. After the financial crisis, Thailand was obliged to liberalize and deregulate her economy in both the real and financial sectors. Thus, it was a precondition to take off to a further episode of economic growth and equitable income distribution. Unfortunately, the economic development was interrupted by a series of non-constitution interventions and ended up with the military taken over. The last disruption resulted in the monopolistic ‘Mega-project-driven’ path of economic development as mentioned above. In sum, the profit earners in Thailand had chosen to switch between moving to seek capital investment opportunity for higher profit abroad and/or acquiring domestic monopolistic power over the market by relying on their Sino-Thai and State relationship. This answers to the question by Asami that once the relationship is matured it would block foreign capital to freely compete with domestic capital spearhead. The model mentioned by Veerayooth may be generalized for a contemporary Thai as well as any emerging economies with similar conditions. Thailand’s economic landscape would never be the same as in the past. But we leave it to further study for any possible change in the coming decades.

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