Asia's Social Infrastructure Demand Estimate

The Case of Thailand

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Abbreviations

ADB	Asian Development Bank
JICA	Japan International Cooperation Agency
LFS	Labor Force Survey
NESDB	National Economic and Social Development Board
NCD	Non communicable disease
NHA	National Housing Authority
NSO	National Statistical Office
OCSC	Office of Civil Servant Commission
SES	Socio Economic Survey
SDGs	Sustainable Development Goals
UCS	Universal Coverage Scheme

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Chapter 1
Introduction

1. The significance of the Study

During the last 50 years, Thailand has entered a drastic change in her population structural. During 1960-2010, population size in Thailand has doubled from 26 million persons to 66 million persons. It is remarkable that Thailand has entered a transition to aging society from the median age of 20 years to 35 years. In addition, most of population 80 percent had once resided in rural (non-municipal) area has reduced. Currently, almost 50 percent of the population is residing in the urban (municipal) area.

Population change was driven population policy since 1970. The policy was designed to tone down the population growth in order to achieve a balanced economic development and growth path. The population policy in the past had applied for a 'Family Planning Program' as main policy instrument among others. The Third National Economic and Social Development Plan (1972-1976) – The Sixth National Economic and Social Development Plan (1987-2000) had set population growth targets in line with the target of the economic and social development plan.

The family planning measure had been effectively reduced the 'Total Fertility Rates, TFR)[1]. The TFP had declined from 6.3 in 1965 before the introduction of a family planning measure to 1.6 persons in 2010 respectively. The population growth rates have decreased from 3 percent per year during the last 50 years to be merely 0.5 percent per year at present. As a result of lowering total fertility rates and death rates, Thailand has entered an undeniable aging society.

The Population Projection Committees under the NESDB has applied the Population and Housing Census of 2010 of the National Statistical Office, Thai Government as a basis (excluding the non-Thai nationals in Thai households and those undocumented persons) to project population trend during 2010-2040. The projection is for various levels; the national (2010-2040), regional (2010-2035), and provincial (2010-2030) level. It also included the national population as well as municipality and non-municipal or the rural population at all level (2010-2035) respectively[2].

[1] Number of average children at birth per a fertile mother

[2] The NESDB population committee has applied a 'Cohort component method' for national and regional population project. The 'Ratio method by age, gender and area' is applied for projection of municipal population. The 'Single year age' population 1-100-year-old was attempted. Assumptions on 'Total Fertility Rates", 'Death rates", "Migration" between regions and "Urbanization Trend" are clearly explained in NESDB (2013).

The NESDB has found that the population projection is quite stable at 64-66.4 million persons in the next 30 years. This is a result of TFR's declining trend towards the threshold of 1.3 persons in 2040. It is noted that the population growth rate may be approaching zero percent per year. As a consequent, the population with age 65 year, approximately 9 percent of total population in 2553 will increase to 14 percent in 2021, and 20 percent in 2031 respectively. In addition, it is clear also that within the next 30 years most of the population will reside in the urban area.

The changing population trend has called for a policy to increase population quality rather than numbers by a family planning program. In order to shift economic structure away from labor-intensive towards an improvement of labor quality and productivity, less reliant on unskilled-skilled migrant labor from neighboring countries. Instead, the population policy should turn to human security policy, and plan for stable income with a higher quality of life for the aged population.

The ADB in her publication on the "Infrastructure for a Seamless Asia" in 2009[3] has pointed out high investment demand for Asia's economic infrastructure (power, water, and sanitation, transport, and telecommunication) from 2010 to 2020. The costs of hard and technical infrastructure for Asia are estimated to be 8 trillion USD approximately. Following the Sustainable Development Goals (SDGs) and updates on a social and economic environment of the region, the ADB has extended the estimate for the period from 2016 to 2030. An updated figure on the demand for hard and technical infrastructure needs in a report "*Bridging the Gap: Infrastructure Needs in Asia*" in February 2017, has pointed large gap of infrastructure needs. It has provided strong policy recommendations as a basis for financial needs for investment.

JICA has started in consultation with the ADB to conduct a research on *Asia's social infrastructure demand* from 2016 to 2030 to complement ADB's demand estimate for economic infrastructure. Social infrastructure, such as school and hospital, is a key capital investment to maintain social services and secure economic development of the region where the population is expected a rise. The domestic public financial gap of these public investments in each Asian country would be enormous.

The financial burden derived from infrastructure investment does not finish at the stage of construction but continue for the long term. A new infrastructure investment requires subsequent expenditures in later years such as the costs of operation and maintenance, rehabilitation and replacement at the end of the facility's lifecycle. The problem of finding out *a financial source* for infrastructure renovation would be crucial

[3] ADB (2009) cited the methodology by Fay and Yepes (2003).

to developing country where domestic saving is still lower than needs. Besides, some countries such as Thailand are facing with aging trend following Japan. Thailand will be facing population aging in the next decades. Thailand is ahead of other Asian countries, Thailand has a declining birth rate owing to declining total fertility rates and declin ing death rate owing to health standard improvement in the last decades. The longevity of population was owing to better public health services.

Approaching aging society, Thailand may need a new type of social infrastructure. Not only the housing and health services and facilities for the aged citizens but also Thailand would need a new supply of skilled labor supply via capable human resource investment to compensate for the declining saving capacity of the household. This comprehensive social infrastructure investment would be the crucial policy of Thailand as well.

2. The Objective, Scope, and Methodology of the Study

The purpose of this research is to estimate the investment demand of Asia's social infrastructure up to 2030: with special reference to the case of Thailand. This is to find appropriate research methodology on social infrastructure demand estimation and forecasting to be learned by other Asian countries.

The gap of demand for social infrastructure in Thailand is defined as infrastructure *other than* the physical or hard infrastructure which has been estimated and forecasted excellently by ADB. Here, it would cover less heavy engineering oriented physical infrastructure like transportation and communication systems, energy generation system, environment protection and prevention and the like. Rather, we concentrate on physical infrastructure which would serve as facilitation of human capital investment, health system at large not only buildings and hard infrastructure but may be inclusive of machinery and technologically advanced facilities. We would like also interest in the housing demand and affordability of low-income households as a basis for welfare improvement of households as well.

The scope of research thus covers mainly the social infrastructure for education and health system in Thailand. In addition, we would also estimate the demand for low-income housing needs and affordability to serve for the long-term urbanization in Thailand. In our research, we have the intention to add estimation on the demand for government facilities alongside with the urbanization and decentralization in Thailand as well. This is to serve for the decentralization of service provision from the central and regional government to local government in the coming decades.

2.1 Review of Conceptual Framework and Methodology

Two methodologies namely the "micro" and "macro" approach as a primary guideline by JICA in the estimation and forecasting of social infrastructures.

Table 1.1: Two Approaches by JICA Recommendations

	Overview	Pros	Cons
1. "Micro" approach	Build up each year's demand by multiplying the projected number of the beneficiary (e.g. student for school, potential patients, low-income households need for low-cost housing) by official construction standard (e.g. square meter per student)	Once, micro level of parameters are obtained from engineering estimation and accounting cost formally, we can arrive at a model case for social infrastructure investment as well as the cost of investment in a static period.	Since engineering parameter is quite general, it may be applicable to other Asian countries. However, the 'unit cost' may need inter-country indexation. This can be applicable to other Asian countries after all.
2. "Macro" approach	Project each year' s demand (dependent variable) by regression and/ or system estimation. The main variable is demographic/ economic factors (independent variables)	Model estimate applies hypothesis testing procedure to test the validity of model to be used for future need of social infrastructure and its cost of investment in dynamic time.	The Econometric model for social infrastructure needs of schooling, housing and health services consumed cost of time in data collection and model estimations.

Note: This is guideline given by JICA for our research.

2.1.1 Macro-Economic Approach

ADB (2009) has released method of multiple regression model by Fay and Yepes (2003) in the infrastructure estimation using multiple regression model, The multiple regression model of is based on the least squares method (OLS) with the explanatory variable of infrastructure stock of each country / year as explanatory variable, per capita income, ratio of agriculture and manufacturing industry to GDP. Its validity is verified by an F test.

$$\mathrm{IJ}(\mathrm{i},\mathrm{t}) = \alpha_0 + \alpha_1 \mathrm{IJ}(\mathrm{I},\mathrm{t}-1) + \alpha_2 \mathrm{y}(\mathrm{i},\mathrm{t}) + \alpha_3 \mathrm{A}(\mathrm{i},\mathrm{t}) + \alpha_4 \mathrm{M}(\mathrm{i},\mathrm{t}) + \alpha_5 \mathrm{D}(\mathrm{i}) + \alpha_6 \mathrm{D}(\mathrm{t}) + \xi(\mathrm{i},\mathrm{t})$$

Where;

IJ (i,t)	= demand for infrastructure stock of type j-th in country i-th at time t;
IJ(I,t-1)	= the lagged value of the infrastructure stock,
y (i,t)	=income per capita of country i-th;
A(i,t)	= share of agriculture value added in GDP of country i-th;
M(i,t)	= the share of manufacturing value added in GDP of country i-th,
D(i)	= a country fixed effect,
D(t)	= a time dummy;
ξ (i,t)	= error term.

It is worth a trial to add the population density and the ratio of urbanization (proportion of the urban resident population in the total population) as an explanatory variable to the above regression model to replace the country fixed effect D(i). Furthermore, if we can collect standard price deflator of construction materials and equipment it may be feasible to estimate the monetary value of social infrastructure investment overtime to 2030.

2.1.2 Review of the Micro-Economic Approach

(1) Estimation of the new construction cost of public facilities

In Japan, maintenance cost and replacement investment in public facilities of local government are based on the projection of the population (e.g., number of children) and infrastructure stock quantity according to government standards such as the "Ministry of Education, Culture, Sports, Science, and Technology". In Thailand, the stock quantity is not easy to access for intonations.

(2) Estimation of renewal expenses of public facilities

In Japan, experiences on estimation methods of renewal costs are being accumulated, mainly from local public entities, against the background of the old infrastructure and aging problems of public facilities. The replacement of buildings, equipment, interior and other after the end of useful life of 60 years follows the Regional Comprehensive Development Foundation guideline. They are obtained from the "Public Facility Update Cost Calculation Software" with relevant infrastructure stock by relevant aging.

(3) Estimation of maintenance cost of public facilities

In Japan, the local governments have followed the guideline of the 'Administrators of public facilities' based on the "Lifecycle cost of FY 2005 building supervised by Ministry of Land, Infrastructure, and Transport".

Nemoto (2011) has proposed a method to estimate the renewal investment demand in line with the declining birthrate and aging society. The study by Foundation Building Conservation Center (2015) has provided comprehensive recommendations on (1) factors which reduce real demand based on 'Effective utilization, (2) shrinking supply of infrastructures investment as result of procurement of liabilities and capital. The study has pointed out important issues on (1) the discipline of private funds raising (2) the consolidation of facilities for multi-functional usage, with proper infrastructure management for a long lifespan, wide area cooperation for effective use.

Based on the above survey, we may summarize the benefit and cost of micro and macroeconomic approaches in the case of Japan and others as follows:

Table 1.2: Comparison of Benefit-Cost between the Micro-and Macro-Economic Approach

	Benefit	**Cost**
Micro approach	It is feasible to calculate the necessary stock build-up in each year for each social investment. Estimated investment demand at the present moment (t) is possible.	The volume of data required is relatively large. The lack of detail data in Asian countries may be a bottleneck.
Macro approach	It is efficient in analyzing the trend (elasticity) of the numerical value over a certain period of time。	The past stock of social infrastructure was assumed to be in line with the observed or *ex-post* demand. It is costly to attempt to model dynamic stochastic model where future demand *ex-ante* is not observable.

Source: reviewed from JICA's document

The macro method is based on (1) official statistics obtained from a database of international institutions and other governmental websites. It may help to collect data by questionnaire survey in Asian countries, (3) the micro estimation if properly modeled may be a good starting point to carry out in other Asian countries. This is based on *pro-rata* assumptions level *of development* as shown by on the per capita income and

demographic dynamics. In our study, Thailand is selected as a case study to be the benchmark for latecomers, Asian countries.

Definition of Demand (A Case of Japan)

Investment demand in any one year for a specific infrastructure in a specific area can be defined as follows:

$$\textit{Infrastructure Investment Demand} = \{\textit{New Investment Demand[1.1]} + \textit{Maintenance Management Investment Demand[1.2]} + \textit{Update Investment Demand[1.3]} + \textit{Large Scale Refurbished Investment Demand[1.4]}\} \quad (1)$$

In the education and medical sectors, it is necessary to estimate demand for multiple forms of infrastructure with different maintenance/maintenance unit prices (Education: Basic education facilities and higher education facilities, medical care: primary medical facilities and secondary and tertiary medical care Facilities), it will construct several expressions according to the form of infrastructure.

Estimation methods used for new investment demand, maintenance investment demand, renewal investment demand, large-scale renovation investment demand are as follows:

[1.1] New Investment Demand

For a specific infrastructure in a specific region, new investment demand in any one year can be derived from the following formula:

New investment demand [**1.1**] = Construction unit cost (**cost per square meter area**) × **new demand amount** (**square meter area**) (2)

The construction unit cost can be estimated by examining the public utility unit price of the government. They are the standard price in the relevant area, or the contractual/actual unit cost derived from the multiple public works projects in recent years.

It is noted that the 'units of demand amount' other than 'square meter area' such as a number of schools, number of classrooms, number of hospitals, and number of beds can also be considered as proxies. The new demand *volume* can be derived from the following equation:

New demand amount = ***Induced demand by population increased in the relevant year*** × ***predetermined coefficient (official maintenance stand)*** (3)

The increased number of population in a studied area is an induced demand for infrastructure. In the education system, they are the increased number of students which induce the demand for education schooling and facility.

The demand for the facility based on past trends such as the number of outpatients and hospitalized patients seems to be positively correlated with the degree of maintenance of public insurance, the prevalence rate of non-infectious diseases caused by aging and income improvement, etc. In medical services, the rising number of in and outpatients has induced demand for beds and pre-cautionary facilities for NCD illness in modern life.

The process of urbanization and migration in the large urban cities will induce the demand for housing and urban infrastructures. For the government, it is to raise the welfare of the urban poor by dwelling provision for low-income people. The local government office building, as well as modern OA facilities, is induced by urbanization. Here, in Thailand, the declining in central government civil servants can be replaced by local government officials and privatization of services.

In Thailand, we intend to estimate the demand according to the increase in the number of *beneficiaries*, in order to satisfy the demand under constraints including policy measures to resolve the constraints in the policy recommendation. As for the predetermined coefficient, it is based on the official standards some may be replicated by other Asian countries.

[1.2] Maintenance investment demand

For specific infrastructure in a specific region, the maintenance demand investment demand in any one year can be derived from the following formula:

Maintenance Investment Demand [1.2] = ***Maintenance unit cost (Maintenance management cost per square meter area)*** × ***Existing stock (square meter area)*** (4)

[1.3] Update Investment Demand

For specific infrastructure in a specific region, demand for renewed investment in any one year can be derived from the following formula:

Update investment demand [1.3] = renewable cost per square meter area[4] x updated demand amount (square meter area) (5)

Update demand quantity can be derived from the following formula:

Update demand amount = existing stock amount[5] ÷ useful life (6)

[1.4] Large-scale refurbished investment demand

For a specific infrastructure in a specific region, large-scale investment demand in arbitrary one year can be derived from the following formula:

Large-scale renovation investment demand [1.4] = maintenance cost (maintenance cost per square meter area[6] × large-scale renovation demand amount (square meter area) (7)

The type of facilities to be estimated is basically based on the three pre-school education facilities, primary and secondary education facilities, and higher education facilities. However, whether modeling is reasonable or not is to examine the types of educational facilities in the country and re-examine. Schools in a form that has a low share of school statistics or that cannot be fitted to the above ISCED classification (e.g., special support schools, technical colleges, vocational schools for disabled people) are not subject to this estimate.

The guideline of the induced demand by population and prescribed coefficient (official maintenance standard) in the estimation of the new demand amount of the education sector, in line with the equation (3) is as follows:

Table1.3: The Morphology of Infrastructure, Beneficiaries and Coefficient: Education

Morphology of infrastructure	Number of beneficiaries	A predetermined coefficient
Preschool education facility	The population of target age × Arbitrary ratio based on past enrollment rate trend etc.	Establishment standard of the model country concerned
Primary/secondary education facilities	The population of target age (compulsory education, assumption that 100% will go to school)	Establishment standard of the model country concerned
Higher education facilities	The population of target age × Arbitrary ratio based on past enrollment ratio trend and GDP per capita etc.	Establishment standard of the model country concerned

[4] same as that adopted in equation (2)
[5] same as that adopted in equation (4)
[6] same as that adopted in formula (2)

2.1.3 Healthcare (medical services facilities)

The specific scope of the facilities covered by this estimate is for hospitals (psychiatric hospitals / general hospitals), general clinics (beds) among facilities type in the medical facility. This is a survey conducted by the Ministry of Health, Labor and Welfare of Japan. Note that the dental clinics are excluded from the fact that the number of hospital beds is negligible even in Japan.

Based on the type of hospital bed, adopted categories of psychiatric bed, infectious disease bed, tuberculosis bed, sick hospital bed, general hospital bed, it is possible to estimate medical demand represented by the number of functionally used hospital beds in Japan.

Table1.4: The Morphology of Infrastructure, Beneficiaries and Coefficient: Health

Morphology of infrastructure	**Number of beneficiaries**	**A predetermined coefficient**
Needs for infrastructure: hospital and facilities	A total number of patients with a probability of in-out patients in the population projection by age as demanded. It is managed by UCS.	the cost standards of the UCS model in Thailand. The 'Capitation cost per person' is paid to health provider (Ministry of Health) by demander (patients), managed by the UCS.

However, in the model country like Thailand, the situation is somewhat different from Japan and other Asian countries. Thailand had launched a universal health care services or formally 'Universal Coverage Scheme (UCS)' for those who could not access to health care services in the mainstream. Middle to high income obtains health care services through the private provision with market prices. The government's civil servants and military are treated from government budget as part of rewarded benefits in serving country. The employees are caring from the social security fund a joint payment between tri-party. The universal health care has served for the rest 60 percent of the population who could not reach the mentioned health services. The universal health care service's cost was paid through government budget in terms of capitation of demand or patient number not the hospital beds from the supply side. We will try to estimate the investment cost of social infrastructure mixed between supply and demand models. Such that, other Asian countries will be able to find an appropriate model for own country.

2.1.4 Low Income Housing Needs

In Japan, "low-income housing" refers to *public housing* of prefectures and municipalities. In addition to this, public *rental housing* supplied by Urban Renaissance Agency etc. existed and played the role of housing supply etc., in urban areas of the high growth period. Currently, it plays a role as a *safety net with* the aging of current residents and an increase in the relatively low-income group, but it is different from the original "low-income house".

Table 1.5: Comparison of Low Income Housing Provision by Selected Countries

Country	Japan	Indonesia	Malaysia
Object	Public housing (prefecture, city village)	Rusunawa and Rusunami	Program Perumahan Rakyat (PPRS and PPRM)
Right form	Lease	Lease, sale	Lease, sale
Maintenance standard	Public housing improvement standard	(Pedoman Teknis Pembangunan Rumah Sederhana Sehat, (403/KPTS/M/2002)	Standard (Perumahan Kebangsaan Bagi Perumahan Kos Rendah Rumah Pangsa, CIS2)
Target income class	Revenue till 25% or less (originally hierarchical), revenue quartile 40% or less (discretion hierarchy)	Household monthly income 4,500,000 Rp or less	Household monthly salary less than 2,500 RM

In Asian countries, policy instruments such as *a sale* of public housing rather than the rent of public housing, allocation of low-income housing development obligation to private developers, and housing finance are mainly used JBIC Development Institute proposed by Kitano, Naohiro et al. (2001). Therefore, even if estimating housing demand for low-income people, it is highly likely that measures to reduce the *financial gap* are *not* only dependent on the provision of public rental housing (the public possesses housing as stock).

In addition, estimating the demand of public housing in Japan estimates the number of households of the policy objectives of the public housing (original hierarchy and discretionary hierarchy) based on estimates of household numbers etc. in the medium to long-term as about 30 years, among them, *"household with less than annual salary poverty"* is estimated. However, this household with less than annual poverty annual income is included *even if it resides in private rental houses*, and it does not necessarily indicate the necessary number of public housing.

In Thailand, low-income housing was mainly planned by the National Housing Authority of Thailand, Ministry of Human Security and Social Welfare. The HHA has compiled land bank in her hand but the problem is the overall funding of housing construction and post finance. The post finance is provided by both the Government Housing Bank and the general Commercial Banks. The NHA has provided 732,249 low-income housing during 37 years (1973-2010). The current government housing policy has launched housing policy aiming at house price of 242,200-2,600,000 baht (the suburb of the BMR and some urban area in provinces). Housing for aging people would be planned for 10 percent of each project.

The target low income has been set at household income less than 15,000 per month in 2003 and adjusted to be less than 40,000 in 2016 for house price not exceeding 740,000 baht a house. The post finance is taken care by finance and banking in general.

It should be noted that numbers of housing supply were provided by the private sector in various forms. This is because most of population and household resided in the rural area for 40 years now. However, recent population and housing census have indicated that population changes and resettlement of Thais toward the urban cities. Rural area and localities have turned to district municipalities and township municipalities over the years from now. It is expected that the urban area will be expanding with both high-middle-and low-income communities living side by side. The demand for housing in various forms would be rising. The cost of land in an urban city may exclude low income from housing services in the center area despite their workplaces would be located there. Demand for labor by urbanites would still be high despite automation. Some work has to be done by low-income workers still. Thus, it would be costly for the low income to commuting from the sub-urban area if transportation system is not properly provided. Therefore, it is a crucial role of the public in the provision of low-income housing. The needs for various types of housing would be necessary. This can be owned, leasing, renting and freely use in short period as a safety net for the urban low-income people.

2.1.5 Government Buildings

In Japan, the definition of the government building in this estimation is a facility for the central government and local public entities to perform the necessary duties to provide public services to citizens. "Law for the construction of public office facilities" means "buildings used by national institutions to handle their affairs, and used by

schools, hospitals and factories, prisons and other storage facilities. For local public bodies, "office" and "branch office, branch office, branch office" generally refers to "government building" under local autonomy law. In addition, according to the provisions of the Constitution, local governments are supposed to set up parliament, and there is a space for Congress to occupy.

In addition, in local autonomy law ordinarily, local public bodies are said to establish public health centers, police stations, and other administrative agencies. In the statistics on the size of the "government building" of the municipality, there are statistics that are limited only to the *"space mainly used for office"* and statistics including other spaces including parliament and civic interaction spaces.

The concept of the number of beneficiaries and prescribed coefficients (official maintenance standards) in the estimate of new demand in the government building, in equation (3) is as follows:

Table1.6: The Infrastructure, Beneficiaries and Coefficient: Government Building

Morphology of infrastructure	Number of beneficiaries	A predetermined coefficient
The government building	The ratio of the number of civil servants per population based on the total population x past trends etc.	Establishment standard of the model country concerned

3. Conceptual Framework in Thailand Case Study

In the current study, we will apply the guideline mentioned above for our projection of needs, where it is appropriated. The research team has also developed own methodology in line with the above-mentioned guidelines.

In the case of Thailand, we would apply national survey data such as 1) The Household Expenditure Survey (SES); 2) The Labor Force Survey (LFS); 3) The Database from the Ministry of Education; and 4) The National Housing Authority (NHA) etc.

The dynamic population projection based on the Population Census 2010 by the NSO and NESDB (2013) would be our main starting input into our model forecasting. The parameters in our model are estimated using standard econometric method for several surveys done by the National Statistical Office (NSO) mentioned above. Thailand was a case where the population is facing an aging trend with lowering Total Fertility Rates in the next decades.

The model for social infrastructure needs would be developed in our study. Later, the sample model may be a guideline for other Asian countries. The social infrastructure need is subjected to the result of rehabilitation and replacement cost of infrastructure. As Thailand is facing *'a middle-income traps'* syndrome, it is challenged on how to rehabilitate, repair and maintenance of existing infrastructure which is deteriorating over time. However, the most important is to estimate *the need for new social infrastructure in Thailand* to be a basis for sustainable growth in the coming decades.

The methodology guideline in this research can be shown by either schematic flows and/or mathematical model. All projection starts from official population projection series by NESDB, the Thai government. The demand for schooling, low-cost housing and health care services and government buildings are designed as follows:

1) Under the trend of population change in Thailand, household demand for education and schooling can be projected from the supply-side. The number of students in schools at every level was determined by multiplying the 'enrollment ratios' with the population at each particular age profile. WaPattanapong, Pramote Prasartkun and Suriporn Panpoung ed., (2013) has applied single year age population to proposed population policy implications. The average five-year age population group is used to represent enrolled population to compare with the single year age population by NESDB.

2) As Thailand is trying to get out of a "Middle Income Trap" syndrome, key determinants would be both physical as well as human capital development. She would need solid structural adjustment on the production side away from labor-intensive in each sector. We intend to take in to account demand-side estimation and projection as well. Thus at equilibrium, we would project the demand for labor by skills (occupation-education) by sector of production. The demand for labor by education was later translated into the demand for schooling by disciplines investment.

3) The demand for healthcare services and hospital facilities and physicians and other human resources depends on the aging structure of a population. The model would predict the number of the patient of non-communicable disease (NCD) and other patients. The translations of demand for health services into physical infrastructure and cost-effective investment will be done by our designed model.

4) The housing need and affordability of low-middle income in Thailand has been main government policy. It is officially serviced by the National Housing Authority of Thailand. Middle-high income housing demand has been taken care by private housing market at large. In our study, we applied the SES database to estimate

the demand for housing by income class. Some income class will be able to afford only 'rent-a-house' rather than a mortgage. The demand for housing for aged citizen may need new vision how to apply new technology for the amenity of aged people and how to design community for senior-new breed family living nearby in the same community.

5) The infrastructure demand for government building will be estimated by applying database on how the social capital stock (the case of government building) is estimated by NESDB. We will apply a model starting from population resettlement under the dimension of 'Urban-Rural'.

The social capital investment although can remedy some welfare's problem *ex-ante* but most of developing countries are facing tendency of an aging society with low saving rates. This would not sufficient to service the social capital investment debt. The gap of social infrastructure needs would be constrained by low domestic saving and capacity constraint to generate income growth. The social policy like this is hard to find a solution *ex-post* without accessibility to international resources. How to quantify the financial solution to relax this financial constraint is however beyond the scope of our study.

4. Organization of Report

In chapter 2, we will describe the economic development and growth of Thailand as a basis for the estimation and report. The sources of growth from the supply side is concentrated for further prediction of input demand for production of human capital and health as well as housing and government services

Chapter 3 describes Social Infrastructure Needs and Its Determinants at the macro level. A regression analysis together with a counterfactual macro-economic model simulation and forecasting will be used to project the gross investment needed for total social infrastructure for human capital development and welfare improvement for low-income housing. This is a methodology developed by this study.

Chapter 4 provides a micro approach in a projection of social infrastructure needs in the education system and their facilities. Here also we have benchmarked Thai education system with international standard i.e., PISA report and come up with the projection for social infrastructure need as well its 'cost saving' owing to shifting of importance from physical alone towards human capital investment. We have added the similar demand and its cost saving in the case of public services by applying data from

the Office of Civil Servant Commission (OCSC).

Chapter 5 we have applied data from the health service system in Thailand, known as the 'Universal Coverage Scheme' (UCS). It is the demand side approach to the health services. It may be one of the successful implementations in the world. Although, we will also describe the drawback of excess demand of UCS where social investment cost on the supply side could not match with expectation. The projection of social infrastructure need is projected from the population structural change towards the ageing cohort, and stochastic drift by the Non Communicable Disease (NCD).

Chapter 6 provides an insight into our approach methodology of 'Low Income Housing Needs and Affordability' model for Thailand. The demand projection is to qualify the level of needs for future urbanization and communities' welfare improvement.

Chapter 7 provides an overall conclusion on our methodology and results. This will be a basis for a further application by the other Asian countries.

Chapter 2

Economic Development and Social Implications in Thailand

1. Introduction

Thailand is a small developing economy in Southeast Asia with a population of 67.2 million persons as of 2014. She is a middle-income country with nominal GDP ranks at the 28th among world countries with GDP per capita of US$5,771 (Nominal.). Currently, manufacturing industry's share is 39.2 percent second to the service sector of 52.4 percent in 2012. Even though the share of agriculture GDP is only 8.4 percent, the sector resides with a majority of the Thai population. Although the population who are still under the poverty line in 201 was reduced to be 7.2 percent, Thailand cannot manage to reduce the income inequality. The Gini's coefficient is 0.484 and 0.375 measured from income and expenditure side respectively in 2011. The Thai economy is quite stable in terms of inflation, unemployment, public debt to GDP ratio. Thailand is a destination of foreign direct investment. The overall creditworthiness is quite satisfactory in the eyes of rating agencies. Thailand has stable external stability with stable exchange rates owing to the foreign currency reserve of 226.17 billion USD as of 2017.

Table 2.1: Current Macro-Economic Statistical Summary for Thailand 2016

Macro-Economic Statistical Summary for Thailand	
Population	67.2 million (July 2014)
GDP	US$1.108 trillion (PPP; 2016) US$404.824 billion (Nominal; 2016 est.)
GDP rank	28th (nominal) / 20th (PPP) (IMF, 2017)
GDP growth	0.9% (2014), 2.9% (2015), 3.2% (2016e), 3.2% (2017f)
GDP per capita	US$15,319 (PPP; 2015) US$5,771 (Nominal.)
GDP by sector	Agriculture (8.4%), Industry (39.2%), Services (52.4%) in 2012
Inflation (CPI)	3.02% (Headline, in 2012); 2.09% (Core, in 2012)
Population below poverty line	7.2% (2015)
Ease-of-doing-business rank	46th (2017)

Gini coefficient	0.484 (income) (2011) 0.375 (expenditure) (2011)
Labor force	39.41 million (2012)
Unemployment	0.9% (2014)
Main industries	Automobiles and automotive parts (11%), financial services (9%), electric appliances and components (8%), tourism (6%), cement, auto manufacturing, heavy and light industries, appliances, computers and parts, furniture, plastics, textiles, and garments, agricultural processing, beverages, tobacco
Exports	US$215.38 billion (2016)
Export goods	Textiles, footwear, fishery products, rice, rubber, jewelry, automobiles, computers and electrical appliances
Main export partners	United States 11.2% China 11.1% Japan 9.4%, Hong Kong 5.5% Malaysia 4.8% Australia 4.6%,Vietnam 4.2% Singapore 4.1% (2015 est.)
Exports	US$215.38 billion (2016)
Export goods	Textiles, footwear, fishery products, rice, rubber, jewelry, automobiles, computers and electrical appliances
Main export partners	United States 11.2%, China 11.1% , Japan 9.4%Hong Kong 5.5%, Malaysia 4.8%, Australia 4.6% Vietnam 4.2 %, and Singapore 4.1% (2015 est.)
Imports	US$194.19 billion (2016)
Import goods	Capital and intermediate goods, raw materials, consumer goods, fuels
Main import partners	China 20.3%, Japan 15.4%, United States 6.9% Malaysia 5.9% , and UAE 4.0% (2015 est.)
FDI stock	US$186.1 billion (Dec 2015)
Gross external debt	US$158.29 billion (Sep 2015)
Public debt	41.83% of GDP (July 2017)
Revenues	2.393 trillion baht (FY2016)
Expenses	2.214 trillion baht (FY2016)
Economic aid	None

Credit rating	Standard & Poor's: A- (Domestic) BBB+ (Foreign) A (T&C Assessment) Outlook: Stable Fitch: A- (Local Currency IDR) BBB+ (Foreign Currency IDR) A- (Country Ceiling) Outlook: Stable Japan Credit Rating Agency:[A (Local Currency IDR) A- (Foreign Currency IDR) A+ (Country Ceiling) Outlook: Stable
Foreign reserves	US$226.17 billion (25 AUG 2017)
Note: *All values, unless otherwise stated, are in US dollars.* Sources: 1) *"Thailand". World Economic Outlook Database. International Monetary Fund. Retrieved 27 Aug 2012.,2) "World Economic Outlook Database". International Monetary Fund (IMF). Retrieved 9 May 2013.* 3) Main data source: **CIA World Fact Book**	

In this chapter, we would like to describe the brief chronology of the Thai economic development during the last decades. This comprises story behind growth episodes during past decades in terms of the economic growth accounting basis. The third section will in point out the trend of population change as well as the implication for the labor market imbalance and an influx of foreign migrant labor to fill up the demand for unskilled labor by labor-intensive sector. The final section describes the social implication in terms of the income inequality despite success improvement in poverty eradication. This is to lay our analysis for the further chapter on future development and the needs for infrastructures.

2. The Chronology of Economic Development, Structural Change, and Welfare

Economic growth and structural change in Thailand has been impressive during 1960-1990's. Thailand has emerged as 'middle-income country' during the period. Agriculture GDP has declined substantially while manufacturing and service sector has shown impressive growth episode. Economic growth had been interrupted when she had faced with financial turmoil in 1997.

After fixing her macroeconomic imbalance with a realignment of proper exchange rate regime, privatization of state enterprise, and rationalization of banking and financial sector in 1997-2000 Thailand has recovered and trying to emerged regain a position of a middle-income country with a competitive position in the export market with sound current account position. The size of her economy after repositioning country profile has been increased with higher per capita income.

Despite the full effort, Thailand has been still locked in the chronicle ' middle-income trap' after the 'financial crises' in 1997. Capital investment in public infrastructure was delayed after the crisis and accentuated by changing policies after several political eruptions. These several setbacks in the Kingdom have crippled her to exploit her potential to sustainable growth.

Even though Thailand was able to pay back the short-term rescued fund to the IMF's and resumed economic growth, she was unable to pull out of her chronicle ' middle-income syndrome' after the 'financial crises' in 1997. The Capital investment in the public infrastructure was delayed. The gross fixed capital investment had declined 21.7, 44.0 and 4.5 percent per year in 1997, 1998 and 1999 respectively. The volatilities of investment in Thailand were observed again during 'global financial crises in 2009, heavy flooding in 2011, political uprising in 2013 and 2014. The low level of capital investment was accentuated by low growth trend of labor forces owing to declining population growth in Thailand after 2000. This implies that Thailand may not be able to achieve a sustainable growth path in the coming decades if without solving the retard in its capital investment and labor productivity.

The capital investment may need further mentioned. They comprise both the capital investment in hard and social infrastructures. The former includes physical infrastructure like transportation and communication networks, energy, as well as management and technology. The social infrastructure, on the other hand, would be indispensable to work with the former efficiently. They are an investment in human capital such as education and training, health and urban welfare provision of public goods and dwelling for the low income. The investment in social infrastructure is, therefore, a sufficient condition for economic development and welfare improvement necessitated by the physical infrastructure investment.

2.1 The Economic Growth Episode of Thailand 1965-2013

The growth episode of Thailand can be separated into three epochs. During 1960's, Thailand has emerged as a less developed economy which had primary sector as her main production base. Thailand was the main exporter of rice, mineral and timber products to earn her foreign exchanges. During 1970's, Thai economy had entered business cycle fluctuation as result of oil shock as well as political upheavals. Growth trend had been affected by second oil shock in 1980 until 1985. After the Plaza Accord in 1985, Thai economy had received an influx of foreign direct investment, especially from Japan after currency realignment. As a result, economic growth trend has shifted up again since 1987-1995.

The rapid economic growth and the saving-investment gap had put pressure on

Thailand to seek for foreign saving. The excess demand for the fund has reflected in the wide gap of saving deposit-loan rates. Under a fixed exchange rate regime, Thailand could stabilize the fluctuation in export earnings in local currency. The contradiction has forced Thailand to open up the flow-of-fund account namely the "Bangkok International Banking Facility or BIBF". This is to compile with IMF's condition to relax the domestic money market and allow the inflow-outflow of foreign fund.

The interest rates arbitrage as well as the influx of cheap foreign fund through domestic banks have facilitated local investment and promoting growth. The 'Impossibility of Trinity' dilemma as a result of the fixed exchange rate regime had overblown of unmanageable money supply and inflationary pressure of asset prices. The weak banking compliance, land and real estate speculation and cheap source of fund flow had escalated the asset prices and overblown commercial banks' balance sheet. Thailand had been attacked by currency speculators several times. The currency attackers had speculated the huge loss of Thai foreign currency reserves and that Thailand would be forced de facto to devalue its foreign exchange rate. Finally, Thailand had to devalue exchange rate substantially to sustain outflow of foreign funds. At the peak, 'Baht-USD' exchange rate was an overshoot of 50 baht from the previous fixed rate of 25.4 baht. Thailand was viciously trapped in the turmoil of financial crisis in 1997. The devaluation had overwhelmingly ruined the balance sheet of commercial banks, companies who had borrowed through BIBF. Thailand had requested for the organized rescue fund 17.4 billion USD from IMF. The aftermath of the bankruptcy of companies, changing shareholders of commercial banks to foreign capital had been recorded already elsewhere.

Economic growth rates shrank to -1.4 and -10.5 percent in 1997 and 1998 respectively. The growth rates of capital investment had declined from its past trend significantly. They had shrunk-20.5, -44.3 and -3.2 percent per year in 1997, 1998 and 1999 respectively. Even though growth had resumed after 1999, the growth episode in the aftermath of Asian financial crises had changed its trend downward since 2000. More importantly, the capital investment and capital stock accumulation has been low and cannot help push up Thailand growth potential as compared with the pre-crisis ear. This has become the bottleneck to Thai economic development and welfare improvement in the current decade and beyond if it is not optimally solved.

Figure2.1: Growth Episode of Thailand 1965-2013 As Shown by

Figure 2.2: Capital Accumulation of Thailand As shown by Growth of

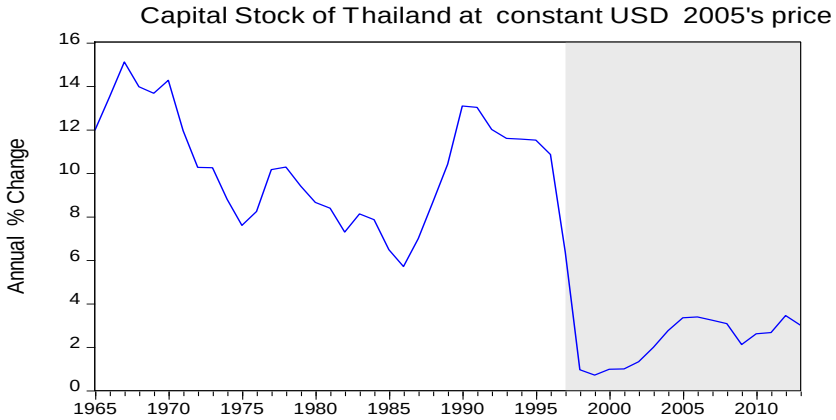
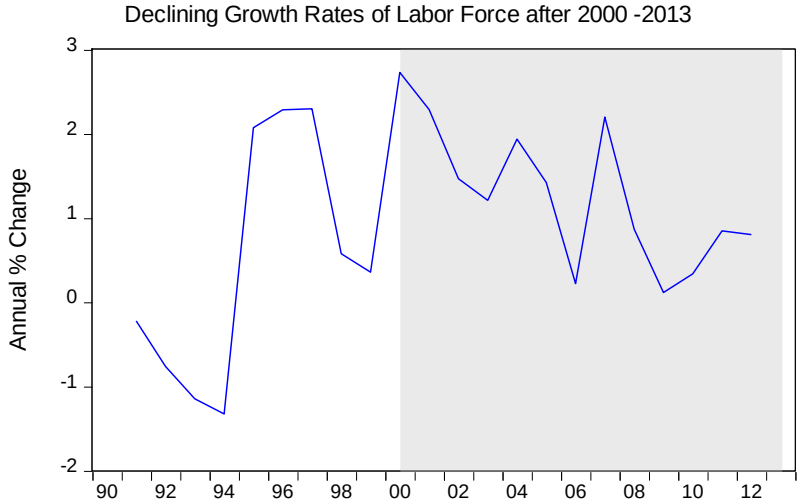


Figure 2.3: Declining Growth of Employment in Thailand 1990-2013 Shown by



Economic growth of Thailand had been vibrant during the past decades in each economic and social development plan since 1972. The average growth of GDP was 7.57 percent per year during 1972-1996. The GDP growth was contributed from the growth of

labor, land, and capital of 0.78, 0.12, and 5.38 percent respectively. Contribution by 'unexplained residual' or 'Total Factor Productivity, TFP' was on average 1.308 percent per year during the 5 planning periods. It was clear that capital accumulation in Thailand was gradually overemphasized in the development planning. The inefficiency of capital deepening in Thailand was as high as 6.7 in terms of 'Incremental Capital-Output Ratio, ICOR' during 1992-1996, pre-Asian financial crisis era. This may explain while financial crisis had erupted in Thailand in 1997.

Table 2.2: Growth Accounting During the Planning Periods of NESDB

Year	Avg. GDP growth	Labor	Land	Capital	TFP	K/Y* Capital-Output ratio	Y/K* Output-capital ratio	ICOR*
1972-76	6.53	0.68	0.31	3.06	2.49	3.34	0.30	1.4
1977-81	7.23	1.52	0.26	4.60	0.85	3.05	0.33	3.2
1982-86	5.37	0.54	0.05	4.36	0.43	3.13	0.32	2.9
1987-91	10.94	0.87	0.00	7.26	2.82	2.96	0.34	4.2
1992-96	7.95	0.33	0.02	7.65	-0.05	3.51	0.29	6.7

Note: * Last year of Plan 2) Labor, Land, Capital, and TFP are sources (contribution to) of Avg. GDP growth
3) ICOR=Incremental capital-output ratio 4) TFP is total factor productivity
Source: NESDB, Capital Stock of Thailand several issues

Table 2.3: GDP, Capital Stock, and Labor Employment Growth Rates 1990-2013

	1990	**1991**	**1992**	**1993**	**1994**
GDP at constant 2005's price (million USD)	8,923.9	96,534.3	104,337	112,946	123,097
(% change.)	11.2	8.6	8.1	8.3	9.0
Capital stock (million USD at constant 2005's price)	268,431	303,366	339,763	379,124	422,921
(% change)	13.1	13.0	12.0	11.6	11.6
LABOR employed (million persons)	32.2	32.1	31.9	31.5	31.1
(% change.)	--	-0.22	-0.76	-1.15	-1.33
Gross fixed capital formation (million USD at 2005's price)	42,914.5	48,356.3	51,565.6	56,348.8	62,753.2

(% change.)	29.6	12.7	6.6	9.3	11.4
	1995	**1996**	**1997**	**1998**	**1999**
GDP at 2005's price (million USD)	134,468	142,404	140,451	125,689	131,280
(% change.)	9.2	5.9	-1.4	-10.5	4.4
Capital stock (million USD at constant 2005's price)	471,585	522,724	555,958	561,216	565,144
(% change.)	11.5	10.8	6.4	0.9	0.7
LABOR employed (million persons)	31.7	32.4	33.2	33.4	33.5
(% change.)	2.07	2.28	2.29	0.58	0.35
Gross fixed capital formation (million USD at 2005's price)	69,809.7	74,718.4	59,370.8	33,055.5	31,988.8
(% change.)	11.2	7.0	-20.5	-44.3	-3.2
	2000	**2001**	**2002**	**2003**	**2004**
GDP at constant 2005's price (million USD)	137,515	140,496	147,967	158,532	168,589
(% change.)	4.8	2.2	5.3	7.1	6.3
Capital stock (million USD at 2005's price)	570,628	576,220	583,767	595,320	611,659
(% change.)	1.0	1.0	1.3	2.0	2.7
LABOR employed (million persons)	34.4	35.2	35.7	36.1	36.8
(%change.)	2.73	2.29	1.47	1.21	1.94
Gross fixed capital formation (million USD at 2005's price)	33,741.2	34,123.7	36,357.9	40,741.8	46,104.3
(%change.)	5.5	1.1	6.5	12.1	13.2
	2005	**2006**	**2007**	**2008**	**2009**
GDP at constant 2005's price (million USD)	176,352	185,333	194,682	199,519	194,870
(% chg.)	4.6	5.1	5.0	2.5	-2.3
Capital stock (million USD at 2005's price)	632,041	653,373	674,442	695,089	709,680
(% change.)	3.3	3.4	3.2	3.1	2.1

LABOR employed (million persons)	37.4	37.5	38.3	38.6	38.7
(%change.)	1.42	0.22	2.20	0.86	0.11
Gross fixed capital formation (million USD at 2005's price)	50,965.1	52,933.7	53,738.2	54,368.8	49,345.1
(%change.)	10.5	3.9	1.5	1.2	-9.2
	2010	**2011**	**2012**	**2013**	
GDP at constant 2005's price (million USD)	210,091	210,253	226,373	230,371	
(%change.)	7.8	0.1	7.7	1.8	
Capital stock (million USD at 2005's price)	728,155	747,460	773,153	796,320	
(% change.)	2.6	2.7	3.4	3.0	
LABOR employed (million persons)	38.8	39.1	39.4	--	
(% change.)	0.34	0.85	0.80	--	
Gross fixed capital formation (million USD at 2005's price)	53,959.0	55,713.7	63,066.0	61,824.5	
(% change.)	9.4	3.3	13.2	-2.0	

Source: Data are from National Accounts, NESDB, Labor Force Survey, NSO several issues

Table 2.4: Macro-Economic Indicators on the Expenditure Side

Year	Private Consumption' expenditure (% growth)	Private Consumption' expenditure % of GDPR	Investment (% growth)	As % of GDPR	Export (% growth)	Trade Openness (x100% GDPR)	Gross Saving As % of Current GDP	Current A/C Balance As % Curren GDP	Inflation in % per year average from monthly base
			(3)	(4)	(5)	(6)	(7)	(8)	
1995	NA	54.5	NA	49.3	NA	0.91	35.05	-8.02	5.8
1996	5.03%	54.2	6.9	49.9	-4.48%	0.83	34.69	-8.03	5.8
1997	-1.41%	54.9	-21.7	40.1	9.05%	0.85	32.20	-2.01	5.6
1998	-10.20%	53.4	-44.0	24.3	10.79%	0.87	32.64	12.53	8.0
1999	4.07%	53.1	-4.49	22.2	8.64%	0.92	30.02	9.81	0.3

2000	7.04%	54.4	3.09	21.9	15.83%	1.06	30.05	7.37	1.7
2001	5.90%	55.7	1.83	21.6	-0.02%	1.03	27.96	4.24	1.6
2002	6.22%	55.8	6.19	21.6	5.89%	1.03	26.58	3.47	0.7
2003	7.35%	55.8	12.64	22.7	9.13%	1.05	27.12	3.13	1.8
2004	7.43%	56.4	15.86	24.7	14.63%	1.16	27.79	1.60	2.8
2005	4.20%	56.5	14.28	27.1	7.76%	1.25	26.38	-4.04	4.5
2006	2.80%	55.3	2.61	26.5	10.79%	1.27	28.06	1.04	4.7
2007	1.19%	53.1	1.75	25.6	8.89%	1.29	31.42	5.93	2.2
2008	2.83%	53.6	2.34	25.8	6.26%	1.37	28.55	0.32	5.5
2009	-1.25%	53.4	-10.8	23.1	-12.54%	1.15	28.51	7.88	-0.8
2010	5.00%	52.1	11.60	24.0	14.13%	1.27	28.72	3.37	3.3
2011	1.77%	52.6	4.87	25.0	9.18%	1.39	29.33	2.54	3.8
2012	6.34%	52.2	10.20	25.7	5.08%	1.37	27.62	-0.41	3.0
2013	0.84%	51.2	-0.82	24.8	2.78%	1.36	26.29	-1.15	2.2
2014	0.62%	51.1	-2.61	23.9	0.04%	1.32	27.67	3.71	1.9

Note 1: Private Consumption Expenditure measured at a constant price; Gross Fixed Capital Formation at Constant price; GDPR is at a constant price; Export and Import growth rates are at constant prices; Trade Openness = Real Export plus Real Import over constant GDP ratio. Note 2: Thailand had invoked the Asían financial crisis in 1997. In 2009 Thailand was affected by the global financial crisis and heavy flooding in Thailand in 2011

Source: World Bank (2015), and WEO (2012)

Knowing that Thailand has been delayed in capital investment, in early 2015, the current government has approved an infrastructure development plan in special economic zones. The plan includes 45 projects, budgeted at 2.6 billion baht. Another 79 projects, worth 7.9 billion baht, are planned to carry out in 2016. Most of the projects are transportation and communication infrastructure investment. These are, for example, the new railway's system, roads system network as well as enlargement of airports. This is to lay integrated hard infrastructure to link with AEC through cross-border trade routes.

The projects are financed by complementary of government revenue, government bond and another funding method such as 'public-private' fundraising. The planned investment budget is US$83 billion over seven years. The idea is to link with 2.4 billion consumers in China and India, and the AEC (ASEAN Economic Community).

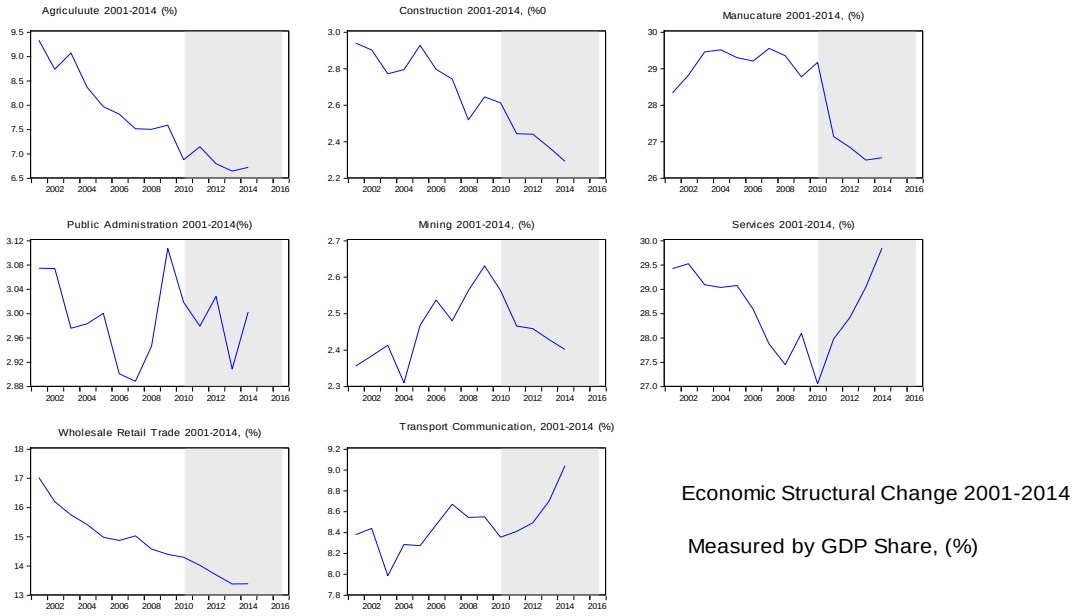
2.2 Structural Adjustment in Thailand 2001-2014

The agricultural sector has declined its contribution in terms of value added share. 'Land' contribution has declined as land frontier has been reached. Our growth accounting below has shown that land has subsequently declined in its contribution in Growth Accounting[1]. This is in accordance with the shifting from agriculture sector to non-agriculture sector in Thailand. Manufacturing share has surpassed the share of agriculture in 1980's. Thailand had a success story of manufacturing growth during 1980-2000. Later, after 2000-2013 the GDP's share of Transport and communication and Service sector have been rising

Before the Asian crisis 1965-1997, Thailand has tried to raise productivity by gradual mechanization in the agriculture sector to counter rising wage rate. Likewise, the manufacturing sector has tried to introduce modern technology and machines during last decades to drive industries successively from labor-intensive to a further level. However, after the financial crises and business cyclical downswings, agriculture, manufacturing, and services sector could not turn away from cheap unskilled labor to technology-intensive that works with skilled labor. In the public sector, capital investment in public infrastructure had been prolonged.

In agriculture, land productivity has declined as an encroachment on new land has reached frontier. Farmers are aging, while the younger generation is reluctant to pursue the farming career. The price of agriculture product has been suppressed and volatility of world demand.

Figure 2.4: GDP Share by Sector 2001-2014



[1] *Growth accounting of GDP (%) = [Growth of Capital (K)* value share of r.K / Y] + [growth of Labor (L)* value share of w.L/Y] + [Growth of Land services (LD) *value share of land value rent*LD/Y] + TFP. Where w = average wage ; r = average rate of return to capital input; rent = land rent ; d(XXX)/dt = derivative (XXX) with time respectively.*

It should be noted that for Thailand, the automotive production and sales employed approximately 417,000 workers in 2015. It is approximately 6.5 percent of total employment across all manufacturing industries. In 2014, Thailand exported US$25.8 billion in automotive goods. As many as 73 percents of automotive sector workers in Thailand may face a risk of job loss due to technological change in the industry towards automation and change consumer's preference[2].

Moreover, China has replaced the United States as Thailand's largest export market while the latter still holds its position as its second-largest supplier after Japan. Thailand's traditional major markets like North America, Japan, and Europe, as well as other Thailand's regional trading partners, have helped Thai export growth in recent economic recovery

Table 2.5: Sources of Growth in Thailand as Shown by Growth Accounting

Sources of Growth In Thailand 2010-2015						
	1999	**2000**	**2001**	**2002**	**2003**	**2004**
GDP growth [dY/dt]/Y	4.4	4.8	2.2	5.32	7.14	6.34
of which contributed to Growth of factor inputs (weighted by value-added share)						
- 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 (r.k) [dK/dt]/K	0.9	1.2	1.0	0.91	1.29	1.81
- Growth of Labor head (w.L)[dL/dt] /L	0.46	0.2	0.58	1.01	0.79	0.87
-Growth of land service (rent.LD) [dLD/dt]/LD	Na.	Na.	Na.	0.03	-0.02	0.01

[2] *Chang, Jae-Hee; Rynhart, Gary; Huynh, Phu (July 2016). ASEAN in transformation: How technology is changing jobs and enterprises (PDF) (Bureau for Employers' Activities (ACT/EMP) working paper; No. 10 ed.). Geneva: International Labour Office, Bureau for Employers' Activities (ACT/EMP). ISBN 978-92-2-131142-3. Retrieved 1 April 2017*

Sources of Growth In Thailand 2010-2015 (continued)						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
GDP growth [dY/dt]/Y	4.53	5.11	4.93	2.48	-2.33	7.8
of which contributed by Growth of factor inputs (weighted by value added share)						
- Total Factor Productivity, TFP (Unexplained Residual of growth determinants)	2.03	2.36	2.16	-0.28	-4.28	4.94
- Growth of Capital service (r.k) [dK/dt]/K	1.96	2.31	2.28	1.99	1.40	2.53
- Growth of Labor head (w.L)[dL/dt] /L	0.50	0.41	0.51	0.69	0.56	0.28
-Growth of land service (rent.LD) [dLD /dt]/LD	0.40	0.04	4.93	2.48	-2.33	0.04

Source of Growth In Thailand 2010-2015(continued)					
	2011	**2012**	**2013**	**2014**	**2015**
GDP growth [dY/dt]/Y	0.1	6.5	2.90	0.71	2.8
of which contributed by Growth of factor inputs (weighted by value added share)					
- Total Factor Productivity, TFP (Unexplained Residual of growth determinants)	-1.45	3.69	0.73	0.2	1.73
- Growth of Capital (rk).[dK/dt]/K	1.28	2.36	2.2	1.27	1.13
- Growth of Labor (wL).[dL/dt] /L	0.35	0.76	-0.03	-0.76	-0.06
-Growth of land service (rent.LD) [dLD /dt]/LD	-0.07	0.0	0.0	na	a

Source: Source: NESDB, Capital Stock of Thailand several issues

The average growth rate of GDP during 1999-2004 was 5.03 percent per year. It was contributed by a growth of capital stock, labor, and a land factor of 1.19, 0.65, and 0.01 percent respectively. During this period, TFP contribution to growth was as high as 3.12 percent per year. Growth performance was on average 3.51 percent per year during 2005-2009. The TFP contribution was 0.89 percent lower than the contribution from the growth of the capital stock of 1.96, from labor 0.59 and from land 0.92 percent per year during the same period. During 2010-2015, growth rates have recovered to 3.87 percent with the contribution from TFP of 1.80 percent. The contribution from capital stock, labor and land factor inputs is 1.64, 0.42 and 0.46 percent per year respectively.

Growth accounting in 2013 may not be a further indication of sector different of growth prospect in Thailand. It seems that agriculture has lost its long-term role as

leading growth contribution in Thailand. The service sector has emerged as a leading sector while it is still not clear of how the manufacturing sector would be heading for in the coming decades. In 2013, which is not a normal year owing to political upheaval in Thailand, the manufacturing sector has been slow down significantly. It has negative TFP like that of the agriculture sector. Overall capital productivity in Thai economy in 2013 was not impressive. The reason has been mentioned earlier. Public and private capital investment in Thailand has been delayed and makes Thailand dipped deep into business cycle dowsing and cannot get out of the 'middle-income syndrome'.

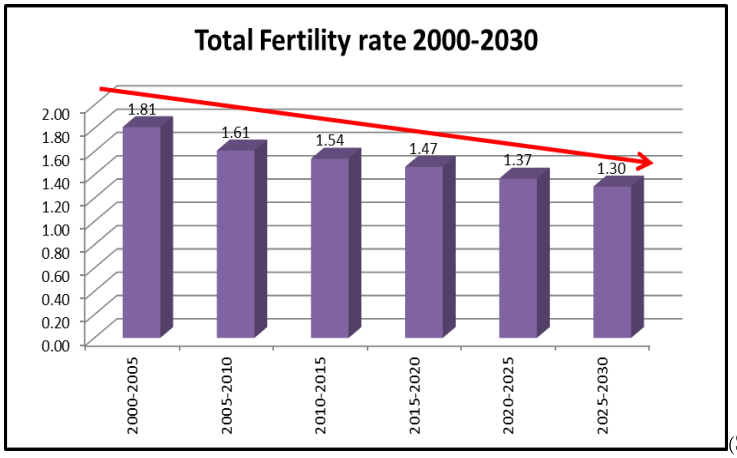
3. Population As Determinants of Sustainable Growth and Welfare 2015-2040

3.1 Population Change towards Aging Society in Thailand

It is projected the Total Fertility in Thailand would be declining 2000-2030. The peak of a population would be in 2025 and declined thereafter until 2040. The gap between genders still exists over time. A number of the male is lower than female projection. It is clear that Thailand enters to the epoch of population aging. The working population is declining as well.

It is clear that declining fertility in Thailand will have deep repercussion on Thai economy in the long-run. Labor force and labor supply would be a shortage in terms of quantity. The more severe constraint for Thailand would be insufficient qualified labor supply for modern industries. Labor shortage problem cannot be solved by relying on foreign migrants like now. In the coming decades, modern industries like the ICT, modern energy engineering, the Artificial Intelligence, and Robot as well as biotechnology etc., would be likely to change the industrialization landscape in the world. Population and labor quality of Thailand has to comply and prepare for such change.

Figure 2.5: Declining Total Fertility rate 2000-2030



(Source: NSO, NESDB)

Aging and urbanization in Thailand would be materialized sooner or later. We cannot avoid preparing the capital investment in hard, technical as well as soft infrastructure for the future. The constraint as result of the aging population may be turned into positive factor as far as biotechnology and medical health investment can be properly planned in Thailand. The non-communicable disease (NCD) where the disease is not caused by infectious agents but rather by a social behavior of human would be dominant threats to our society like other developed and developing countries in the urbanization process. We, therefore, need to prepare the public and private investment in the preventive medical health. The rising proportion of the female population would be also a benefit than the cost. Clearly, household type would be much oriented to 'single head' as result of high divorce rates, 'one-person' as single women are more independent to live and work without marriage as before. Thus, the demand for dwelling in the urban area is indispensable. Especially, low-income housing would be topic among policy planners in Thailand in the coming decades.

Figure 2.6: Population by Age Cohort: Male and Female 2010-2040

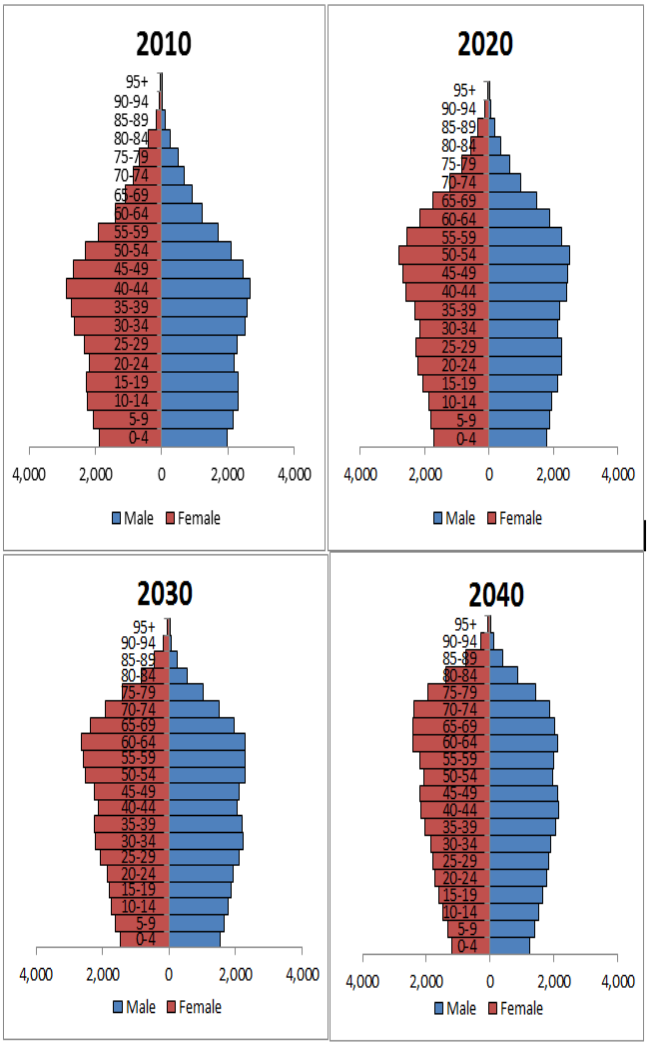
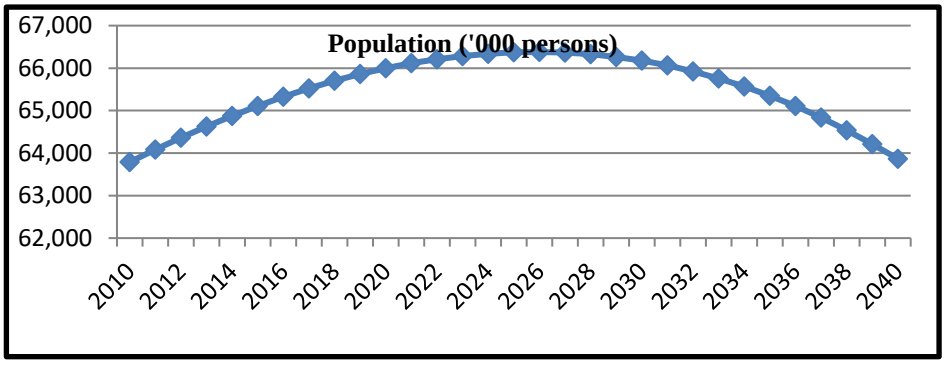
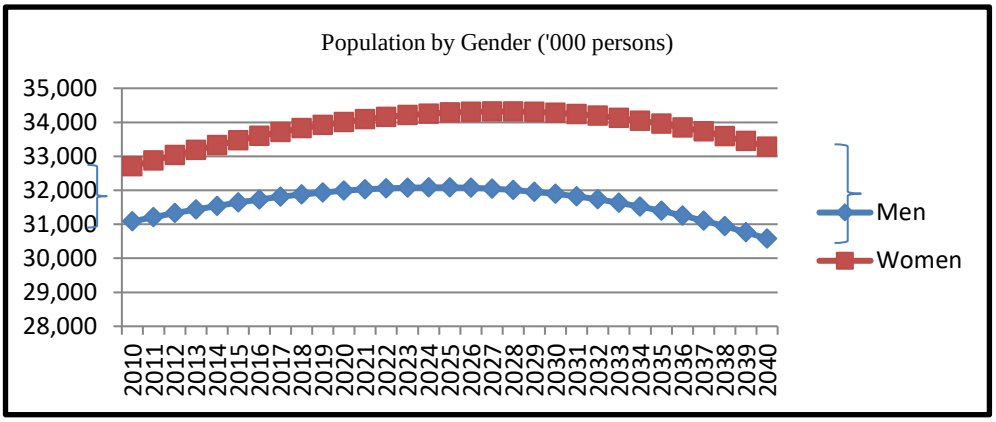


Figure 2.7: Trend of Population in long-run 2010-2040



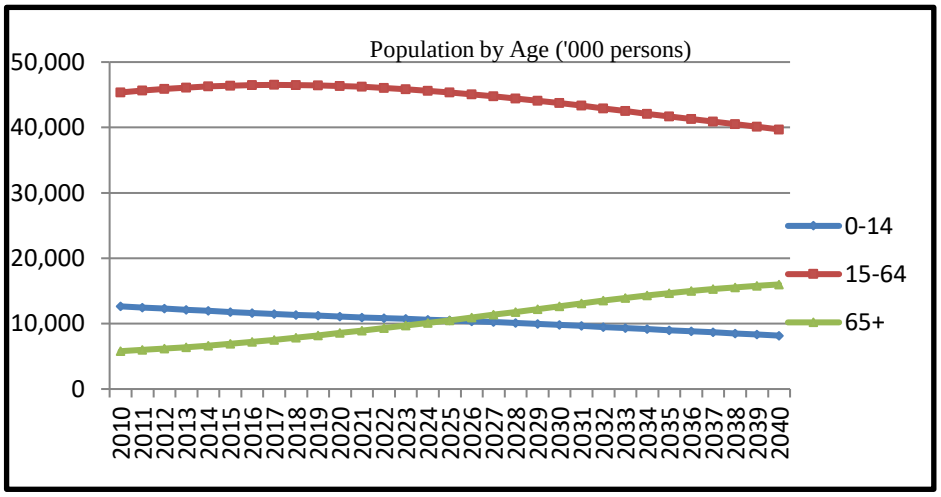
(Source: NSO, NESDB)

Figure 2.8: Widening Gender Gap



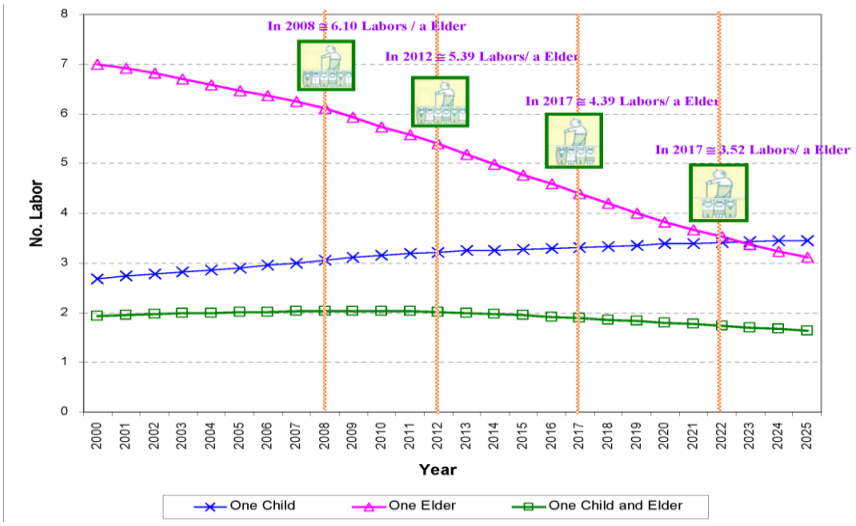
(Source: NSO, NESDB)

Figure 2.9: Trend of Population Aging 2010-2040



(Source: NSO, NESDB)

Figure 2.10: Increasing burden of Working population 2000-2025



3.2 Structural Change in Thai labor market 2000-2015

Not only was the structural change in production sector observed during the phase of new normal (2000-2015), there was a structural change in the labor market as well. Skills by the level of education and occupation are defined as follows:

Table 2.7: Skilled – Unskilled Labor Definition this study

Occupation	Human capital Investment intensity	Skill Classification
1. Managers	Occupation dominant.	Skilled
2. Professionals Technicians and associate professional	Occupation dominant	Skilled
3.1 Clerical support workers	Moderate	Skilled
3.2 Clerical support workers	Low intensity	unskilled
4.1 Service and sales workers	Moderate	Skilled
4.2 Service and sales workers	Low – intensity	unskilled
5.1 Skilled agricultural, forestry and fishery workers	Moderate	Skilled
5.2 Skilled agricultural, forestry and fishery workers	Low – intensity	unskilled
6.1 Craft and related trades workers	Moderate	Skilled
6.2 Craft and related trades workers	Low – intensity	unskilled
7.1 Plant and machine operators and assemblers	Moderate	Skilled
7.2 Plant and machine operators and assemblers	Low – intensity	unskilled
1.1 Elementary occupations Workers	Moderate	Skilled
1.2 Elementary occupations	Low - intensity	unskilled

Note 1) Skilled Matching Criterion by Occupation-Human capital Investment 2) Low human capital intensity is inclusive of Primary education and lower; secondary and post-secondary education both general and vocational stream 3) High human capital intensity is inclusive of tertiary education up to doctoral degree respectively.

There is a clear increasing trend of skilled labor employment in most of the

sector. Most of them are 'wage earner' type of skilled labor. The monthly wage gap between skilled and unskilled labor is a key factor in determining employment by labor skill formation. The wage gap between skill-unskilled labors who is Thai nationals has induced employment substitution between skill and unskilled labor. Employers who would need skilled labor to suit skill intensive technology investment could not find the proper supply from the labor market. While on the other hand, an employer who sticks to labor-intensive technology could neither find unskilled labor in the market.

The Asian financial crisis since 1997 and maybe global financial crisis, as well as an unstable political situation in Thailand, have affected public investment in both physical as well social infrastructures. The domestic private sector has behaved accordingly in delaying their capital investment in firms' types of machinery and equipment. The only private capital investment was from foreign firms at large. As a result, the private sector has been pressured to employed foreign migrants to optimize their wage cost solution.

The influx of these foreign migrants has suppressed the average wage in Thai labor market as well. The prolonged capital investment by private and public sector has suppressed overall productivity of capital and labor, simultaneously resulting in declining TFR too.

Cheap wage bill may help firms to survive but it has deteriorated the demand for education and training investment of households. Households may be able to borrow to finance the investment to higher education in vocational and graduate level but they may be not certain of a long-run return on education investment since wage rates have been suppressed for so long. This may lower intake of young children into the school system. The situation of shortage of labor in Thailand thus did not lead to higher wage and skills' formation as mostly understood in the textbook. Rather, population aging, shortage of unskilled labor, delay in human capital investment has resulted in severe skill labor shortage where unskilled labors are solved by foreign migrants, wage suppression and deterioration in household welfare.

Structural change in Thai labor market can be seen from the declining trend of employed persons both wage and non-wage earners (self-employed) in agriculture sector vis-à-vis others. We can observe a rapidly rising trend of skill labor employment in all other sectors since 2011. In fact, the rising trend of skill wage earners has been very clear in these sectors. This implies that Thai industries and services have changed to employ more skilled labor. Clearly, we observe the rising trend of skill wage during the latter half of 2000. This does not mean that unskilled wage would be stagnant but rather we can observe the rising trend of unskilled wage as well.

For the agriculture sector, it is interesting to see the shifting downward trend of

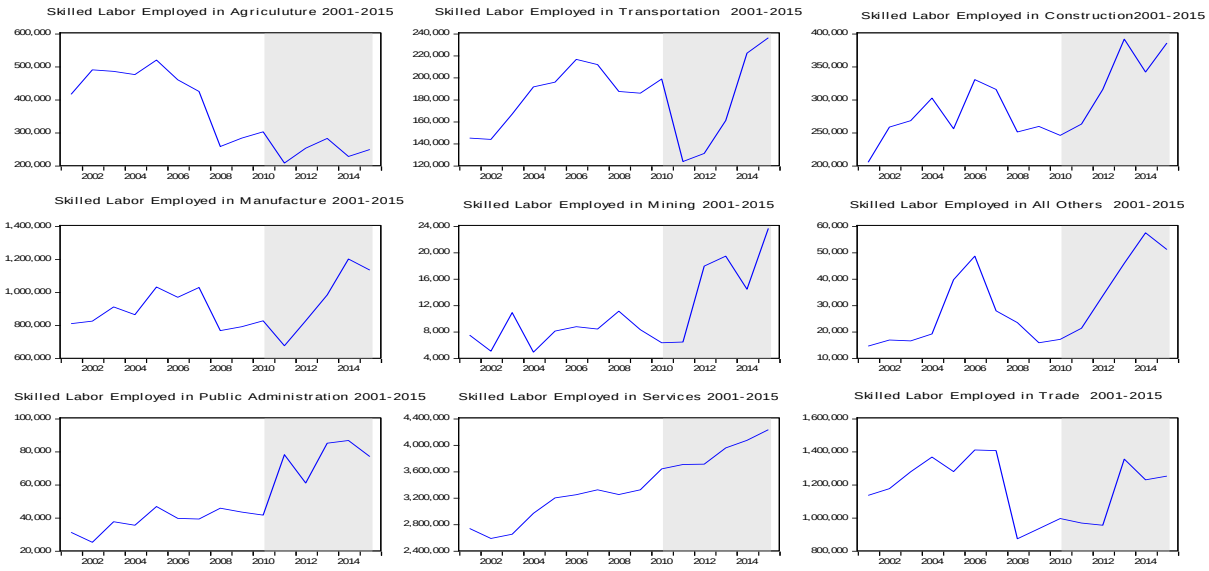
skill wage after 2011, while there has been increasing trend of unskilled wage during 2006-2013. This may be a result of rising paddy price as result of government rice policy. It has declined thereafter owing a downward movement of agriculture price and mechanization in the rural paddy field to substitute for the shortage of unskilled labor.

The Thai labor market has been shifted to normal trend after the long suppression of daily wage. This might be the result of rising of a minimum wage to 300 baht a day in 2012. There might have spilled over effect to pull unskilled labor from rural field to urban area. Assuming that average wage is average productivity of labor by sector. The unskilled wage gap still exists among sectors too. The average monthly wage gap of unskilled labor in manufacturing –agriculture sector has been widening during a phase of business cycle. The service – manufacture wage gap was not significant. However, we observe the declining trend of public administration average wage per month of the unskilled labor.

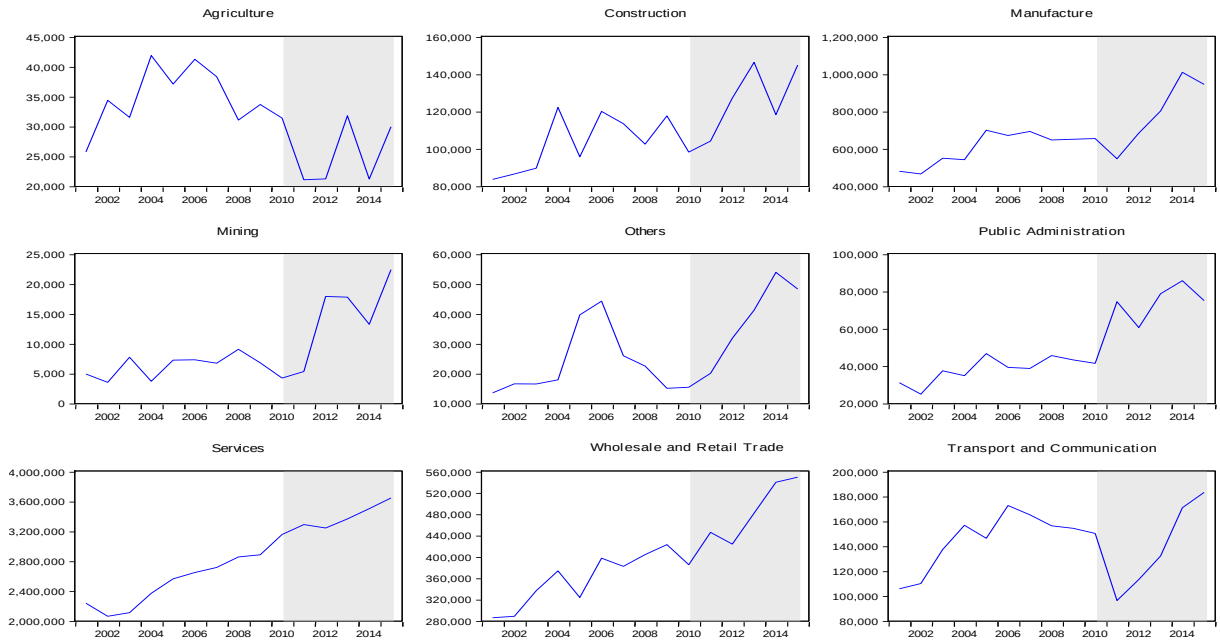
The average wage of skilled labor in every sector is much higher than those of the unskilled labor. This confirms the average higher return on investment in education and training as well heath factor of human capital theory. Skill wage of manufacturing sector 40,000-45,000 baht per month during 2013-2014 twice of that skill labor's wage in the agriculture sector and 1.5 times of skill labor's wage in the service sector. Interesting enough, we observe the skill labor's wage for the public sector was as high as 60,000 baht a month in 2013.

The wage gap of skill and unskilled labor among sectors in Thailand are consistent with human capital investment paradigm. That is to say, should Thailand would shift her economy towards capital-intensive away from labor-intensive industries by further capital investment in physical infrastructure is a necessary condition to solve the over-dependent on foreign migrant labor. The higher capital intensity would only sufficiently work with higher qualified labor with proper modern skills. Thus, Thailand would need to have proper human capital investment. In order to raise the "Human Development Index", Thailand would need further social investment in human capital investment in education and training, health and urban welfare of her populations. Moreover, as public sector investment in physical infrastructure would also need qualified personnel to provide service from civil servants of central and local government officials, we would also need to raise their productivity too.

Figure 2.11: Total Skilled Labor Employment and Skill Wage Earners by Sector 2001-2015

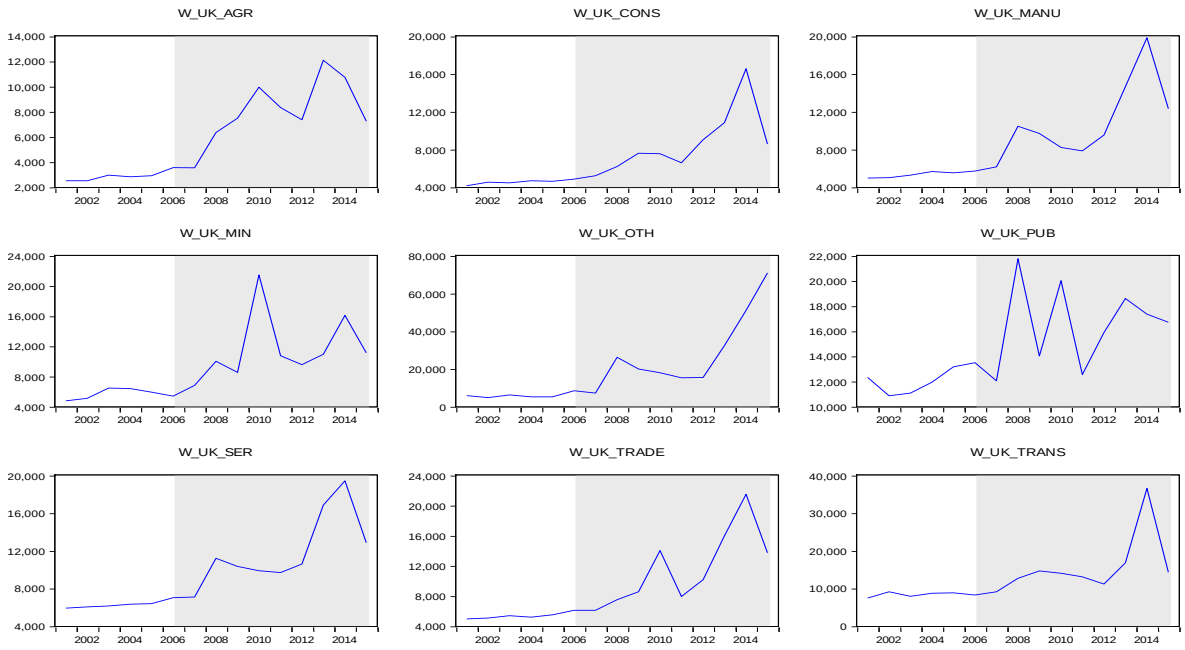


Total Employed Skilled Labor (wage and non-wage earners) 2001-2015 (number in persons)

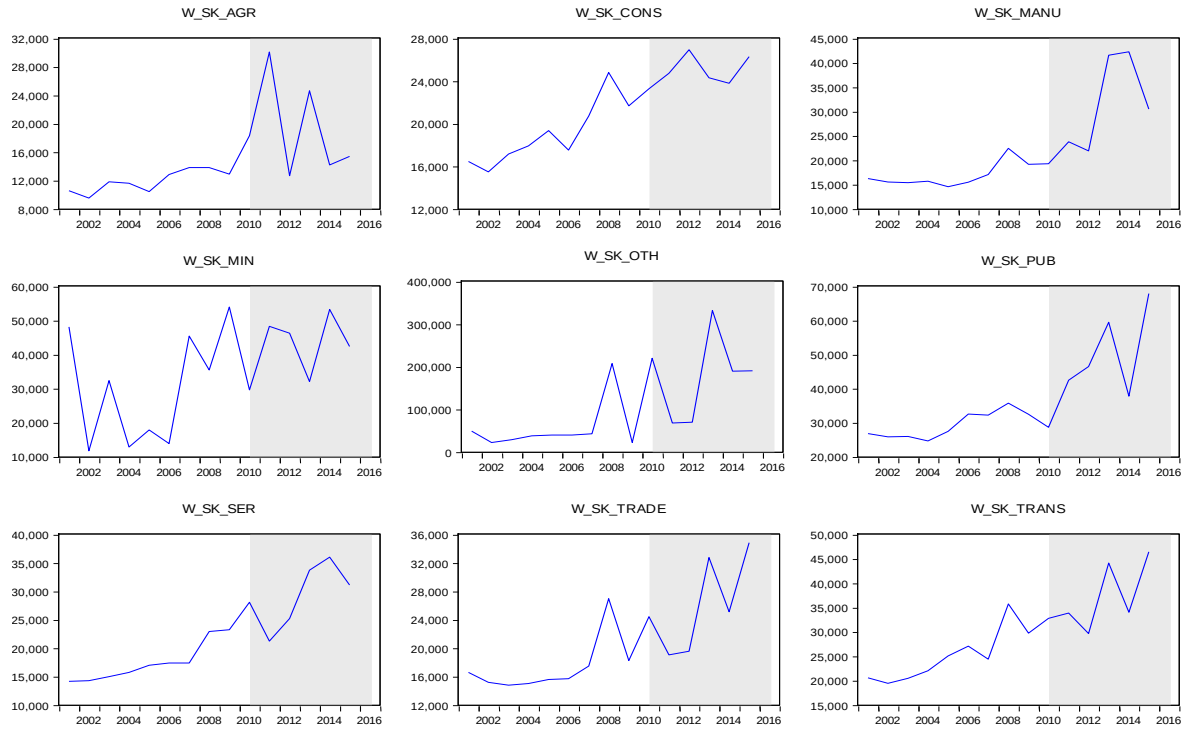


Number of Skilled Wage Earner by National Account Sector 2001 2015 (in persons)

Figure 2.12: Unskilled and Skill Wage Earners by Sector 2001-2015



Average Wage of Unskilled Labor (imputed from wage earners)
2001 2015 (in baht per month)



Average Wage of Skilled Labor 2001 2015
(in baht per month)

Note: imputed from skilled w age earnersl

3.3 Rural-Urban Internal Migration and International Migration

Depopulation in Thailand has been critical in the Rural Sector. The wage differential over the decades between rural-urban and over concentration of urbanization has caused rapid 'Internal Migration' out of rural to urban. Education investment could not supply sufficient skilled labor. Low unskilled wage has caused a shortage of Thai unskilled labor supply. Employers employ foreign migrants for labor-intensive economic activities. Bangkok has become Mega-Urban City Area while on contrary, rural becomes 'hallowing'. It is not clear whether internal migration will reach a turning point as has been observed in many other forerunners countries.

FDI and Aggregate demand expansion have induced excess demand for labor. The capitalization of Thai industry has been delayed. Most of the domestic industry relied on cheap wage unskilled labor. The excess demand gap for unskilled labor was fulfilled by guest labor from neighboring countries

According to Limskul, Puttanpong, and Borwornchaithamrong (2015), the AEC Integration would have a positive impact on Thai economic development. The labor-intensive has to reduce her dependency on foreign guest labor or move outward to neighboring countries.

Table 2.8: Internal Migration and International Migration Thailand - ASEAN

Internal Migration in Thailand 2002-2009

		2002	2004	2005	2006	2007	2008	2009
NORTHEASTERN	Urban	168,349	99,841	34,657	45,500	34,750	18,069	18,729
	Rural	554,373	294,551	118,148	137,974	90,731	107,000	83,226
NORTHERN	Urban	88,932	56,084	48,761	28,869	26,140	17,874	19,516
	Rural	236,421	121,000	50,274	66,310	43,032	55,421	47,646
SOUTHERN	Urban	83,132	48,665	44,377	25,154	21,114	25,110	29,170
	Rural	73,466	53,812	37,655	24,877	34,866	25,423	32,196
CENTRAL	Urban	336,610	215,655	206,603	132,724	120,635	149,229	213,283
	Rural	280,101	203,358	197,717	102,030	116,443	106,253	116,094
Bangkok	Urban	1,535,793	794,104	654,381	440,641	485,085	390,238	452,782

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Note: data is shown in terms of 'Net Migration'.

Source: Limskul, Puttanpong, and Bowonthumrongchai (2015)

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- Migrants stock in Thailand and ASEAN

2015								
	Tha	cam	lao	MYM	ROASEAN	ROW	vie	Migration Ou
Tha		106,850	4,729	117	197,915	660,534	1,133	**971,278**
cam	214,868		1,356	47	8,957	309,632	127	**534,987**
lao	183,421	925		53	11,554	339,594	183	**535,730**
MYM	1,261,521	185	393		41,356	187,378	645	**1,491,477**
ROASEAN	24,067	1,892	20	905		4,818,458	9,216	**4,854,559**
ROW	617,386	11,416	4,336	170,200	2,516,972		13,794	**3,334,104**
vie	12,869	129,997	9,245	303	54,035	1,996,558		**2,203,007**
Migration In	**2,314,133**	**251,264**	**20,079**	**171,626**	**2,830,789**	**8,312,153**	**25,099**	

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Source: Limskul, Puttanpong, and Bowonthumrongchai (2015)

The internal migration (net) from rural to urban was observed phenomena (not shown here) during 1980, 1990, and 2000. It was a time where population and labor force in Thailand increased. The wage gap between rural-urban had induced an outflow of internal migrations Thailand. In the past, the net migration was significant from rural and urban (non-BMR) area to the BMR per se. The period from 2000-2009 has depicted a reverse trend of internal migration outflow to BMR with declining trend.

The constraint of public-private capital investment has resulted in the delay technological change in Thai industries. The agriculture, manufacture and services activities in Thailand still relied on labor-intensive technology. Thus, employers chose to hire foreign migrants instead of Thais who would seek lesser tough jobs. In 2015, it was found that most of the foreign migrants were from neighboring countries, especially from Myanmar, Cambodia, and Laos.

The current situation of the labor market in Thailand can be summarized as follows: Total Thai 39 million persons are employed in 2010. Among those employed persons who are defined as *skilled* are altogether 3.5 million persons or 9% of total employment. The foreign guest labors in Thailand amount to 1.8 million persons or 4.8% of total employment. They comprise highly skilled worker of 100,714 persons and semi and low skilled worker of 1.79 million persons respectively. Mining and Quarrying is the sector which employs intensive foreign skilled labor (4.46% of total labor employed in this sector). In term of wage bills, Mining and Quarrying sector has paid 25.73% of total wage bills in this sector. The service sector is the biggest absorption of foreign skilled labor. They amount to 60,533 persons. The Manufacturing sector has absorbed a large number

of 'Unskilled Foreign Labors'. They have amounted to 553,892 persons or 10.78%

Table 2.9: Thai-Foreign Employed Labor by Skills (Persons)

	National Skilled Labor	Foreign Skilled Labor	National Unskilled Labor	Foreign Unskilled Labor	Total
Agriculture, forestry and fishing	31,611	261	16,485,412	354,477	16,871,761
Mining and Quarrying	5,246	1,584	27,004	1,645	35,479
Manufacturing	400,474	19,873	4,165,493	553,892	5,139,732
Public Utilities	42,158	784	94,549	1,668	139,159
Construction	165,037	6,468	1,104,525	117,225	1,393,255
Wholesale and retail trade, repair of motor vehicles motorcycles	269,200	11,107	4,187,545	202,933	4,670,785
Transportation and storage	48,688	2,105	696,021	11,852	758,666
Service	2,426,102	60,533	5,204,183	259,562	7,950,380
Unknown	65,137	1,999	2,180,919	290,425	2,538,480
Total					39,497,697

Table 2.10: Thai-Foreign Employed Labor by Skills (in percentage)

	National Skilled Labor	Foreign Skilled Labor	National Unskilled Labor	Foreign Unskilled Labor	Total
Agriculture, forestry, and fishing	0.19%	0.00%	97.71%	2.10%	100.00%
Mining and Quarrying	14.79%	4.46%	76.11%	4.64%	100.00%
Manufacturing	7.79%	0.39%	81.04%	10.78%	100.00%
Public Utilities	30.29%	0.56%	67.94%	1.20%	100.00%
Construction	11.85%	0.46%	79.28%	8.41%	100.00%
Wholesale and retail trade, repair of motor vehicles motorcycles	5.76%	0.24%	89.65%	4.34%	100.00%

	National Skilled Labor	Foreign Skilled Labor	National Unskilled Labor	Foreign Unskilled Labor	Total
Transportation and storage	6.42%	0.28%	91.74%	1.56%	100.00%
Service	30.52%	0.76%	65.46%	3.26%	100.00%
Unknown	2.57%	0.08%	85.91%	11.44%	100.00%

Source: NSO's Population Census 2010 with adjustment.

3.4 Income Distribution and Welfare

Thailand has reached the level of economic development where poverty has reduced substantially. The implication of poverty reduction means an improvement of household's welfare. The government policies in the past have contributed to the rising agricultural products' price. There are debt relief measures for farmers and low-income housing for the urbanites, universal health care program, self-help village development programs (OTOP, village fund, village investment fund…). These policies have indicated social welfare improvement for the Thais.

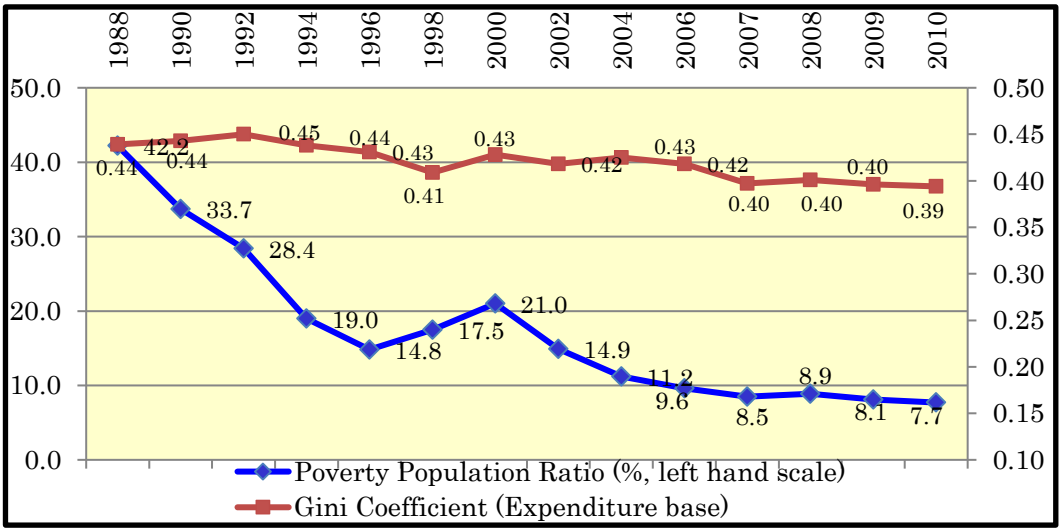
Even though poverty has declined but income inequality was still being worsened. The Gini's coefficients have not been significantly improved over the decades of economic development in Thailand.

Table 2.11: Poverty Line and Income distribution 1988-2010

year	Poverty Line in Baht per Month per person	Population below Poverty Line (%)			Gini's Coefficient (Computed from SES)	
		WHK	Urban	Rural	HH expenditure base	HH Income base
1988	633	42.2	23.7	49.7	0.439	0.487
1990	692	33.7	20.5	39.2	0.443	0.515
1992	790	28.4	12.1	35.3	0.450	0.536
1994	838	19.0	9.9	22.9	0.438	0.520
1996	953	14.8	6.8	18.2	0.431	0.513
1998	1,130	17.5	7.1	22.0	0.409	0.507
2000	1,135	21.0	8.6	26.5	0.428	0.522
2002	1,190	14.9	6.4	18.9	0.418	0.507
2004	1,242	11.2	4.6	14.2	0.425	0.493
2006	1,386	9.6	3.6	12.0	0.418	0.511

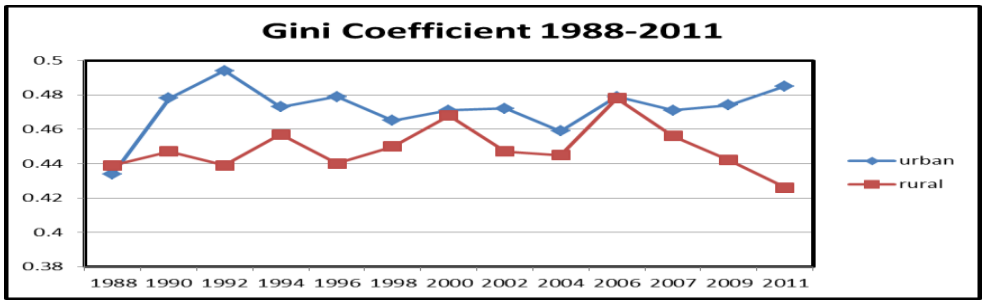
2007	1,443	8.5	3.3	10.7	0.397	0.497
2008	1,579	8.9	3.0	11.5	0.401	・・・
2009	1,586	8.1	3.0	10.4	0.396	0.485
2010	1,678	7.7	2.6	10.4	0.394	・・・
Source: Socio-economic Survey, National Statistical Office, Computed by NESDB						

Figure 2.13: Poverty Ratio and Expenditure Inequality of Households



Source: NESDB, Thai government.

Figure 2.14: Worsen inequality among Urban Households, Improved income inequality among Rural Households (Measured from income base)



Source: NESDB, the Thai government

4. Conclusions

The overall economic development in Thailand during last decades can be concluded as follows:

1) Impressive growth episode during 1960-2000 has reached its frontier as 'middle-income country'. As the new epochal trend of growth was lower than past

record and indicated that Thailand cannot overcome the 'middle-income trap' syndrome.

2) Thailand has shifted her level of capital deepening to be lower than its past trend after the financial crisis. The capital accumulation and population declining trend in terms of 'Total Fertility Rates' and the shortage of labor supply imply that Thailand could not reach her sustainable growth potential in the long-run. If Thailand could raise labor productivity and skills to compensate for labor supply shortage, she would be able to overcome this bottleneck. Unfortunately, insufficient and misled human capital investment in education has resulted in an insufficient 'skill formation' of her human resource. The lack of sufficient competency and qualifications has been constraints for long-run sustained growth.

3) The economic growth in Thailand has been successful in reducing poverty level but still could not overcome income inequality (measured by the Gini's coefficients). The urbanization process may bring about severe inequality than a rural area.

4) The findings mentioned above has justified a study on how to raise productivity and growth through further capital deepening and human capital investment. The clarification of needs of social infrastructure development is an answer to these questions.

Chapter 3
Social Infrastructure Demand: A Macro Approach

1. Introduction

In this chapter, we would like to construct an explicit model to estimate and forecast the 'Social Infrastructure Demand in Thailand' up to 2030. We would apply both the database of international institutions as well as those from Thai government's publications. The social infrastructure comprises 1) Education (schools, university and laboratory facility), 2) Healthcare (medical services facility), 3) Low-income housing, and 4) Government service (building and facility) respectively. The model would be an example of how the task can be attempted explicitly and would be a lesson learned by other Asian developing countries.

In this chapter, we report the macro approach in demand estimation applying both the panel data analysis as well as model simulation. The latter is a counterfactual model simulation with A Computable General Equilibrium Model.

2. Panel Regression Model

ADB (2009)[1] has released method of multiple regression model by Fay and Yepes[2] (2003) in the infrastructure, estimation using multiple regression model, The multiple regression model of is based on the least squares method (OLS) with the explanatory variable of infrastructure stock of each country/year as the explanatory variable, per capita income, a ratio of agriculture and manufacturing industry to GDP. Its validity is verified by an F test.

$$\mathrm{IJ}\ (\mathrm{i},\mathrm{t}) = \alpha_0 + \alpha_1\ \mathrm{IJ}(\mathrm{I},\mathrm{t}-1) + \alpha_2\ \mathrm{y}\ (\mathrm{i},\mathrm{t}) + \alpha_3\ \mathrm{A}(\mathrm{i},\mathrm{t}) + \alpha_4\ \mathrm{M}(\mathrm{i},\mathrm{t}) + \alpha_5\ \mathrm{D}(\mathrm{i}) + \alpha_6\ \mathrm{D}(\mathrm{t}) + \xi(\mathrm{i},\mathrm{t})$$

[1] ADB (2009), Seamless Asia

[2] Fay and Yepes "Investing in infrastructure: what is needed from 2000 to 2010?", World Bank Policy Research Working Paper 3102, July 2003 http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-3102

IJ (i,t) = demand for infrastructure stock of type j-th in country i-th at time t;
IJ (i, t-1) = the lagged value of the infrastructure stock,
y (i,t) =income per capita of country i-th;
A(i,t) = share of agriculture value added in GDP of country i-th;
M(i,t) = the share of manufacturing value added in GDP of country i-th,
D(i) = a country fixed effect,
D(t) = a time dummy;
ξ(i,t) = error term.

It is worth a trial to add the population density and the ratio of urbanization (proportion of the urban resident population in the total population) as an explanatory variable to the above regression model to replace the country fixed effect D(i). Furthermore, if we can collect standard price deflator of construction materials and equipment it may be feasible to estimate the monetary value of social infrastructure investment overtime to 2030.

In our study, we have elaborated the ADB model above to for further analysis with a 'panel regression'. Our model has a left-hand variable as gross fixed capital formation $I(i,t)$ the need for total investment of the i-th economy over the period of study 1990-2015 for further capital accumulation and growth. It is assumed to be inclusive both of physical and *social investment* which we are interested. The explanatory variables are real GDP, $y(i,t)$ representing the *size* of the economy i-th. The urbanization of the i-th economy, $U(i,t)$ in economic development. The level of industrialization of an economy, $M(i,t)$ shown by value-added share of manufacture in total GDP. We may hypothesize also that the trend factor, $D(t)$ represents the level of exogenous shift in technology over time. The stochastic movement around the trend of the residual component or 'disturbance' term $\xi(i,t)$.

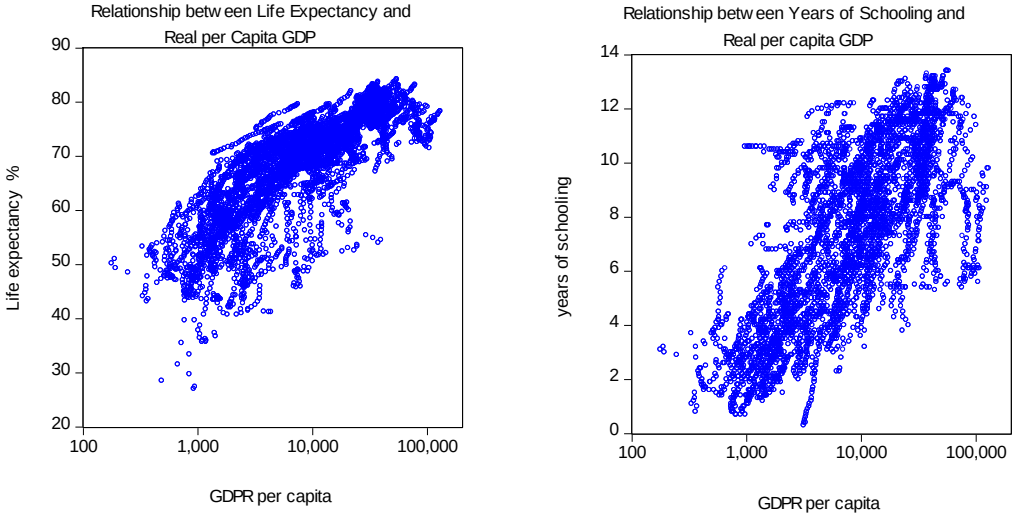
The policy variable $HDI(t)$ non-parametric indices of human capital development. It is a composite index of human capital components and wellbeing of economy i-th. Human Development Index (HDI)[3] emphasizes human ultimate capabilities for assessing the development of a country, not economic growth alone.

The Human Development Index (HDI) is a summary measure of average achievement in critical dimensions of human development: *a long and healthy life, being knowledgeable and have a decent standard of living*. The HDI is, therefore, scores of a composite index of a geometric mean of three normalized indexes.

[3] http://hdr.undp.org/en/content/human-development-index-hdi

The *health* dimension is assessed by life expectancy at birth; the *education* dimension is measured by mean of years of schooling for adults aged 25 years and more and expected years of education for children of school entering the age. The *standard of living* dimension is measured by gross national income per capita. The HDI uses the logarithm of income, to reflect the diminishing importance of income with increasing GNI.

Figure 3.1: Relationship between Human Capital and Real GDP per capita



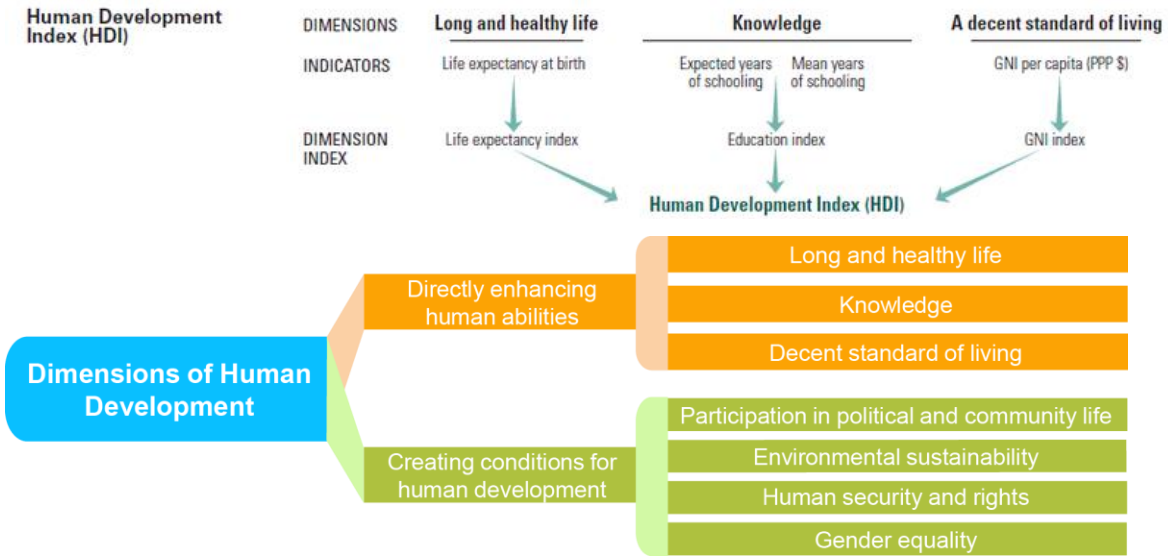
Note: scattered plot with pooling dataset of HDI report

Source: UNDP (2016)

As economic development proceeds, we may postulate that the real per capita income (GDPR) is rising to reflect the well-being of a country. Here, the graphs have shown a positive relationship between income per capita rising and the life expectancy of the population as well as the length of years of schooling for human capital development.

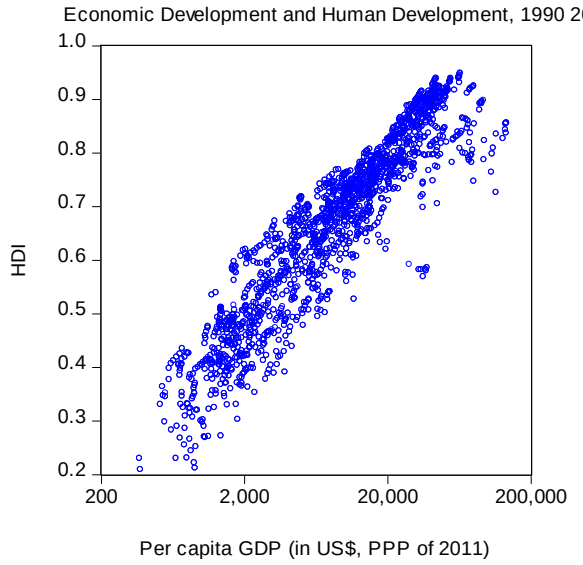
As life expectancy and years of schooling is a component of HDI, we, therefore, plot the epoch of economic development represented by rising per capita income of countries and HDI. They are positively correlated over time and across the level of development.

Figure 3.2: Schematic Presentation of the Dimension of Human Development



Source: UNDP (2016)

Figure 3.3: Relationship between HDI and Real GDP per capita

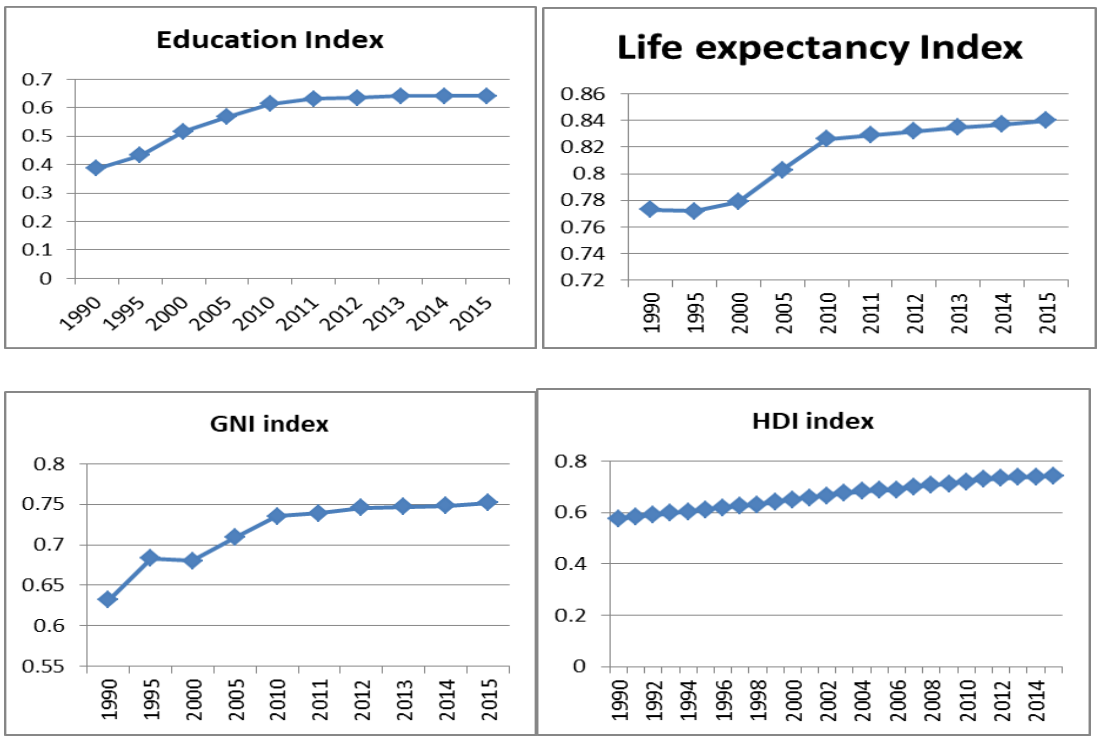


Note: scattered plot with pooling dataset of HDI report

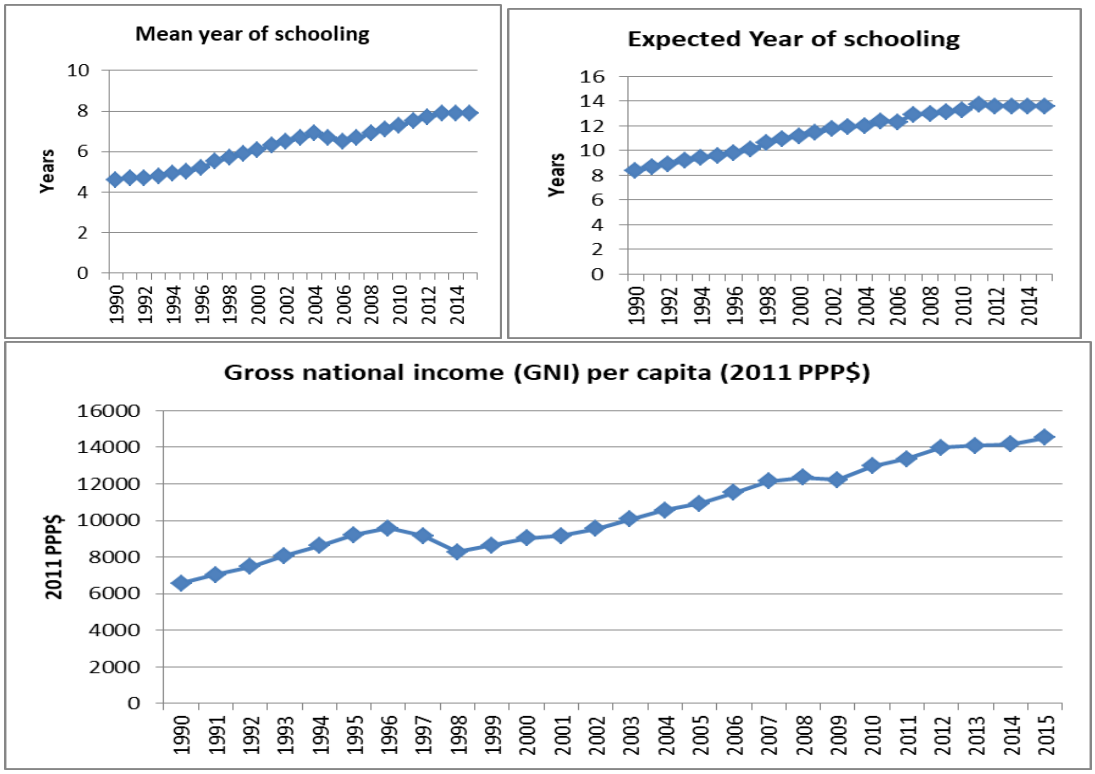
Source: UNDP (2016)

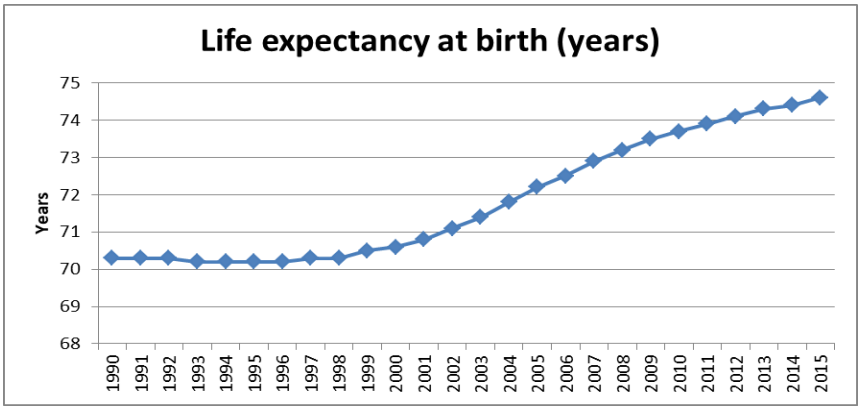
Thus, as any government's policy is to improve country's welfare, they can measure *ex-post* the score of the HDI index. The government has to put her effort, *ex-ante* in the social investment of *human capital* such as lengthen the years of schooling and training in education, improve access to health services to lengthen the life expectancy with healthy lifespan, and to improve the urban welfare.

Figure 3.4: HDI index and components of Thailand



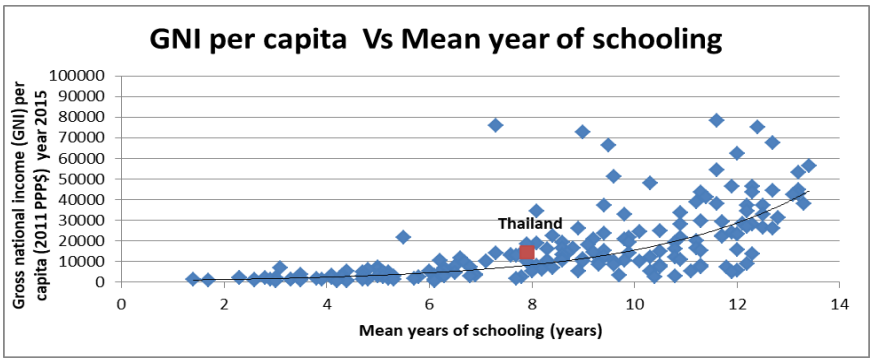
The Graphic for HDI component are as follows:





It should be noted also that the relationship between HDI component such as 'Mean years of schooling' for Thailand has positive relationship with the rising per capita income as well.

Figure 3.5: Positive Relationship between 'Mean year of schooling' and Real GDP per capita for Thailand.



Definition Education is composite of two variables, *mean year of schooling and expected years of schooling.*

Education index =

$$\left(\frac{\text{Mean years of schooling}}{15}+\frac{\text{Expected years of schooling}}{18}\right)\Big/_{2}$$

Life expectancy index = f(Life expectancy at birth)

$$=\frac{\text{Life expectancy at birth (years)}-20}{85-20}$$

GNI index is hypothesized to be a function of per capita Gross National Income ($PPP).

= f(GNI per capita ($PPP))

$$= \frac{\log(\text{GNI per capita}/100)}{\log(75{,}000/100)}$$

HDI index is a geometric means of three indices

$$\text{HDI} = \sqrt[3]{\text{Life expectancy index x Education Index x GNI index}}$$

It is calculated from baseline data of Thailand's health index is 0.84 while education index is as low as 0.64 respectively in 2015. It

2.1 Econometric Model and Estimation Result

The system of equations may be simultaneously estimated using 3SLS or GMM. Here the data are from UNDP (2016)

$$\text{GFCFR}(i,t) = \alpha_0 + \alpha_1 \text{GFCFR}(i,t-1) + \alpha_2 \text{GDPR} + \alpha_3 \text{URBAN}_{\text{Ratio}(i,t)} + \alpha_4 \left[\frac{\text{MVAR}(i,t)}{\text{GDPR}(i,t)}\right] + \alpha_5 \text{HDI}(i,t) + \alpha_6 \text{TIME}(t) + \xi(i,t) \quad (1)$$

$$\text{HDI}(i,t) = \beta_0 + \beta_1 Yrs(i,t) + \beta_2 Life(i,t) + \beta_3 GDPRcap(i,t) + \varepsilon \quad (2)$$

$$\left[\frac{\text{GFCFR}}{\text{Pop}}\right] = \alpha_0 + \alpha_1 \left[\frac{\text{GDPR}}{\text{Pop}}\right] + \alpha_2 \text{URBANratio} + \alpha_3 \left[\frac{\text{MVAR}}{\text{Pop}}\right] + \alpha_4 \text{HDI} + \alpha_6 \text{TIME} + \zeta \quad (3)$$

GFCFR(i,t) = investment expenditure of both physical infrastructure and including social investment in terms of gross fixed capital formation in country i-th at time t; (t=1990,1995,2000,2010,2011-2015)

GDPR (i,t) = real GDP of country i-th; (in PPP , US$ 2011 constant price)

URBAN(i,t) =share of an urban population of country i-th; as indices of 'urbanization'

MVAR(i,t) =the manufacturing value added of country i-th; indices of industrialization

HDI(i) =Human Development *Index* of country i-th as policy target instrument, with components in the *formula assumed to be policy*

instruments

Yrs(i) = years of schooling an index of Human capital investment
Life(i) = Life expectancy at birth, an index of Health in Human capital investment
GDPRcap = real GDP per capita to represent the level of welfare or well being
TIME(t) =a time dummy as a proxy of trend-setting
ξ, ζ, ε =error terms as the stochastic process

In the model, we assume that human capital can be represented by the '*Human Development Index*'.[4] The social infrastructure investment is *assumed* to rise with the index over time or *vice versa*, other things being constant[5]. Estimation of the above equation of gross investment (including social investment), we have found that the i-th economy has vastly different in sizes, either population, GDP per capita etc. Thus, we may encounter with econometric difficulties like heteroskedsticity and multi-collinearity etc. We, therefore, would also test any other forms of a specification as well. Drop economy *i-th* and time subscript *t* for simplicity.

Since HDI is constructed from per capita income as one component, we may drop GDPR/Pop to avoid over-identification after trials. It may be treated as an instrumental variable instead. The system of equations may be estimated separately as well. It is assumed that there is no feedback of gross investment and HDI component in our model. They are policy instruments. We assume parametric component of the HDI as follows:

Human capital investment in terms of mean year of schooling and live expectancy years has increased over the forecasting horizon to 2030. The wellbeing of Thais is expected to increase in terms of GNI to 20,000 USD, (2011 PPP) in 2030.

[4] http://hdr.undp.org/en/data
[5] The gross domestic product or income may be endogenously determined the HDI while ODA or government investment (nominal value) on social infrastructure is exogenous.

Table 3.1: Hypothetical Improvement of HD's Component Target 2016-2030

	HDI component			
	expected year schooling(years)	**mean year schooling (years)**	**GNI (2011PPP$)**	**Life expectancy (years)**
2010	13.30	7.30	12,976	73.70
2011	13.70	7.50	13,354	73.90
2012	13.60	7.70	13,993	74.10
2013	13.60	7.90	14,095	74.30
2014	13.60	7.90	14,169	74.40
2015	13.60	7.90	14,519	74.60
2016	13.66	8.03	14,851	74.78
2017	13.65	8.14	15,171	74.97
2018	13.67	8.23	15,419	75.14
2019	13.68	8.29	15,699	75.32
2020	13.83	8.50	16,048	75.73
2021	13.98	8.72	16,405	76.15
2022	14.14	8.93	16,771	76.57
2023	14.30	9.16	17,144	76.99
2024	14.46	9.39	17,525	77.41
2025	14.62	9.62	17,915	77.84
2026	14.78	9.86	18,314	78.27
2027	14.95	10.11	18,722	78.70
2028	15.11	10.36	19,139	79.13
2029	15.28	10.62	19,565	79.56
2030	15.45	10.89	20,000	80.00

The parametric calculation of HDI is by inserting the component into the formula. The assumed level of HDI (sim) is clearly above the business as usual level of HDI(bau)

Table 3.2: Hypothetical HDI, Thailand

	2010	2011	2012	2013	2014
HDI INDEX	0.72	0.73	0.73	0.74	0.74
HDI INDEX (Scenario 1)	0.72	0.73	0.73	0.74	0.74
	2015	2016	2017	2018	2019
HDI INDEX	0.74	0.74	0.75	0.75	0.75
HDI INDEX (Scenario 1)	0.74	0.74	0.75	0.75	0.75
	2020	2021	2022	2023	2024
HDI INDEX	0.76	0.76	0.76	0.77	0.77
HDI INDEX (Scenario 1)	0.76	0.77	0.77	0.78	0.79
	2025	2026	2027	2028	2029
HDI INDEX	0.77	0.77	0.78	0.78	0.78
HDI INDEX (Scenario 1)	0.80	0.80	0.81	0.82	0.83
	2030				
HDI INDEX	0.79				
HDI INDEX (Scenario 1)	0.84				

Figure 3.4: Hypothetical Improvement of HDI in Thailand

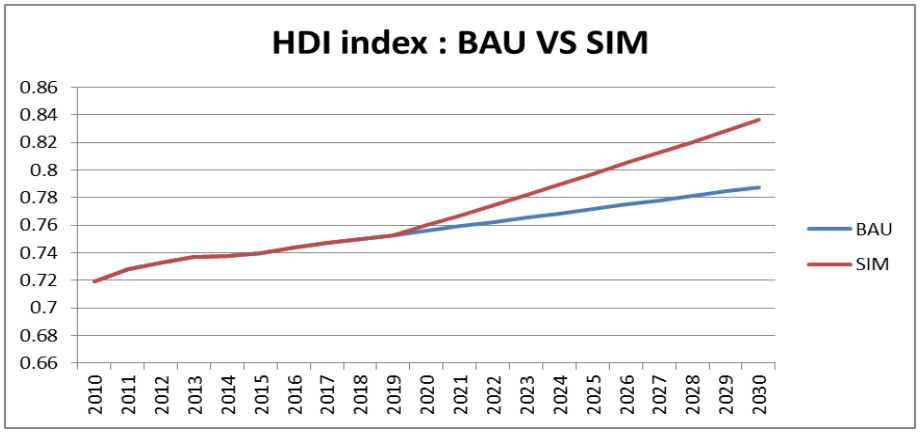


Table 3.3: Hypothetical GDP per capita Thailand as Proxy of Economic Development Level

	2010	2011	2012	2013	2014
GDP per capita (2011 PPP $billions)	13,584.0	13,654.0	14,585.0	14,915.0	14,976.0
GDP per capita (2011 PPP $billions) (scenario 1)	13,584.0	13,654.0	14,585.0	14,915.0	14,976.0
	2015	2016	2017	2018	2019
GDP per capita (2011 PPP $billions)	15,345.0	14,851.0	15,171.0	15,419.0	15,699.0
GDP per capita (2011 PPP $billions) (scenario 1)	15,345.0	14,851.0	15,171.0	15,419.0	15,699.0
	2020	2021	2022	2023	2024
GDP per capita (2011 PPP $billions)	16,024.0	16,343.0	16,660.0	16,974.0	17,304.0
GDP per capita (2011 PPP $billions) (scenario 1)	16,048.0	16,405.0	16,771.0	17,144.0	17,525.0
	2025	2026	2027	2028	2029
GDP per capita (2011 PPP $billions)	17,644.0	17,987.0	18,335.0	18,690.0	19,053.0
GDP per capita (2011 PPP $billions) (scenario 1)	17,915.0	18,314.0	18,722.0	19,139.0	19,565.0
	2030				
GDP per capita (2011 PPP $billions)	19,424.0				
GDP per capita (2011 PPP $billions) (scenario 1)	20,000.0				

After, we obtain the coefficients from multi-countries experiences; we use this information in the model forecasting. The policy maker is assumed to set a *target* level of *Human capital development* i.e., *schooling achievement years, life expectancy, and well being in terms of per capita income level overtime 2015-2030.*

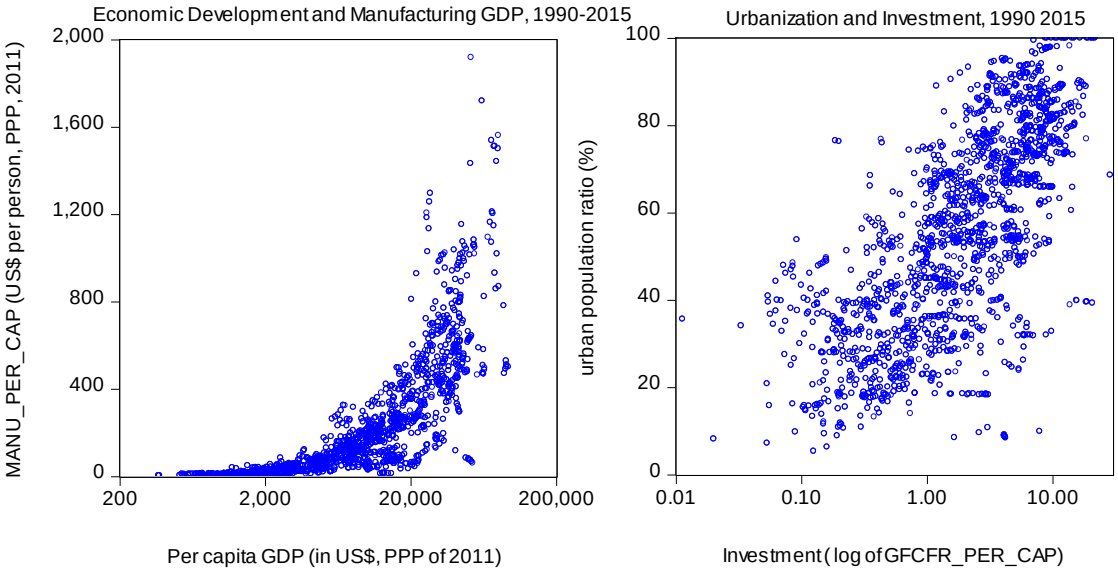
The NESDB's national account statistic on *Value of Total Construction classified by type of assets* 1993-2016 together with data series of the *private and public construction investment, the capital stock at current replacement cos*t (million baht), the a*nnual depreciation at current replacement cost* are used in our estimation. We calibrate the construction investment with the total gross fixed investment needed for scenarios of the planned level of the HDI mentioned in the equation above over planning horizon 2016-2030. Given the share of construction

types in the series, we solve for the investment in construction of buildings and related facilities by *type of social infrastructure.* The postulation of the relationship between total gross investment from model GFCFR is allocated to be and social investment by type j-th respectively.

$$GFCFR\_social(j) = \delta(j)GFCFR \qquad (4)$$

$\delta(j)$ =distribution of social infrastructure demand by type j-th, in terms of construction investment by types of assets. Here, *schooling achievement years (j=1), life expectancy (j=2), and well being in terms of per capita income(j=3) level overtime respectively.*

Figure 3.6: Pattern of Growth of Manufacture and Urbanization



Note: Applying multicounty data from UNDP (2016)

Firstly, we have estimated the determination of the **GFCF per capita as a function of HDI** (constant 2011price, $billion). We estimate the Panel Data Model equation (3) mentioned above, applying data from UNDP (2016).

Eq1: gfcfr_per_cap = F(gdpr_per_cap, hdi, year)

LOG(GFCFR_PER_CAP) = 22.9220556556 + 0.037666 + 0.98583802142 * LOG(GDPR_PER_CAP) + 2.39327973596 * LOG(HDI) - 0.0150574835249 * YEAR + [AR(1) = 0.258397813744]

(See Appendix for statistic results)

Eq2: gfcfr = F(gfcfr_per_cap, pop)

```
GFCFR = GFCFR_PER_CAP * POP
```

Since the GFCF is nominated in Local Currency Unit (constant 2011 price, billion baht), we, therefore, have to match the GFCF from UNDP database to national account of Thailand in terms of construction investment.

Eq3: gfcfr_lcu = F(gfcfr, p_lcu)

```
gfcfr_lcu = p_lcu * GFCFR
```

In addition, we estimate the GDP deflator in local currency unit to be consistent with the data of UNDP.

Eq4: p_lcu = F(gp_lcu, p_lcu)

```
p_lcu = p_lcu(-1) - 1 * gp_lcu
```

Now, we have to transform the gross fixed capital formation (GFCF from the model) into the GFCF only for construction investment by public and private sector. The series is from National Account Statistic, these are the construction of

1) Building is residential, industrial, commercial, service & transport building of which social infrastructure investment are school, hospital building
2) other buildings are commercial, industrial, service & transport, dam, road and bridge, and temple respectively
3) other non-building are port, parking lots, advertisement structure, swimming pool, sport structure

The projection of GFCF from the model is translated into the investment in construction by types of asset in current price (in billion baht), assuming the *share* of *'Social Investment'* in terms of building in schooling, health and residents or dwelling inclusive of the housing. The non-construction investment is identified from total GFCF projection after construction investment is projected. In our study, we would like to assume that part of 'public investment' of non-construction can be reallocated to

the social infrastructure investment in the mode of types of equipment and laboratory for schools and hospitals. The rest of public investment can be a 'subsidy' for a low-income housing project for the rental resident by NHA (National Housing Authority) in various forms e.g., public-private partnership, or government housing project for the low-rank civil servants, etc.

Eq5: gfcf_lcu = F(gfcfr_lcu, p_gfcf)

gfcf_lcu = p_gfcf * gfcfr_lcu
gfcf_construction = f(gfcf_lcu, con)
gfcf_non_construction = gfcf_lcu – gfcf_construction

Here the gfcf_lcu is a value of total gfcf in a current price of a local currency. The Construction classified by type of assets (in the current price, billion baht), from national account statistic, Thailand. It can be allocated into:

School building

Eq6: gfcf_school_lcu = F(a_school, gfcf_lcu)

gfcf_school_lcu = a_school * gfcf_construction

Health building

Eq7: gfcf_health_lcu = F(a_health, gfcf_construction)

gfcf_health_lcu = a_health * gfcf_construction

Residential building

Eq8: gfcf_resident_lcu = F(a_resident, gfcf_lcu)

gfcf_resident_lcu = a_resident * gfcf_construction

Other building

Eq9: gfcf_otherbuild_lcu = F(a_otherbuild, gfcf_lcu)

gfcf_otherbuild_lcu = a_otherbuild * gfcf_construction

a_health; a_school; a_resident	Share of building investment in construction by type
a_otherbuild	Share of other building 's investment in construction
gdpr_per_cap	GDP per capita (2011 PPP $billions),
gfcf_lcu	Gross fixed capital formation in construction from National account statistic, NESDB (billions baht)
gfcf_health_lcu	Healthcare's social investment (billions baht)
gfcf_otherbuild_lcu	Other building 's social investment
gfcf_resident_lcu	Residential bldg. as social investment (billions baht)
gfcf_school_lcu; gfcf_resident_lcu; gfcf_health_lcu	GFCF constructin by type as social investment by type (billions baht)
gfcfr	Gross fixed capital formation (2011 PPP $ billions), UNDP (2016) from model projection
gfcfr_lcu	Gross fixed capital formation in local currency (constant 2011,billions baht)
gfcf_lcu	Gross fixed capital formation in local currency (current billions baht)
gfcf_construction; gfcf_non_construction	Gross fixed capital formation in local currency (current billions baht) for construction and non-construction
gfcfr_per_cap	Gross fixed capital formation per capita (2011 PPP $ billions), UNDP (2016)
gp_lcu	percent Growth of GFCF price deflator
hdi	HDI index, UNDP (2016)
p_gfcf	Price converter between current and constant price
p_lcu	Price converter between local currency unit and ppp $)
pop	population
year	year

3. Projection of Social Infrastructure Need in terms of Gross Investment

We do simulate the effect of improvement in HDI index altogether with the improvement in GDP per capita.

Figure 3.7: Projection of GFCF with Hypotheical HDI 2016-2030

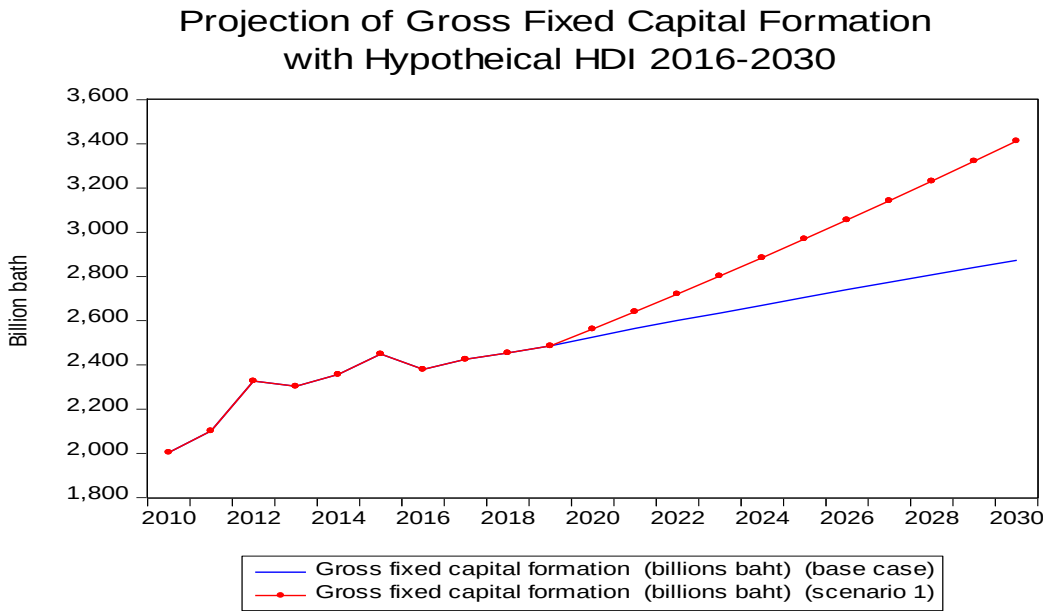


Table 3.4: Gross Fixed Capital Formation (billion baht)

Gross Fixed Capital Formation (Billion baht)	2010	2011	2012	2013	2014
Gross fixed capital formation (billions baht) (base case)	2,004.0	2,101.6	2,327.0	2,303.4	2,356.8
Gross fixed capital formation (billions baht) (scenario 1)	2,004.0	2,101.6	2,327.0	2,303.4	2,356.8
GFCF change from base case (Billion baht)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	2015	2016	2017	2018	2019
Gross fixed capital formation (billions baht) (base case)	2,449.7	2,379.9	2,425.4	2,454.6	2,485.8
Gross fixed capital formation (billions baht) (scenario 1)	2,449.7	2,379.9	2,425.4	2,454.6	2,485.8
GFCF change from base case (Billion baht)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	2020	2021	2022	2023	2024
Gross fixed capital formation (billions baht) (base case)	2,525.6	2,564.8	2,600.8	2,634.7	2,669.9
Gross fixed capital formation (billions baht) (scenario 1)	2,562.2	2,640.6	2,720.8	2,802.2	2,885.2
GFCF change from base case (Billion baht)	**36.6**	**75.8**	**119.9**	**167.5**	**215.3**
	2025	2026	2027	2028	2029
Gross fixed capital formation (billions baht) (base case)	2,705.7	2,740.6	2,774.5	2,807.8	2,840.8
Gross fixed capital formation (billions baht) (scenario 1)	2,969.7	3,055.8	3,143.2	3,232.0	3,322.2
GFCF change from base case (Billion baht)	**264.0**	**315.1**	**368.7**	**424.2**	**481.3**
	2030				
Gross fixed capital formation (billions of baht) (base case)	2,873.4				
Gross fixed capital formation (billions baht) (scenario 1)	3,413.5				
GFCF change from base case (Billion baht)	**540.1**				

Table 3.5: Gross Fixed Capital Formation in Construction and Non-Construction, measured in current prices 2010-2019 (Billion Baht)

item	Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	**Gross fixed capital formation (billions of baht) (base case)**	**2003.971**	**2101.552**	**2326.978**	**2303.441**	**2356.783**	**2449.726**	**2379.856**	**2425.434**	**2454.649**	**2485.781**
2	**Gross fixed capital formation (billions of baht) (scenario 1)**	**2003.971**	**2101.552**	**2326.978**	**2303.441**	**2356.783**	**2449.726**	**2379.856**	**2425.434**	**2454.649**	**2485.781**
2.1	Gross fixed capital formation: Construction %	44.75%	43.61%	44.54%	45.68%	44.06%	47.31%	51.45%	51.45%	51.45%	51.45%
2.2	Gross fixed capital formation: Non-construction %	55.25%	56.39%	55.46%	54.32%	55.94%	52.69%	48.55%	48.55%	48.55%	48.55%
3	**Gross fixed capital formation: Construction**										
3.1	RESIDENTIAL%	29.87%	32.21%	31.27%	31.29%	31.65%	27.14%	25.32%	25.32%	25.32%	25.32%
3.2	SCHOOL %	1.97%	1.91%	1.95%	1.87%	1.56%	3.16%[6]	2.75%	2.75%	2.75%	2.75%
3.3	HOSPITAL%	0.75%	0.41%	0.97%	1.18%	1.04%	1.29%	1.52%	1.52%	1.52%	1.52%
3.4	OTHER building%	1.85%	2.47%	3.21%	3.15%	3.49%	3.95%	2.43%	2.43%	2.43%	2.43%
3.5	Other Non-Building %	65.56%	63.00%	62.59%	62.51%	62.26%	64.46%	67.98%	67.98%	67.98%	67.98%
4	**Gross fixed capital formation : Construction (base case)**	**896.772**	**916.455**	**1036.34**	**1052.166**	**1038.466**	**1158.916**	**1224.328**	**1,247.78**	**1,262.81**	**1,278.82**

[6] It is noticed that share in 'school' category of construction as part of the gross fixed capital formation has increased from 1.56 % in 2015 to 3.16 % in 2015 and later decreased to 2.75 % in 2016 to its long-term trend. It is reported in the National Accounts Statistics, NESDB. Our model has applied a normal trend from 2016 for our analysis.

item	Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
4.1	Social Infrastructure RESIDENTIAL (base case)	267.8	295.2	324.1	329.3	328.7	314.5	310.0	316.0	319.8	323.8
4.2	Social Infrastructure SCHOOL (base case)	17.7	17.5	20.2	19.7	16.2	36.6	33.7	34.4	34.8	35.2
4.3	Social Infrastructure HOSPITAL (base case)	6.7	3.8	10.1	12.4	10.8	14.9	18.6	19.0	19.2	19.5
4.4	OTHER building (base case)	16.6	22.6	33.3	33.1	36.2	45.8	29.7	30.3	30.6	31.0
4.5	Other Non_Buildings (base case)	587.9	577.4	648.7	657.7	646.5	747.0	832.3	848.2	858.4	869.3
5	**Gross fixed capital formation : Construction (scenario1)**	**896.772**	**916.455**	**1036.34**	**1052.166**	**1038.466**	**1158.916**	**1224.328**	**1,247.78**	**1,262.81**	**1,278.82**
5.1	Social Infrastructure RESIDENTIAL (scenario 1)	267.8	295.2	324.1	329.3	328.7	314.5	310.0	316.0	319.8	323.8
5.2	Social Infrastructure SCHOOL (scenario 1)	17.7	17.5	20.2	19.7	16.2	36.6	33.7	34.4	34.8	35.2
5.3	Social Infrastructure HOSPITAL (scenario 1)	6.7	3.8	10.1	12.4	10.8	14.9	18.6	19.0	19.2	19.5
5.4	OTHER building (scenario 1)	16.6	22.6	33.3	33.1	36.2	45.8	29.7	30.3	30.6	31.0
5.5	Other Non-Building (scenario 1)										

item	Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
		587.9	577.4	648.7	657.7	646.5	747.0	832.3	848.2	858.4	869.3
6	**Gross fixed capital formation: Non-construction**										
6.1	Private %	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
6.2	Public %	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
6.2.1	Education %	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
6.2.2	Health %	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
6.2.3	Residential%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
7	**Social Infrastructure Investment Need ,**	**1,107.20**	**1,185.10**	**1,290.64**	**1,251.28**	**1,318.32**	**1,290.81**	**1,155.53**	**1,177.66**	**1,191.84**	**1,206.96**
	Non-construction (base case)										
7.1	**Public**	**221.44**	**237.02**	**258.13**	**250.26**	**263.66**	**258.16**	**231.11**	**235.53**	**238.37**	**241.39**
7.1.1	Education	88.58	94.81	103.25	100.10	105.47	103.26	92.44	94.21	95.35	96.56
7.1.2	Health	106.29	113.77	123.90	120.12	126.56	123.92	110.93	113.06	114.42	115.87
7.1.3	Residential	4.43	4.74	5.16	5.01	5.27	5.16	4.62	4.71	4.77	4.83

Source: Model simulation in this study; see system model and applying national accounts of Thailand

Table 3.6: Social Infrastructure Investment Need 2020-2030, measured in current price (Billion Baht)

Item	Description	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1	**Gross fixed capital formation (billions of baht) (base case)**	**2525.593**	**2564.822**	**2600.817**	**2634.717**	**2669.888**	**2705.744**	**2740.647**	**2774.497**	**2807.834**	**2840.823**	**2873.385**
2	**Gross fixed capital formation (billions of baht) (scenario 1)**	**2562.221**	**2640.628**	**2720.754**	**2802.241**	**2885.197**	**2969.723**	**3055.753**	**3143.219**	**3232.045**	**3322.151**	**3413.456**
2.1	Gross fixed capital formation: Construction %	51.45%	51.45%	51.45%	51.45%	51.45%	51.45%	51.45%	51.45%	51.45%	51.45%	51.45%
2.2	Gross fixed capital formation: Non-construction %	48.55%	48.55%	48.55%	48.55%	48.55%	48.55%	48.55%	48.55%	48.55%	48.55%	48.55%
3	**Gross fixed capital formation: Construction**											
3.1	RESIDENTIAL%	25.32%	25.32%	25.32%	25.32%	25.32%	25.32%	25.32%	25.32%	25.32%	25.32%	25.32%
3.2	SCHOOL %	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%
3.3	HOSPITAL%	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%
3.4	OTHER building %	2.43%	2.43%	2.43%	2.43%	2.43%	2.43%	2.43%	2.43%	2.43%	2.43%	2.43%
3.5	Other Non-Building %	67.98%	67.98%	67.98%	67.98%	67.98%	67.98%	67.98%	67.98%	67.98%	67.98%	67.98%
4	**Gross fixed capital**	**1,299.30**	**1,319.48**	**1,338.00**	**1,355.44**	**1,373.54**	**1,391.98**	**1,409.94**	**1,427.35**	**1,444.50**	**1,461.47**	**1,478.23**

Item	Description	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	formation: Construction (base case)											
4.1	Social Infrastructure RESIDENTIAL (base case)	329.0	334.1	338.8	343.2	347.8	352.5	357.0	361.4	365.8	370.1	374.3
4.2	Social Infrastructure SCHOOL (base case)	35.8	36.3	36.8	37.3	37.8	38.3	38.8	39.3	39.8	40.2	40.7
4.3	Social Infrastructure HOSPITAL (base case)	19.8	20.1	20.4	20.6	20.9	21.2	21.5	21.7	22.0	22.2	22.5
4.4	OTHER building (base case)	31.5	32.0	32.5	32.9	33.3	33.8	34.2	34.6	35.0	35.4	35.9
4.5	Other Non_Buildings (base case)	883.2	896.9	909.5	921.4	933.7	946.2	958.4	970.3	981.9	993.5	1,004.9
5	**Gross fixed capital formation : Construction (scenario1)**	**1,318.15**	**1,358.48**	**1,399.70**	**1,441.63**	**1,484.30**	**1,527.79**	**1,572.05**	**1,617.04**	**1,662.74**	**1,709.10**	**1,756.07**
5.1	Social Infrastructure RESIDENTIAL (scenario 1)	333.8	344.0	354.4	365.1	375.9	386.9	398.1	409.5	421.0	432.8	444.7
5.2	Social Infrastructure SCHOOL (scenario 1)	36.3	37.4	38.5	39.7	40.9	42.1	43.3	44.5	45.8	47.1	48.4
5.3	Social Infrastructure HOSPITAL (scenario 1)	20.1	20.7	21.3	21.9	22.6	23.3	23.9	24.6	25.3	26.0	26.7

Item	Description	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
5.4	OTHER building (scenario 1)	32.0	32.9	33.9	35.0	36.0	37.1	38.1	39.2	40.3	41.5	42.6
5.5	Other Non-Building (scenario 1)	896.0	923.5	951.5	980.0	1,009.0	1,038.5	1,068.6	1,099.2	1,130.3	1,161.8	1,193.7
6	**Change in Gross fixed capital formation: Construction**	18.84	39.00	61.70	86.18	110.77	135.81	162.11	189.69	218.24	247.62	277.84
6.1	Social Infrastructure RESIDENTIAL (Change)	4.77	9.88	15.62	21.82	28.05	34.39	41.05	48.03	55.26	62.70	70.36
6.2	Social Infrastructure SCHOOL (Change)	0.52	1.07	1.70	2.37	3.05	3.74	4.46	5.22	6.01	6.82	7.65
6.3	Social Infrastructure HOSPITAL (Change)	0.29	0.59	0.94	1.31	1.69	2.07	2.47	2.89	3.32	3.77	4.23
6.4	OTHER building (Change)	0.46	0.95	1.50	2.09	2.69	3.29	3.93	4.60	5.29	6.01	6.74
6.5	Other Non-Building (Change)	12.81	26.51	41.94	58.58	75.30	92.32	110.20	128.95	148.35	168.33	188.87
7	**Gross fixed capital formation: Non-construction**											
7.1	Private %	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
7.2	Public %	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
7.2.1	Education %	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%

Item	Description	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
7.2.2	Health %	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
7.2.3	Residential%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
8	**Social Infrastructure Investment Need ,**	**1,226.29**	**1,245.34**	**1,262.81**	**1,279.27**	**1,296.35**	**1,313.76**	**1,330.71**	**1,347.14**	**1,363.33**	**1,379.35**	**1,395.16**
	Non construction (base case)											
8.1	**Public**	**245.26**	**249.07**	**252.56**	**255.85**	**259.27**	**262.75**	**266.14**	**269.43**	**272.67**	**275.87**	**279.03**
8.1.1	Education	98.10	99.63	101.03	102.34	103.71	105.10	106.46	107.77	109.07	110.35	111.61
8.1.2	Health	117.72	119.55	121.23	122.81	124.45	126.12	127.75	129.33	130.88	132.42	133.94
8.1.3	Residential	4.91	4.98	5.05	5.12	5.19	5.26	5.32	5.39	5.45	5.52	5.58
9	**Social Infrastructure Investment Need,**	**1,244.07**	**1,282.14**	**1,321.05**	**1,360.62**	**1,400.89**	**1,441.94**	**1,483.71**	**1,526.18**	**1,569.30**	**1,613.05**	**1,657.39**
	Non-construction (scenario 1)											
9.1	**Public**	**248.81**	**256.43**	**264.21**	**272.12**	**280.18**	**288.39**	**296.74**	**305.24**	**313.86**	**322.61**	**331.48**
9.1.1	Education	99.53	102.57	105.68	108.85	112.07	115.35	118.70	122.09	125.54	129.04	132.59
9.1.2	Health	119.43	123.09	126.82	130.62	134.49	138.43	142.44	146.51	150.65	154.85	159.11
9.1.3	Residential	4.98	5.13	5.28	5.44	5.60	5.77	5.93	6.10	6.28	6.45	6.63
10	**Social Infrastructure Investment Need,**	**17.78**	**36.81**	**58.23**	**81.34**	**104.54**	**128.17**	**153.00**	**179.03**	**205.97**	**233.71**	**262.23**
	Non-construction, Additional											

Item	Description	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
10.1	**Public**	**3.56**	**7.36**	**11.65**	**16.27**	**20.91**	**25.63**	**30.60**	**35.81**	**41.19**	**46.74**	**52.45**
10.1.1	Education	1.42	2.94	4.66	6.51	8.36	10.25	12.24	14.32	16.48	18.70	20.98
10.1.2	Health	1.71	3.53	5.59	7.81	10.04	12.30	14.69	17.19	19.77	22.44	25.17
10.1.3	Residential	0.07	0.15	0.23	0.33	0.42	0.51	0.61	0.72	0.82	0.93	1.05

Source: Model simulation in this study; see system model and applying national accounts of Thailand

It should be noted that the demand for social infrastructure projected from a hypothetical target of HDI component would be oriented to the physical assets i.e., building proper. The investment in learning facilities, laboratory equipment, computers and software in the education system as well as hospital types of equipment with high technology and costly would be considered to be re-allocated from 'public investment' in the non-construction. However, the social investment in hospital facilities can be done explicitly in the projection. The availability of data has limited such possibility.

4. *Hypothetical* Macroeconomic Impact of the Investment in Social Infrastructure

In order to evaluate the impact of hypothetical investment in human capital education and health as well as the wellbeing of the population via low-income housing, have applied an economic model to assess the impact.

Model simulation is based on 'A Computable General Equilibrium Model' by N. Puttanapong, K.Limskul and T.Bowonthumrongchai (2017)[7]'s model. In brief, the model consists of 5 parts, 3 Players: 9 Production sectors, domestic agents (Household and Government) and Foreign agent (Rest of the world) and 2 markets: good and services markets and primary factor markets and 4 type of labors, Thai nationals and foreign migrants 'Skilled-unskilled labor' respectively. We also have 7 households with 5 income classes. The model has applied database from Social Account Matrix (SAM) based on the official Input-Output table of 2010 published by NESDB with a brief description as follows:

The household is disaggregated into the household by income type, labor by skilled and nationality according to data combination from the Social-economic survey 2009, Labor force survey 2010 and national household census 2010 respectively.

The model is a system of equations representing equilibrium in the product market, labor market through price and quantity adjustment. For sake of simplicity, we do not show the whole system of equations. At macro-economic equilibrium, the aggregate demand and supply are simultaneously reached.

[7] N. Puttanapong, K.Limskul and T.Bowonthumrongchai (2017), A Study on Macroeconomic Impacts of Immigration Using a SAM-Based CGE model, summited to OECD (2017), *How Immigrant Contributed to Thailand's Economy.*
https://www.oecd.org/migration/how-immigrants-contribute-to-Thailand-s-economy-9789264287747-en.htm

We are interested in the role of human capital investment as well as wellbeing improvement through residential investment. The incremental human capital investment will have an impact on return on investment through rising productivity and wage. Following Meijl et al. (2006)[8] and Berrittella (2012)[9], defines the labor supply curve which is the function of wage. This model applied the projection of labor force Thailand[10] and main countries of origin of immigrants[11] as the value of *LMAX*. (Details of these projections are shown in Appendix A).

$$LS_{l,t} = LMAX_{l,t} - \frac{\beta_{l,t}}{Wage_{l,t}^{\alpha_{l,t}}}$$

where

$LS_{l,t}$: Supply of type *l* labor

$LMAX_{l,t}$: Maximum of working force of type *l* labor

$Wage_{l,t}$: Average wage of type *l* labor

$\beta_{l,t}$: Constant of labor supply equation (for type *l* labor)

$\alpha_{l,t}$: Elasticity of labor supply equation (for type *l* labor)

The dynamic growth path of the economy is governed by the inter-temporal accumulation of capital. It obeys the dynamic relationship between investment, capital stock, and depreciation.

$$KD_{k,j,t+1} = KD_{k,j,t}\left(1 - \delta_{k,j}\right) + IND_{k,j,t}$$

where

$IND_{k,j,t}$: Type *k* of new capital investment in sector *j* (whether public or private)

$\delta_{k,j}$: Depreciation rate of capital of type *k* used in industry *j*

$$IT_t^{PUB} = PK_t^{PUB} \sum_{k,pub} IND_{k,pub,t}$$

where

PK_t^{PUB} : Price of new public capital

$IND_{kpub,t}$: Type *k of* new capital investment volume in public sector

[8] Van Meijl, H., T. van Rheenen, A. Tabeau and B. Eickhout (2006), "The impact of different policy environments on agricultural land use in Europe", Agriculture, Ecosystems & Environment, Vol. 114, No. 1.

[9] Berrittella, M. (2012), "Modelling the labor market of minority ethnic groups", Journal of Policy Modeling, Vol. 34, No. 3.

[10] The official projection of Thai population has been jointly conducted by National Economic and Social Development Board and Institute of Population and Social Research of Mahidol University

[11] The projection of population and labor force of Myanmar, Lao PDR and Cambodia is undertaken by The Frederick S. Pardee Center for International Futures, University of Denver

$IT_t^{PRI} = PK_t^{PRI} \sum_{k,bus} IND_{k,bus,t}$

where

PK_t^{PRI} : Price of new private capital

$IND_{k,bus,t}$: Type k of new capital investment volume in private business sector

In our context, the investment of public and private construction by asset type mention earlier would provide a basis for the dynamic economic growth of Thai economy.

In model simulation, the growth of HDI's component is estimated to raise the Total Factor Productivity or a shift parameter in the production function in the model. In addition, the labor productivity is assumed to grow as HDI component like mean years of schooling, expected a year of schooling, life expectancy is assumed to grow in line with the assumption in the last section. The shift parameters, as well as labor input, will drive the increase of production. It is assumed also that the investment in buildings or social investment in our study will raise the capital stock growth. Given the growth path assumed in the business as usual of future scenarios, the growth potential by HDI target elements will drive additional growth on both supply and demand side as shown in macroeconomic impact below.

The HDI target will give rise to a solution to replace the unskilled labor from neighboring countries in the long-run. The physical capital investment in couple with human capital investment will hypothetically raise the labor productivity towards sustained growth in the long-run 2020-2030. We have applied the CGE model mentioned above but show only the macroeconomic impact here. The overall real GDP's gain as a result of HDI component as well as gains from the aggregate demand or expenditure side is shown in the table.

Table 3.7: Impact of Hypothetical Investment in Social Infrastructure on Thai Macro Economy 2020-2030

Macro Variables (measured in billion baht)	2020	2021	2022	2023	2024
Change in Real Gross Domestic Product	8.6	17.8	28.7	41.0	54.9
Change in Real Export	3.2	6.8	11.2	16.3	22.2
Change in Real Government Expenditure	1.7	3.3	5.1	7.0	9.0
Change in Gross Fixed Capital Formation	2.4	5.0	8.1	11.8	16.1
Change in Real Import	2.8	6.0	9.8	14.3	19.5
Change in Private Consumption Expenditure	3.8	8.0	12.9	18.6	25.1
	2025	2026	2027	2028	2029
Change in Real Gross Domestic Product	70.4	87.9	107.7	129.9	155.0
Change in Real Export	28.9	36.7	45.8	56.2	68.2
Change in Real Government Expenditure	11.1	13.3	15.6	18.0	20.7
Change in Gross Fixed Capital Formation	20.9	26.5	32.9	40.2	48.6
Change in Real Import	25.5	32.5	40.5	49.8	60.6
Change in Private Consumption Expenditure	32.3	40.5	49.8	60.4	72.3
	2030				
Change in Real Gross Domestic Product	183.1				
Change in Real Export	82.0				
Change in Real Government Expenditure	23.5				
Change in Gross Fixed Capital Formation	58.1				
Change in Real Import	72.9				
Change in Private Consumption Expenditure	85.7				

Note: Direct summation of right -hand real expenditure change is not matched to change in real GDP owing to we did not add the change in investment in the table. Besides, the change has to be weighted by GDP share.

Appendix

Table A3-1: Determination of Real Gross Fixed Capital Formation (GFCFR)

Dependent Variable: GFCFR

Method: Panel EGLS (Period random effects)

Sample (adjusted): 1995 2015

Periods included: 9

Cross-sections included: 157

Total panel (unbalanced) observations: 1187

Swamy and Arora estimator of component variances

Cross-section SUR (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	24.94328	6.771433	3.683604	0.0002
GFCFR(-1)	1.020276	0.154731	6.593870	0.0000
URBAN_POP	-0.209444	0.083715	-2.501886	0.0125
MANU_SHARE	1.427857	0.605181	2.359389	0.0185
HDI	-51.02846	16.05867	-3.177626	0.0015
GDPR	0.021882	0.035602	0.614635	0.5389

Effects Specification

	S.D.	Rho
Period random	0.000000	0.0000
Idiosyncratic random	92.82143	1.0000

Weighted Statistics

R-squared	0.970836	Mean dependent var	144.0161
Adjusted R-squared	0.970713	S.D. dependent var	543.1343
S.E. of regression	92.94946	Sum squared resid	10203369
F-statistic	7862.875	Durbin-Watson stat	1.150210
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.970836	Mean dependent var	144.0161
Sum squared resid	10203369	Durbin-Watson stat	1.150210

Table A3-2: Determination of Real Gross Fixed Capital Formation per capita

Dependent Variable: LOG(GFCFR_PER_CAP)

Method: Generalized Linear Model (Newton-Raphson / Marquardt steps)

Sample: 1990 2015

Included observations: 1286

Dispersion computed using Pearson Chi-Square

Coefficient covariance computed using observed Hessian

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-4.410516	0.108404	-40.68589	0.0000
LOG(MANU_PER_CAP)	0.261630	0.017525	14.92905	0.0000
LOG(URBAN_POP)	0.147137	0.036183	4.066418	0.0000
HDI	4.812901	0.168638	28.53978	0.0000

Mean dependent var	0.708444	S.D. dependent var	1.268308
Sum squared resid	282.7789	Log likelihood	-850.8531
Akaike info criterion	1.329476	Schwarz criterion	1.345524
Hannan-Quinn criter.	1.335500	Deviance	282.7789
Deviance statistic	0.220576	Restr. deviance	2067.059
LR statistic	8089.172	Prob(LR statistic)	0.000000
Pearson SSR	282.7789	Pearson statistic	0.220576
Dispersion	0.220576		

Note: Explanation of the signs of estimated coefficients.

(1) Description of variables: URBAN_POP = urban population; MANU_SHARE = share of manufacturing GDP; HDI = Human Development Index; GDPR= Gross Domestic Product (constant price); GDPR_PER_CAP= real GDP per capita;

(2) The coefficient of determination of Gross Fixed Capital Formation (GFCF) by HDI is -**51.02846** (**level variables**)**, while** the 'log of GFCF per capita' determined by the log of HDI is however is +**2.39328**.

It can be rationalized as follows: First, the level of GFCF is negatively correlated with HDI since the relationship is convex. The marginal increment of HDI by GFCF increases with a decreasing rates. The inverse relationship is negatively shown by the coefficients estimates. The per capita income one of the HDI's component is convex and has a negative relationship with the economic welfare level.

Secondly, after 'log linearization' of the variables GFCFR_Per_Capita and HDI. The positive coefficient measured 'elasticity' of HDI index on the gross fixed capital formation per capita by 2.39 percent.

The HDI is an index representing the 'loci of equality between demand and supply for human capital inputs at 'equilibrium'. Thus, *around the neighborhood of equilibrium* position, the *increase of gross fixed capital formation per capita induced a positive growth of HDI* especially the per capita income or welfare of samples country (given the year of schooling, and the life expectancy) assuming the inverse relationship exists.

Chapter 4

Social Infrastructure Needs on Human Capital: Education and Government Services

1. Introduction

The World Bank [1] has noted that Thailand's economy has grown up continuously since 2014, owing to the recovery of domestic demand in line with and the US as well as EU markets. Thailand's export growth has been modest and lagging behind several Asian countries, due partly to a decline in competitiveness. The World Bank has further noted that further improvements in competitiveness will be important for sustained economic growth and rising incomes for the Thai people. The World Bank has pointed out the importance of raising the quality of education for all will help increase the skills and productivity of the labor force. It is a key to improving Thailand's competitiveness.

From statistics, Thailand has made great progress in expanding *basic education.* This can be judged from the 'mean years of schooling' (UNDP's Human Development Index). However, from now the key lies in how to raise the quality of education series to maximize students' potential in joining Thailand's skilled workforce.

The fact is that almost 1/3 of Thai 15-year-old students are "functionally illiterate." They lack the skills needed to manage daily living and employment tasks that require reading skills beyond a basic level to compete in the '21st Century Skills'[2]. The inequality of resource allocation is skewing particularly acute for small village schools, which face teacher shortages and have less than one teacher per classroom. All educators in Thailand acknowledged that the small village schools are also severely under-resourced making it difficult to deliver quality education. Not only because they have a poor and inadequate supply of teaching materials, poor physical infrastructure but most importantly they do not have experienced teachers with sufficient qualification for the education for the '21st Century's skills'.

[1] The World Bank, Thailand Economic Monitor – June 2015: Quality Education for All. http://www.worldbank.org/en/country/thailand/publication/thailand-economic-monitor-june-2015

[2] They are 'Collaboration and teamwork, Creativity and Imagination, Critical thinking, Problem-solving' Flexibility and adaptability, Global and cultural awareness, Information literacy Leadership. See https://www.envisionexperience.com/.../13-essential-21st-century-skills-for-todays-stude...

In this part of the analysis, we would like to estimate the need for soft infrastructure to promote the buildup of human capital. It is inclusive of education and health investment. In this chapter, we concentrate on education investment in quality rather than the physical quantity in line with the above remarks by the World Bank.

We build a simple model to project the number of students at each education level. This follows the conceptual framework in Chapter 3. In addition, we will project the need for the related physical infrastructure in education services such as a number of schools and related facilities. With unit cost, we will estimate the cost of infrastructure investment.

The last section is an estimation of social infrastructure need for the public services. We have applied the database of Office of the Civil Servant Commission (OCSC) to prove the declining demand for public personnel, thus, the physical infrastructure. The study has pointed out the replacement by shifting to human capital investment in quality rather than quantity. This is consistent with the demand for physical schooling social infrastructure which would need to be replaced by investment in the quality of both structures as well as students' modern facilities to reach the baseline of 21st Century Skills formation for further sustainable development in Thailand.

2. What Determine the Social Infrastructure Needs in Education?

The key determinations in estimation the education needs from the *supply side* comprise variables such as the single-year age population trend, the assumption on structural change of ***enrolment ratios*** of schooling over time. With certain assumption on drop-out of a school system, survival rate, the *labor pool* can be determined by *population out of school with age greater than 15-year-old.*

On the *demand side*, given the labor force participation rate as a function of equilibrium *wage rate* in labor market, labor demand and employment is determined by economic growth and development. In our study, level of economic development is represented by *GDP per capita* as a proxy of all other variables.

In our study, we begin from the demand for labor from our model projection for OECD (2017)[3]. That is to project the labor demand by 'Occupation- Education' in order to justify the demand for social infrastructure related to human capital investment. The answer is to find the future demand for 'skills and unskilled labor' overtime.

[3] Puttanapong N., Limskul K., and Bowonthumrongchai T. (2017), A Study on Macroeconomic Impacts of Immigration Using a SAM-Based CGE model, submitted to OECD (2017), *How Immigrant Contributed to Thailand's Economy*. https://www.oecd.org/migration/how-immigrants-contribute-to-Thailand-s-economy-9789264287747-en.htm

The matrix of occupation-education was retrieved from the labor force survey (NSO) and rebasing to 2015 to represent a structure of employment in Thailand. The total demand for labor by occupation is 38.50 million persons. Here, it is noted that the demand for labor by occupation with primary education and less than elementary is 15.84 million persons. The labor demand by secondary, vocational and tertiary education is 9.74 million, 3.09 and 5.82 million persons respectively. The demand for labor by occupation-education may change over time according to their respective wage gap by such dimension.

Table 4.1: Matrix of Demand for Labor by Occupation-Education Level 2015 (persons, adjusting for presentation)

Occupation/Education 2015	Primary and lower	Secondary	Vocational	Tertiary and upper	Total
Managers	270,717	324,012	172,387	754,918	1,522,034
Professionals	28,014	98,141	94,447	1,941,403	2,162,005
Technicians and associate professional	115,728	28,8487	338,896	1,002,062	1,745,173
Clerical support workers	61,608	375,511	329,975	687,171	1,454,265
Service and sales workers	2,935,984	2,666,577	833,996	924,718	7,361,275
Skilled agricultural, forestry and fishery workers	8,897,664	2,725,675	361,766	205,505	12,190,610
Craft and related trades workers	2,070,668	1,447,727	592,276	203,226	4,313,897
Plant and machine operators and assemblers	1,468,509	1,821,829	366,571	101,162	3,758,071
Elementary occupations	2,602,176	1,162,083	153,336	79,294	3,996,889
Total	15,848,892	9,747,959	3,090,314	5,820,165	

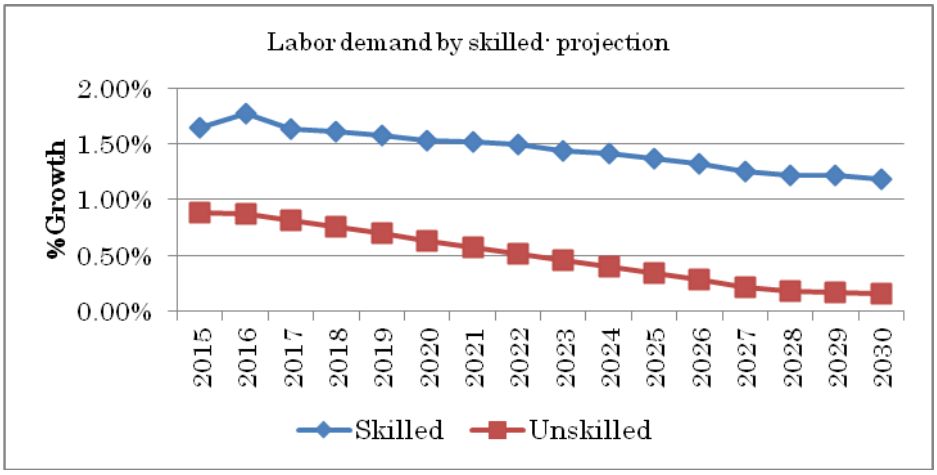
Note: (1) Primary and below= primary education and less than elementary; Secondary = lower + upper secondary general stream + post-secondary academic and teacher training; Vocational = upper secondary vocational + post-secondary vocational; tertiary and upper = Bachelor degree academic+ Higher technical education + teacher training+ Master and Doctor Degree respectively. (2) The matrix does not cover non-education, non-education and unknown. Thus, grand total row sum of employed persons by education is not consistent with total column sum of employed persons by occupations.

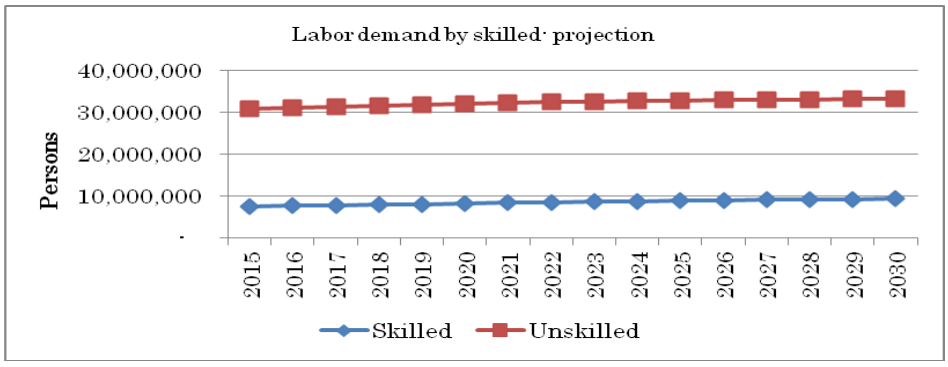
Pattanapong N., et., al. (2017) has predicted the demand for skills and unskilled labor using their CGE model. Their baseline forecast has shown that demand for labor by skills has increased gradually over time in the range of not exceeding 1.0 percent or from 5 to 10 million persons during 2015-2030. The demand for labor is driven by

average growth rates of GDP of 2.93 percent in 2015 to 3.03 and 3.49 percent by end of 2020 and 2030 respectively. Here, the real stock of capital accumulation is assumed to growth 0.82 percent in 2015 to 1.15 and 2.16 percent by end of 2020 and 2030 respectively.

It is hypothesized that if capital deepening would be assumed with larger growth magnitude, demand for skills-unskilled labor would have to change with consistent manner.

Figure4.1: Labor Demand Projection by Skills





Source: Pattanapong N., et., al. (2017)

It is expected that the need for skills labor would be highly demanded. In other words, Thailand would need higher level of human capital accumulation (i.e., by education level) to drive economic growth and development. Thus, the social capital investment would be required to push up sufficiency and efficiency of physical capital stock. Thailand will desperately need both hard, soft infrastructure as well as social infrastructure.

On the supply side, a simple projection of the number of students by education level is based on the population projection (a single year age group), the assumption on *enrollment ratio* by age group. However, on the demand side, a number of student in school is rather a function of expectation of employment signal in the labor market. There is a *time lag* between demand signal in the labor market and household's education investment in school.

The educational system in Thailand may need to shift to quality and ability of students instead of quantity achievement as in the past. The declining total fertility and demand for labor for knowledgeable society would demand the increased ability to compete with other countries.

System of Equations

The following mathematical model is the conceptual framework for our 'Demand for Social Infrastructure' in case of education services.

Demand for Labor

LD-by-education = f{ *wage-by-education , GDP, General- price-level*} (1)

Assuming continuous mapping exists, the inverse demand for labor is found as:

Real_Wage-by- education = f^{-1} {GDP, LD-by-education} (2)

Supply of Labor

Labor Force = *Population at out of school system age >15* (3)

LS-by-education = *Labor Force * survival rate* (4)

LS-by-education = h {*wage-by-education, Labor Force Participation Rate-by-education*Labor force, CPI*} (5)

Equilibrium in the labor market

Equilibrium condition: **LD** = **LS**= **L*** (6)

W***-by-education** = W(L^*, *GDP, General Price Level*) (7)

Determination of Demand for Schooling

No.-students = *Pop-by-enrolled-age*enrollment-ratio* (8)

Where,

Enrollment-ratio = ER{*GDP/Pop, lagged* L^*, *general price level, other exogenous factors*} (9)

Demand for Social infrastructure: SI

SI=SI{ *No.-students, conversion-factor-student-physical*} (10)

Cost of Social Infrastructure investment: SI_F(t)

Determined from Capital Stock Formation

$$\mathbf{SI\_F(t)} = \text{SI\_F}\{SI, SK(t-1), dep\_rate\}$$

$$\mathbf{SK(t)} = SK(t-1) - dep\_rate * SK(t-1) * + SI\_F(t) \quad (11)$$

The educational system in Thailand mainly focuses on quality, equality, and ability of students to build a knowledge society, and competitiveness. This is to invest in social infrastructure for qualified students, with equality in education services across area and classes.

The forecasted number of students is used as a basis for an approximation of a number of teachers and school personnel needed and school facilities. Furthermore, a requirement of school facility between areas is allocated by applying a standard ratio provided by Ministry of Education. The required space on school facility is determined by the forecasted number of students and teachers.

2.1. Population Growth, Enrollment and Students Projection by NESDB

The population at each enrolled age ratio has been projected to decrease along the declining trend of total fertility rates since 1980. The NSO reports that enrolled population with age range of 0-21 year has been declining from 62.3 percent of total population in 1980 to 29.8 and 20.0 percent in 2010 and 2040 respectively.

For future projection, Thai enrollment age in school is assumed to be declining by NESDB (2013)[4]. The projection is fundamentally based on *the supply side.* It does not explicitly take into account the labor demand by production sector in the labor market. In the last decades, Thailand has relied on labor-intensive technology in her production. Labor demand required a cheap wage for labor-intensive development epoch.

The NESDB projection may obtain information from the fact that majority of the labor force and supply has passed only a primary education or lower. This had constituted to cheap wage cost during the past decades. As income per capita rises, household starts to invest in the higher level of human capital, especially in education. Thus, it is rational to assume that in the coming decades, higher *human capital investment in Thailand will be the key determinant of future development.* As a result, it is *hypothesized* that *declining* enrollment ratio in primary education (both net and gross),

[4] VaPattanapong P., Prasartkun P., and Panpoung S. ed., (2013), Policy Implication of the Population Projection in Thailand 2010-2040, Population and Social Research Institute, Mahidol University, Submitted to the National Education and Social Development Board.

increasing enrollment ratios in secondary and tertiary education is consistent with the path towards sustainable growth and development.

Table4.2: Population with Enrolled Age 0-21 Year, 1980-2040

	1980	1990	2000	2010	2020	2030	2040
Enrolled Age Population ('000 persons)	44,825	54,549	60,916	63,790	65,996	66,174	63,864
Pre-kindergarten (0-2 year)	6,663	2,593	2,581	2,279	2,097	1,776	1,443
Kindergarten (3-5 year)	3,327	2,913	3,057	2,409	2,171	1,871	1,534
Primary (6 - 11 year)	7,091	6,840	6,132	5,203	4,462	4,016	3,362
Lower Secondary (12 - 14 year)	3,511	3,601	3,074	2,750	2,351	2,138	1,831
Upper Secondary (15 - 17 year)	3,393	3,403	3,153	2,781	2,482	2,196	1,927
Higher Education (18 - 21 year)	3,928	4,574	4,252	3,577	3,500	2,970	2,703
Enrolled Age Population (0 - 21 year)	27,913	23,924	22,249	19,000	17,063	14,966	12,800
Enrolled Age Population (3 - 21 year)	21,250	21,331	19,668	16,721	14,966	13,190	11,357
Percentage distribution of enrolled age population, % by age range							
Pre-kindergarten (0-2 year)	14.90	4.8	4.2	3.6	3.2	2.7	2.3
Kindergarten (3-5 year)	7.40	5.3	5.0	3.8	3.3	2.8	2.4
Primary (6 - 11 year)	15.80	12.5	10.1	8.2	6.8	6.1	5.3
Lower Secondary (12 - 14 year)	7.80	6.6	5.1	4.3	3.6	3.2	2.9
Upper Secondary (15 - 17 year)	7.60	6.2	5.2	4.4	3.8	3.3	3.0
Higher Education (18 - 21 year)	8.80	8.4	7.0	5.6	5.3	4.5	4.2
Enrolled Age Population (0 – 21) year, % of total	**62.30**	**43.9**	**36.5**	**29.8**	**25.9**	**22.6**	**20.0**
Enrolled Age Population (3 – 21) year	**47.40**	**39.1**	**32.3**	**26.2**	**22.7**	**20.0**	**17.8**

Note: based on the assumptions as follows: (1) Enrolment ratios of primary, secondary of both stream education is 100.00% (2) The ratio between vocational: general stream in secondary education is assumed to be 60:40 in 2018 and beyond until 2040. (3) Graduation rates from primary-secondary education are assumed to hold as base year 2010/2014. (4) Diploma vocational applied from projection of Ministry of Education.

Source: National Statistical Office for the year 1980-2000 and National Economic and Social Development Board for the year 2010-2040.

Table 4.3: Number of Students by Education Level, 1980-2040

(1,000 persons)	2010	2011	2012	2017	2022	2032	2040
Pre-Primary (3-5 year)	1,797	1,806	1,897	2,226	2,116	1,803	1,534
Primary (6 - 11 year)	5,067	4,992	4,872	4,324	4,163	3,661	3,159
Lower Secondary (12 - 14 year)	2,802	2,662	2,511	2,239	1,945	1,793	1,579
Upper Secondary (15 - 17 year)	2,068	2,107	2,105	2,093	1,915	1,693	1,509
General Stream	1,314	1,368	1,390	938	747	660	589
Vocational Stream	754	739	715	1,154	1,169	1,032	921
Diploma Vocational	400	381	335	592	754	661	592
Higher Education (18 - 21 year)	1,757	1,812	2,170	2,258	2,245	2,208	2,165
University First year (18-year-old)	578	793	790	807	784	731	662

Note: National Statistical Office for the year 1980-2000 and National Economic and Social Development Board for the year 2010-2040

Table 4.4: Labor Force by Education Level 2006-2011

(1,000 persons)	2006	2007	2008	2009	2010	2011
All	36,429	36,942	37,700	38,427	38,643	38,922
Primary and Pre-Primary (3-11 year)	21,743	21,560	21,443	21,364	21,268	20,661
Lower Secondary (12 - 14 year)	5,205	5,459	5,764	5,948	6,087	6,241
Upper Secondary (15 - 17 year)						
General Stream	3,177	3,404	3,625	3,816	4,018	4,141
Vocational Stream	1,192	1,221	1,241	1,333	1,333	1,341
Diploma Vocational	1,386	1,470	1,566	1,661	1,701	1,795
Higher Education (18 - 21 year)	3,726	3,827	4,061	4,304	4,238	4,742

Source: National Statistical Office, Labor Force Survey

As population projection has shown a declining total fertility rate, it also induced a declining trend of *the new entrant*s into the labor force. The cheap wage episode has ended. However, as capital deepening was ineffective in Thailand owing to risk and

uncertainty of investment climate in Thailand. As a result, industrial development in Thailand has to rely on *foreign migrants* as the main source of labor supply until wage gap between national and foreign labor would be gradually narrowed down.

We have shown that the trend of labor demand by skills is rising in Thailand over the next decades. In fact, labor force surveyed by the National Statistical Office (NSO) has shown that the population out of school and labor pool has their education level consistent with the trend assumed by NESDB. Especially, a labor force with vocational education and tertiary has been increased during 2006-2011. The labor force with primary education and lower has been declining over the period.

2.2 Testing of Hypothesis on Relationship between the Economic Development and Enrollment Ratios

In this part of the study, we would like to test the *hypothesis that gross enrollment rates of the population with primary education is declining* with economic development. In addition, as a country rises towards middle-high income level there is an increasing trend of secondary and tertiary education level's enrollment ratios. The econometric estimate here cannot reject the null hypothesis as well as its 'sign' of the relationships mentioned earlier with significance level.

The scattered plot of panel data below depicts a hypothetical direction of economic development level measured by logarithmic of GDP per capita and gross enrollment ratios. The population who would be grossly enrolled in primary education level at their age range (not a single year age group) would be expected to decline as a country is having a higher level of development. Consistently, a rising income per capita would also induce rising enrollment ratios of secondary and tertiary education.

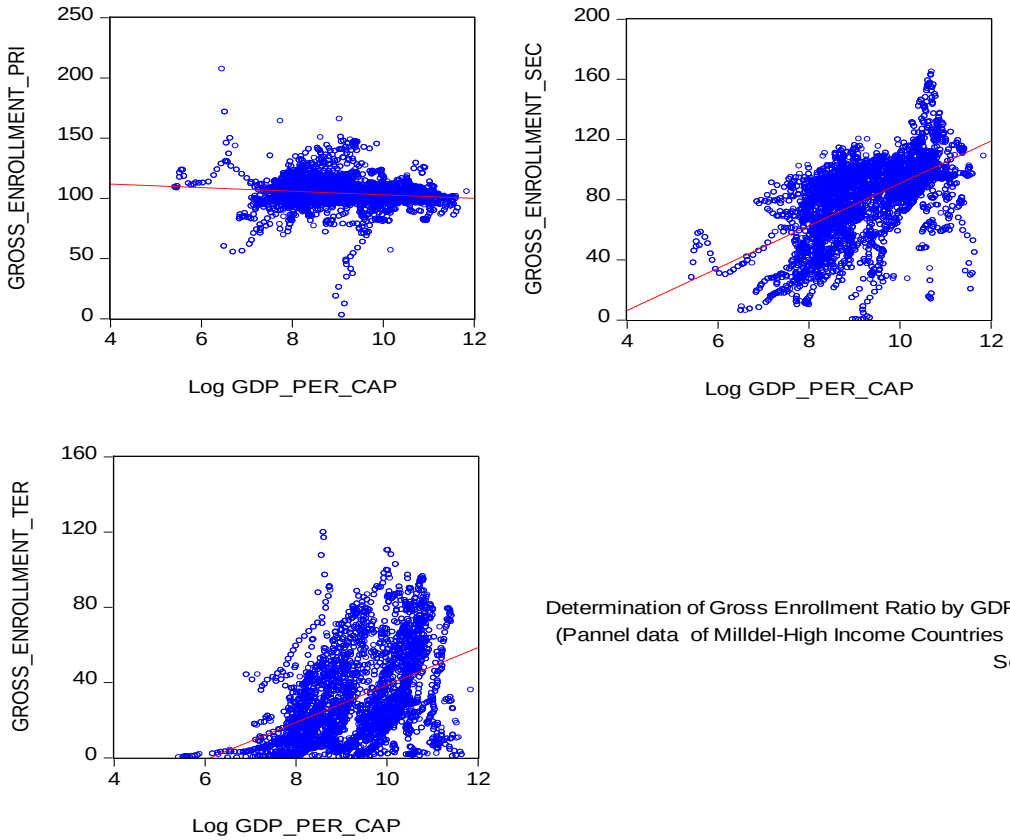
The speed of adjustment towards equilibrium enrollment ratios is shown in below. The magnitude of response of enrollment ratios in primary education to the growth of per capita income is -1.29 percent of average ratio. The speed of population enrolled in primary education in school that is likely to decline per one percentage point of per capita income increases is period -0.01 percent[5].

Accordingly, the enrollment ratios of secondary and tertiary education are estimated to increase 14.29 and 9.94 percent with respect to the growth of income per capita respectively. The speed of rising human capital intensity (measured by enrollment ratios of secondary and tertiary education) would be growing at 0.208 and 0.198 percent

[5] This is by estimation of a double logarithmic function equation. It is not shown in Table

over time. This is a speed of human capital accumulation towards sustainable economic development in the long-run.

Figure 4.2: Determination of Gross Enrollment Ratio by GDP per capita.



Determination of Gross Enrollment Ratio by GDP per capita
(Pannel data of Milldel-High Income Countries 1960-2015)
Source: WB

Table 4.5: Determination of Gross Enrollment Ratio by GDP per capita

Enrollment Ratios	Constant Term	log(GDP_ per capita)	AR(1)	R^2/ Pearson Statistic	D.W./AIC	Estimation Model
Primary Education	115.6881 (68.37)	-1.293798 (-7.19)	-	R^2 =98.47	AIC =7.42;	Generalized Linear Model (N=2821)
Secondary Education	69.24 (3.85)	3.918 (2.24)	0.957 (167.91)	R^2 =0.977	D.W. =1.75	Ordinary Least Square (N=2321)
Secondary Education	50.77 (14.74)	14.29 (39.14)		Pearson Statistic	AIC =8.88	Generalized Linear Model

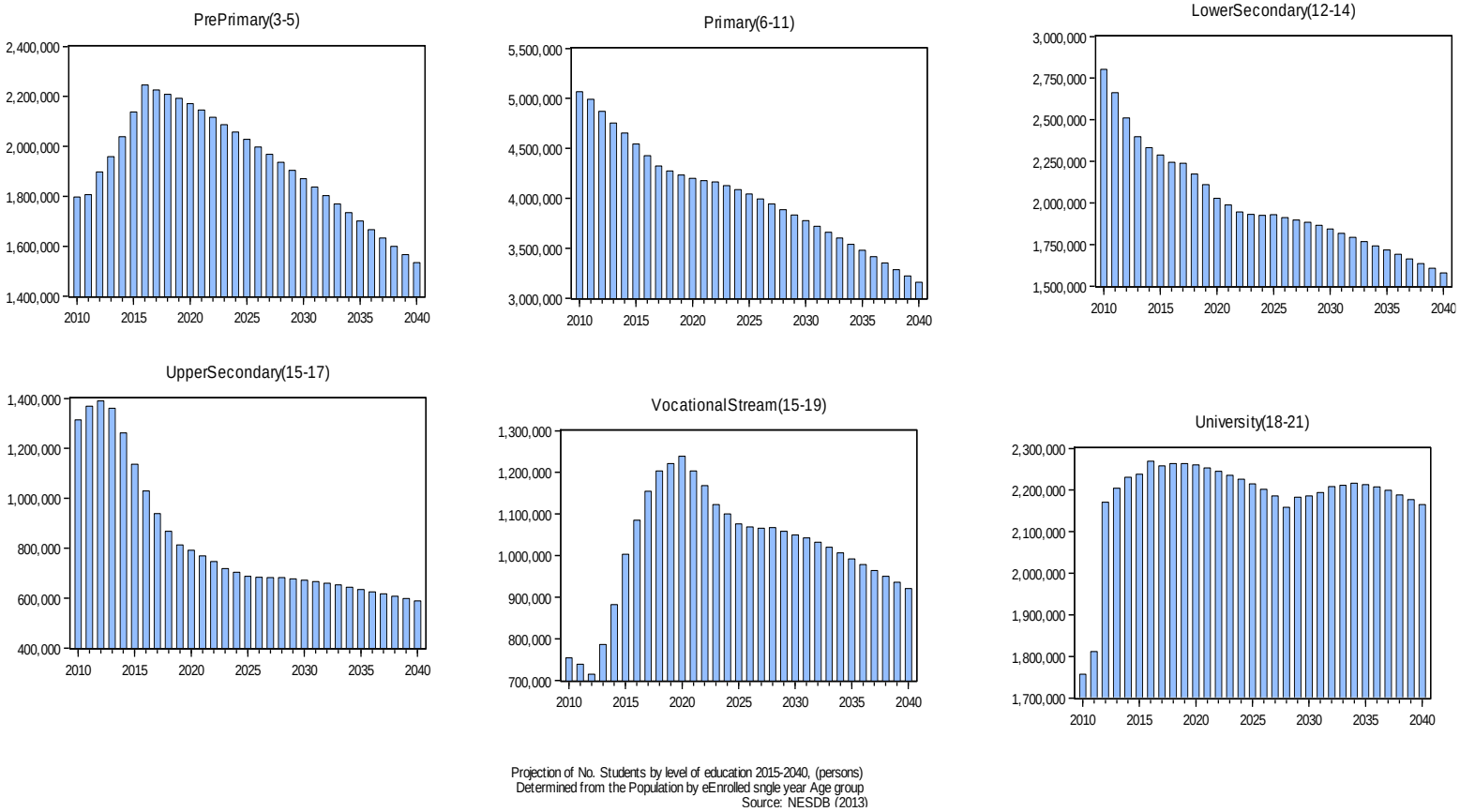
				390.41		(N=2517)
Tertiary Education	-114.33 (-4.27)	3.70 (3.61)	1.01 (450.53)	R^2 =0.987	D.W. =1.20	Ordinary Least Square (N=2500)
Tertiary Education	-60.71 (-17.51)	9.94 (26.98)		Pearson Statistic 442.01	AIC =8.92	Generalized Linear Model (N=2821)

Note: (1) Z-Statistic in the bracket for GLM and t-statistic for OLS.

The PISA report by OECD (2015) has emphasized the quality improvement of education by reducing the inequality of Thai education system. OECD stressed that inequality in *instruments and types of equipment* for learning has a clear relationship with *PISA score* (indicating education quality outcome). In science literacy, it is reported by PISA 2015 that the 15-year-olds in Thailand score 421 points compared to an average of 493 points in OECD countries. Girls perform better than boys with a statistically significant difference of 9 points (OECD average: *3.5 points higher for boys)* on average, 15-year-olds score 415 points in mathematics compared to an average of 490 points in OECD countries. Girls perform better than boys with a statistically significant difference of 3 points (OECD average: 8 points higher for boys). Thailand has shown an average performance in reading of 15-year-olds of 409 points, compared to an average of 493 points in OECD countries. Girls perform better than boys with a statistically significant difference of 31 points (OECD average: 27 points higher for girls).

Thai student has low evaluation performance in reading among countries judged by PISA score. Girls have done better than boy students. The performance in problem-solving in terms of mean score in 'collaborative problem-solving performance' was also low for boys and girls students in Thailand. The change between 2006 and 2015 in the index of social inclusion within schools is one of the largest among PISA-participating countries and economies. The difference in science performance, among students within schools, associated with a one-unit increase in the PISA index of economic, social and cultural status (ESCS) is one of the *smallest* among PISA-participating countries and economies. The variation in science performance associated with the socio-economic status of students, as measured by the PISA index of economic, social and cultural status (ESCS) decreased strongly between 2006 and 2012, compared to other PISA-participating countries and economies (-6.5 %, rank 52/52).

Figure 4.3: Demand for Education of Population at Enrollment Age



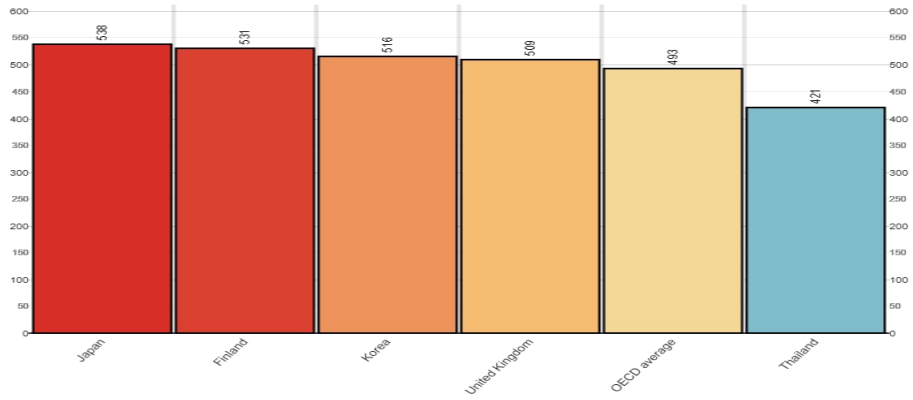
Note: Assumption on Enrollment Ratio is given exogenously.

Source: NESDB (2013).

Before accounting for students' and schools' PISA index of economic, social and cultural status (ESCS), science performance is higher in public schools than in private schools. (28 PISA Score, rank 3/58). After accounting for students' and schools' PISA index of economic, social and cultural status (ESCS), science performance is higher in public schools than in private schools (41 PISA Score, rank 6/58). In Thailand, a high share of students is in the bottom two deciles of international economic, social and cultural status (ESCS), compared to other countries and economies participating in PISA. (55.1 %, rank 4/69) In Thailand, a low share of students is in the top two deciles of international economic, social and cultural status (ESCS), compared to other countries and economies participating in PISA. (7.9 % rank 61/69). Compared to the share non-disadvantaged low performers in science, the share of disadvantaged low performers in science is one of the lowest among countries and economies participating in PISA. (1.7 Ratio, rank 66/68). The variation within schools in science performance is weakly associated with students' and schools' socio-economic status, as measured by the PISA index of economic, social and cultural status (0.3 %, rank 62/67).

Thai Student Performamce Benchmarking with PISA (2015):[6]

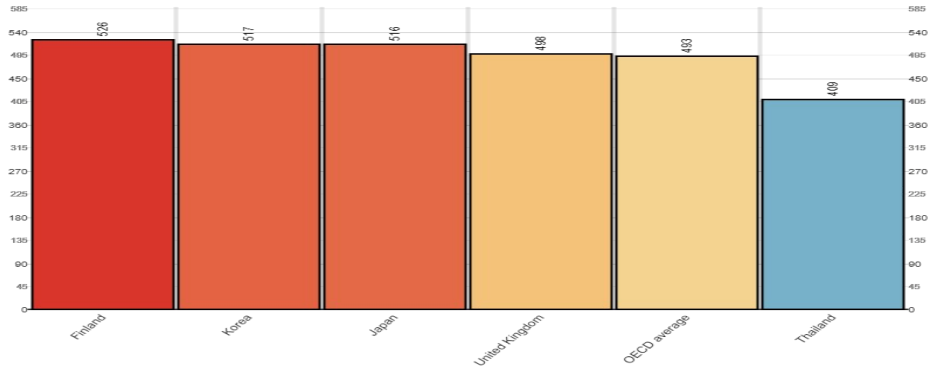
Science: Singapore outperforms all other participating countries/economies in science. Japan, Estonia, Finland, and Canada, in descending order of mean performance, are the four highest-performing OECD countries. Below is to benchmark Thailand with selected forerunners.



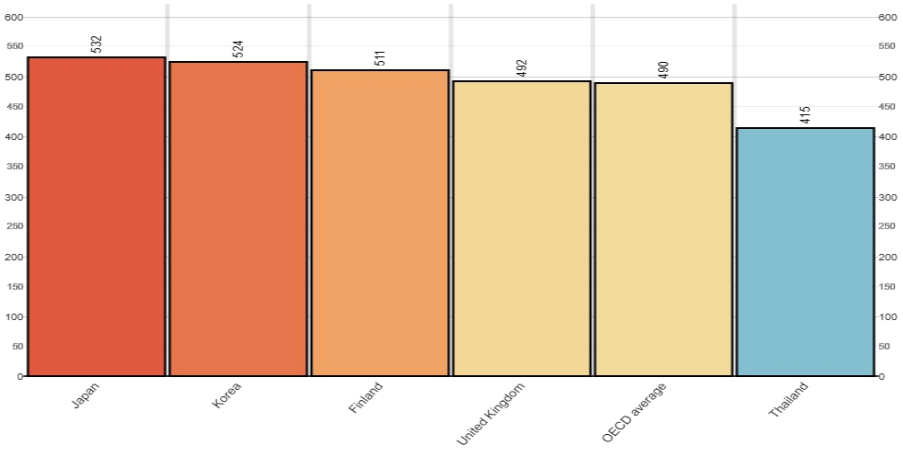
Reading: Singapore, Hong Kong (China), Canada and Finland are the

6 "Education GPS, *OECD*, 3/23/2018, 5:42:42 PM http://gpseducation.oecd.org. Accessed March 2018.

highest-performing countries and economies in reading.



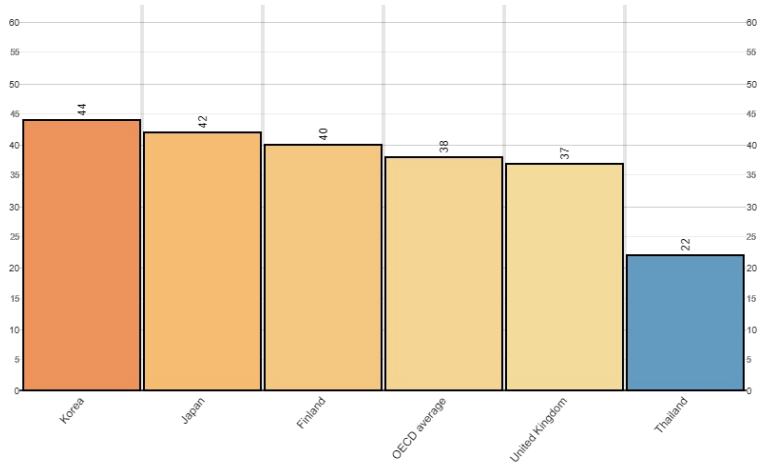
Mathematics: Asian countries/economies outperform all other countries in mathematics. Singapore scores highest in the mathematics of all participating countries and economies: 564 points more than 70 points above the OECD average of 490 points. Three countries/economies score below Singapore, but higher than any other country/economy in mathematics: Hong Kong (China), Macao (China) and Chinese Taipei. Japan is the highest-performing OECD country, with a mean mathematics score of 532 points.



Equity: *PISA defines equity in education as providing all students, regardless of gender, family background or socioeconomic status, with high-quality opportunities to benefit from education. Defined in this way, equity implies neither that everyone should achieve the same results, nor that every student should be exposed to identical approaches to teaching and learning. Rather, it refers to creating the conditions for minimizing any adverse impact on student's socio-economic status or immigrant background on their performance.* Canada, Denmark, Estonia, Hong Kong (China) and Macao (China) achieve high performance and high in education opportunities.

Socio-economically disadvantaged students across OECD countries are almost three times more likely than more advantaged students not to attain the

baseline level of proficiency in science. On average across OECD countries, advantaged students score 88 points higher in science than the disadvantage. **Between 2006 and 2015 no country or economy improved its performance in science and its equity levels simultaneously**.



If Thailand would like to achieve higher 'education quality' better allocations of educational resources for underprivileged schools has to be done first. Currently, the resources allocation is skew to students from middle class and well-to-do family in an urban area more than their rural counterpart.

To achieve the goals, Ministry of Education needs to target on the development of teacher, teaching process, and evaluation process on students. Moreover, students are required to develop skills to analyze, be creative, be responsible, and work as a team. The development process may be done with the help of technology.

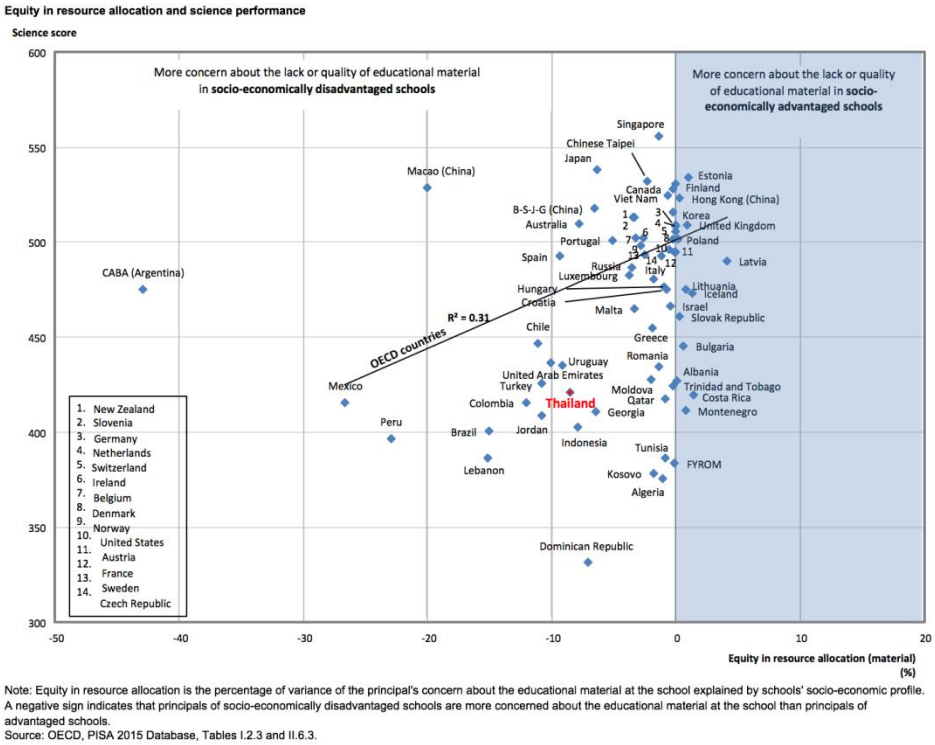
Also, the equality to access in education is another important thing that government is paying attention especially for low income or poor people. This is to promote and enforce Thai children to compile with compulsory education. Lastly, the effectiveness of education service provision can be achieved through the efficient allocation of social resources, having good governance.

The study by World Bank (2018)[7] has pointed out role of institutional alignment and sound administrative system (Overview, page 2) in deliverying goods-quality education core of knowledge and skills rather than just credentials. Sufficient education facilitations, textbook and teachers with coherent curriculum can expect students to engage in meaningful classroom interactions that produce learning. The study also negate the solid correlation between public spending and learning

[7] *"World Bank. 2018. Growing Smarter : Learning and Equitable Development in East Asia and Pacific. World Bank East Asia and Pacific Regional Report;. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/29365 License: CC BY 3.0 IGO."* URI http://hdl.handle.net/10986/29365. Accessed March 26, 2018.

outcome if it is not a quality spending. Singapore and Vietnam have surpassed other ASEAN countries in performances of learning. Thailand has been underperformed as she could not manage education inputs efficiently despite public spending on education is significantly over 4 percent of GDP, 20 percent of the annual budget, teachers earn 25 percent more than GDP per capita. It was clear in World Bank report (2018, Overview, page 16) that top performing system in Japan in the past decades had their central government subsidized local government aiming to equalize public resource across unevn spatial dimension. For nine-year compulsory education, local government fund two-thirds of the cost of teachers' salaries, and central government subsidized thre remaining third to help '*equalize the quality of teachers* across municipalities and schools'. As result, disadvantaged schools have the same share of qualified teachers as advantaged school and more teachers per student.

Figure 4.4: It is a matter of Equity in Educational Resource Allocation



Note: Equity in resource allocation is the percentage of variance of the principal's concern about the educational material at the school explained by schools' socio-economic profile. A negative sign indicates that principals of socio-economically disadvantaged schools are more concerned about the educational material at the school than principals of advantaged schools.
Source: OECD, PISA 2015 Database, Tables I.2.3 and II.6.3.

Source: OECD (2016), PISA 2015 Results (Volume II): Policies and Practices for Successful Schools, PISA OECD Publishing, Paris http://dx.doi.org/10.1787/97/89264267510-en

Table 4.6: Comparison of Selected Indicators of Education 2015

Indicator	Finland	United Kingdom	Japan	Korea	OECD average	**Thailand**
Shortage of educational material (mean index)	0.09	0.04	0.72	0.42	0.00	0.34
Cumulative expenditure per student aged 6 to 15 by educational institutions (equivalent USD using PPPs)	101,527	114,920	93,200	79,517	N/A	27,220
Shortage of educational material (mean index)	0.09	0.04	0.72	0.42	0.00	0.34
Shortage of education staff (mean index)	0.00	-0.12	0.49	0.19	-0.01	0.27
Equity in staff allocation between schools (difference in the index of a	**-0.04**	**-0.36**	**-0.13**	**0.24**	**-0.34**	**-0.33**

shortage of education staff between socioeconomically advantaged and disadvantaged school)						
Students attending government or public schools (**15 year-olds,** %)	95.5	94.2	68.2	66.3	83.5	86.1
Class size in language-of- instruction class	19	24	36	31	26	37
Student-teacher ratio in the school	10.30	14.67	11.52	15.09	13.06	19.77
Science teachers with a university degree (**ISCED level 5A**) **and a major in science in schools attended by 15-year-old students** (%)	86.6	93.2	N/A	88.6	73.8	87.0
Teachers attended a programme of professional development in the previous three months (%)	51.6	80.6	34.8	69.1	50.9	73.0
Mean index of school autonomy (**percentage of tasks for which the schools have considerable responsibility**)	74.7	91.5	73.3	66.3	71.3	90.0
Coverage of the national 15-year-old population in PISA (**2015**)	0.97	0.84	0.95	0.92	N/A	0.71
Student performance in science (**mean score**)	531	509	538	516	493	421
Indicator	**Finland**	**United Kingdom**	**Japan**	**Korea**	**OECD average**	**Thailand**
Average trend in science performance (**score-point change per three-year period between 2006 or later and 2015**)	-11	-1	3	-2	-1	2
Student performance in maths (**mean score**)	511	492	532	524	490	415
Top performers in reading (**percentage of students scoring at Level 5 or 6**)	13.7	9.2	10.8	12.7	8.4	0.3
Low performers in collaborative problem solving (**percentage of students scoring below Level 2**)	18.1	22.4	10.1	12.9	28.1	54.1

Relative performance in collaborative problem solving after accounting for performance in science, reading and mathematics (difference between observed and expected performance, in score points)	7	12	23	20	3	2
Average time per week spent learning in regular lessons, in hours	24.2	26.5	27.5	30.3	26.9	31.8
Students who expect to complete a university degree (%)	27.1	41.8	58.7	75.3	44.2	68.9
Disadvantaged students being enrolled in a vocational track (%)	0.0	0.7	38.6	27.8	19.6	21.4
Students who fall in the bottom 20% of international economic, social and cultural status index (ESCS) (%)	2.1	4.6	7.9	6.5	12.1	55.1
Students who fall in top 20% of the international economic, social and cultural status index (ESCS) (%)	32.7	34.6	11.4	9.5	27.2	7.9
Low performers in science among disadvantaged students (in the bottom quarter of the economic, social and cultural status index (ESCS) (%)	19.7	25.7	17.2	23.2	34.0	56.2

Indicator	Finland	United Kingdom	Japan	Korea	OECD average	**Thailand**
Top performers in science among disadvantaged students (in the bottom quarter of the economic, social and cultural status index (ESCS) (%)	6.8	4.4	5.9	4.6	2.5	0.1
Low performers in science among advantaged students (in the top quarter of the economic, social and cultural status index (ESCS) (%)	4.5	7.2	3.4	7.0	9.3	28.4
Top performers in science among advantaged students (in the top quarter of the economic, social and cultural status	25.4	22.1	25.7	20.2	15.8	1.5

index (ESCS) (%)						
Increased likelihood of disadvantaged students (in the bottom quarter of ESCS) scoring below Level 2 in science, relative to non-disadvantaged students (3 other quarters of ESCS)	2.61	2.17	2.89	2.38	2.78	1.70

Source: OECD (2016), PISA 2015 Results (Volume II): Policies and Practices for Successful Schools, PISA, OECD Publishing, Paris http://dx.doi.org/10.1787/97/89264267510-en

The above mentioned education figure has to be qualified with transparent allocation process with monitoring of duplication of students numbers in each school. There may be a duplication of student's number record in the registration of 117,431 persons in the Basic Education System in Thailand as of 2017.

Furthermore, the NESDB[8] has reflected the concern of the government on human quality improvement with education investment. That is the cabinet cautious on the *mismatching* of investment in education discipline which does not being required by the labor market.

3. Forecast Number of Students and Social Infrastructure Needs

In order to project the number of social infrastructures needed by Thai education system over time, we firstly assumed parameters as shown below. The assumptions are based on the data which available in the past. The methodology can be either apply the past record with some foresting value by any model[9] to project future parameters and applying to project the future value of required variables *pro rata.* Alternatively, we can set own scenarios for future parameterization. The latter can be based on the assumption which the modeler treats what would be 'Policy parameters'. The 'normative assumption' vs. a 'positive assumptions' may be different but should be explainable to the reader.

[8] NESDB note no.1111/054 January 2018.

[9] This is, for example, the ARIMA model, or other simple trend models which is available from any standard software such as Eviews.

In this chapter, we intentionally apply the 'positive assumption' or the constant of parameterization process from past period as our hypothetical assumption in our forecasting. This is to see how heuristic the result would be soundly obtained. This can be named as a 'Baseline forecasting Path' for our purpose. Given, the unit cost we may be able to identify the cost of investment in education in our study. This is consistent with the 'microeconomic approach by JICA'. Here, we treated the overall *pro rata* projection where the maintenance and replacement investment is inclusive in the projection.

Table 4.6: Data sources for projection

Data	Sources	Unit
Demographic Projection	NESDB; 2013 Thailand population projection	Thousands of people
Schooling age interval	Office of Basic Education Commission, Ministry of Education	-
Enrollment rate	Office of the Permanent Secretary Ministry of Education; 2015 School enrollment rate	%
The proportion of upper secondary student	Ministry of Education	%
Student/teacher ratios	• For primary and secondary school; Ministry of Education, Ministry of Public Health, Queensland Independent School, Silpakorn University • For undergraduate level; Office of the Higher Education Commission: OHEC.	Ratio

Table 4.7: Number of Students and schools by Level of Education

	Education Year				
	2011	**2012**	**2013**	**2014**	**2015**
Number of Schools	**31,255**	**31,116**	**31,021**	**30,922**	**30,816**
Main Schools	30,945	30,832	30,753	30,667	30,537
Subsidiaries	310	284	268	255	279
No. of Schools By Level					

Primary	21,693	21,436	21,293	21,167	21,300
Lower Secondary	6,994	6,974	6,988	6,974	6,965
Upper Secondary	2,517	2,548	2,544	2,544	2,551
No. of Students (persons)	**7,608,543**	**7,397,961**	**7,243,713**	**7,114,804**	**6,980,871**
Pre-Primary	1,010,700	980,825	921,489	900,666	890,328
No. Student-Room ratio	1.16	1.16	1.16	1.16	1.15
Primary	3,461,367	3,386,853	3,329,922	3,291,578	3,244,395
No. Student-Room ratio	1.17	1.17	1.17	1.17	1.17
Lower Secondary	2,036,863	1,901,340	1,829,744	1,789,585	1,767,833
No. Student-Room ratio	1.32	1.31	1.31	1.31	1.30
Upper Secondary	1,099,613	1,128,943	1,162,558	1,132,975	1,078,315
No. Student-Room ratio	1.36	1.36	1.36	1.36	1.34
No. Student-Room ratio	1.21	1.21	1.21	1.21	1.21
Total No. of Class rooms	**355,229**	**353,944**	**346,302**	**346,342**	**344,699**

Source: Ministry of Education

Table 4.8: Classroom Size Distribution

School Size	**Student per room**	**No. of Schools**
Size no.1	Less than 20 persons	1,059
	21 - 40	2,488
	41 - 60	3,388
	61 - 80	3,515
	81 - 100	2,768
	101 - 120	2,359
Sub Total		**15,577**
Size no.1	121 - 200	6,791
Size no. 3	201 - 300	3,547
Size no. 4	301 - 499	2,310
Size no. 5	500 - 1,499	1,899
Size no. 6	1,500 - 2,499	390

Size no. 7	more than 2,500	302
All		**30,816**

The forecasted number of students is used as a basis for an approximation of the number of teachers and school personnel needed and school facilities. Furthermore, a requirement of school facility between areas is differently distributed; we, therefore, apply a standard ratio provided by Ministry of Education. The required space on school facility is determined by the forecasted number of students and teachers.

Table 4.9: The assumption on student-teacher ratio

Education level	Number of students (per 1 teacher)
Primary school	25
Secondary	20
Vocational school (Classroom)	30
Vocational school (Operation labs)	15

For undergraduate level, we have applied the requirement ratio of college professors according to majors and professions. We have estimated the proportion of college students in each major by using the survey from OHEC[10] in 2016.

The parameters mentioned above will be used as starting value for needs project in this study. Together with these parameters, we will use also the cost per square meter of school building and facilities construction announced by the Ministry of Education as our benchmark as well. (See Tabel 4.11 below).

Table 4.10: The Student – Professor Requirement Ratio of college students as classified by major

Major	Proportion, %	Number of students (per 1 professor)
General Programme	1.22	18

[10] Office of the Higher Education Commission

Education	4.54	15
Humanities and Arts	8.85	25
Social Sciences, Business, and Law	42.54	25
Science, Mathematics, and Computing	12.41	20
Engineering, Manufacturing, and Construction	13.13	20
Agriculture and Veterinary	3.18	20
Health and Welfare	6.76	8
Services	4.33	25
Others	3.01	18

Source: Office of Higher Education, Thailand

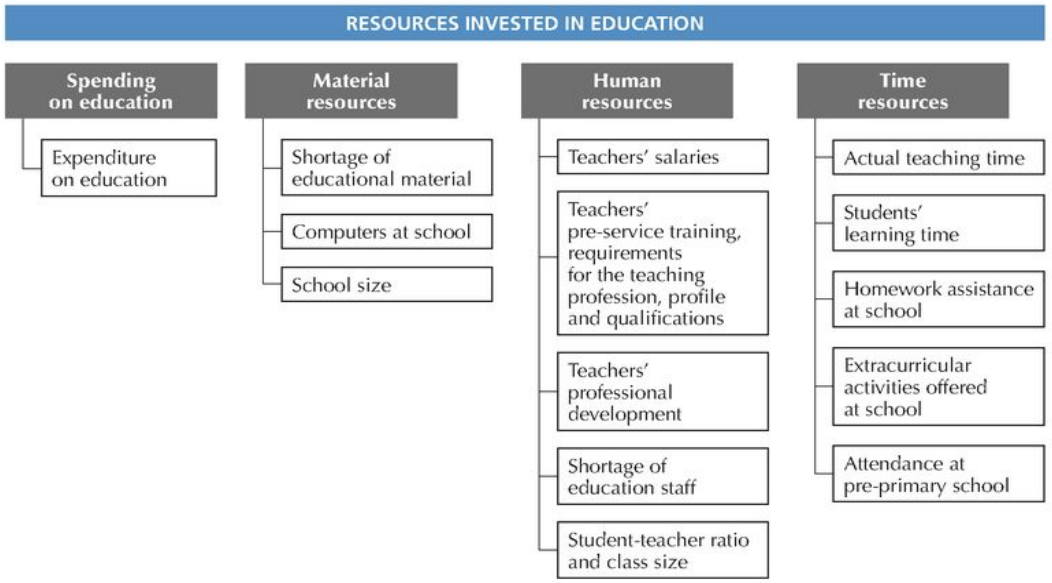
Applying ratio of teacher/student ratio for each major to calculate the number of college professors required we estimate *required school facility space* accordingly. We'll follow the Ministry of Education's standard for educational space demand and Ministry of Public Health's standard for the least space required for the school facility. Finally, we estimate the amount of space required for the school facility. The projection of budget for education section as a basis for the cost of the social infrastructure facility needed following the official guideline. As a result of declining fertilities, numbers of students at every educational level are expected to decline as well. This implies that the number of school personnel and total physical space needed will be declining.

However, as Thailand has had her PISA score and ranking much below an average of OECD. Thailand would not be able to build learning society with the '21st Century's skills' even though she would dream of in decades to come. Thus, to increase Thai's human skills we, therefore, need to invest in social investment other than just buildings, and hard infrastructure but also on soft infrastructure as well as social ones. Thailand has limited resources to be allocated to so many social programs every budget year.

Thus, we would like to propose a social infrastructure investment programme where physical buildings and laboratory would be maintained for minimum requirement but we would rather invest more in soft infrastructure like knowledge creation path. We mean the big data and information system of knowledge accessibility; invest in human knowledge in schools and university, a concentration of science and mathematical base of our student's achievement by PISA's recommendation. The more equitable allocation of educational resources throughout across income classes is necessary.

The OECD report (cf. PISA 2015) has emphasized the 4-dimension of social investment resources needed in education namely: spending on education or expenditure on education; material resource shown by shortage of educational materials, computer at schools, and school size; human resource investment needs showing by teachers' salaries, pre-services training's requirement for teaching profession profile and qualifications, teachers' professional development, shortage of educational staffs, students-teacher ratios and class size; and time resources which is actual teaching time, students' learning time, homework assistant at school, extracurricular activities offered at schools, and attendance at pre-primary school respectively.

Figure 4.5: Resources Need for Social Investment in Education



Source: OECD (2016), PISA 2015 Results (Volume II): Policies and Practices for Successful Schools, PISA, OECD Publishing, Paris
http://dx.doi.org/10.1787/97/89264267510-en

In our study, we have only projected the human resource needs, as well as physical space, needs *pro rata*. It is just part of the whole story. Our projection has

shown the declining needs for human resources in an undergraduate level of education requires some qualifications. As the number of population in schools decline, the intake to undergraduate or university level will be declining as well.

However, it would also imply that the physical number of instructor or human headcount would be *replaced* by the *soft infrastructure* on skills formation, management, information, and science and engineering facilities at the right faculty. The bid data accessibility would be tools to help for those deep learning of philosophy, geography, history, the spatial dimension of large database and software on maps and search engines etc.

As the world would come close to each other, the communication via media with multi-languages would require high-level software, thus, learning ability towards '21st Century Skills' can be improved among the Thais. This can raise understanding of own society, culture, history, and the world at large as its citizens.

Hereafter, we would try to estimate the social infrastructure needs in the schooling system. For basic education, lower secondary education (general stream), most of the facilities are more or less similar. They comprise main learning building, office building for general operation, and other facilities in schools. The official regulation of standard types, construction format, as well as fair price is sampling and shown below.

In order to be simple in estimation, we calibrate construction cost per square meter of the schooling system. These are *office building* for operation, *learning building,* and *facilities.* The cost is inclusive of related facilities and types of equipment. Thus, it is a lump sum unit value of school infrastructure investment.

The office building for operation is approximately 8,113.94 baht per square meter, 7,222.85 baht per square meter for learning building, and 8,146.56 baht per square meter for facilities construction. We use this unit value to estimate the cost of investment in constructions.

It should be noted here that the physical space need above means new buildings would be also needed as well. More importantly, some of the old buildings have to be dismantled as it has reached its assets' lifetime while some other buildings have to be rebuilt and maintenance for further use until the end of its lifetime of asset.

Table 4.11: Standard Designated Construction Building and Facilities for Schooling System

A. Office Bldg			
Types	Floor Area (sq. Meters)	Baht per (sq. Meters)	Imputed Bldg Value (Baht)
Type11	2,939.00	7,287.72	21,418,600
Type12	2,465.00	7,500.20	18,488,000
Type13	2,670.00	7,541.20	20,135,000
Type14	987.00	10,126.65	9,995,000
Average	2,265.25	8,113.94	17,509,150.00

Note: Type1 comprises concrete office building with air condition and/or fans , toilets, meeting rooms etc.

Table 4.11: Standard Designated Construction Building and Facilities for Schooling System (continued)

B. Learning Bldg			
Types	Floor Area (sq. Meters)	Baht per (sq. Meters)	Imputed Bldg Value (Baht)
Type21	324.00	7,030.86	2,278,000
Type22	229.50	7,124.18	1,635,000
Type23	306.00	7,019.61	2,148,000
Type24	382.00	7,023.56	2,683,000
Type25	459.00	7,104.58	3,261,000
Type26	230.00	8,139.13	1,872,000
Type27	306.00	8,437.91	2,582,000
Type28	244.00	8,303.28	2,026,000
Type29	320.00	8,518.75	2,726,000
Type210	630.00	6,473.02	4,078,000
Type211	783.00	6,398.47	5,010,000
Type212	936.00	6,279.91	5,878,000
Type213	635.00	10,992.13	6,980,000
Type214	791.00	10,418.46	8,241,000
Type215	630.00	6,914.29	4,356,000
Type216	630.00	7,163.49	4,513,000
Type217	630.00	7,390.48	4,656,000

Type218	630.00	7,668.25	4,831,000
Type 219	783.00	7,300.13	5,716,000
Type220	936.00	7,160.26	6,702,000
Type221	162.00	2,981.48	483,000
Type222	902.40	6,981.38	6,300,000
Type226	1,353.40	6,873.80	9,303,000
Type227	1,579.20	6,857.90	10,830,000
Type228	1,052.80	7,284.38	7,669,000
Type229	1,504.00	6,668.88	10,030,000
Type230	1,804.80	6,625.11	11,957,000
Type231	2,105.60	6,672.21	14,049,000
Type232	384.00	5,864.58	2,252,000
Type233	1,338.00	5,627.06	7,529,000
Type234	2,088.00	8,381.70	17,501,000
Type237	3,596.00	7,451.89	26,797,000
Average	896.40	7,222.85	6,464,750.00

Note: Type2 comprises concrete office building with lighting, blackboard, tables and chairs, fire extinguish tube, board, shelfs and cabinet for books etc.,

Table 4.11: Standard Designated Construction Building and Facilities for Schooling System (continued)

C. School Facilities			
Types	Floor Area (sq. Meters)	Baht per (sq. Meters)	Imputed Bldg Value (Baht)
Type31	200.00	5,270.00	1,054,000
Type38	532.00	5,562.03	2,959,000
Type311	1,840.00	6,838.04	12,582,000
Type313	796.00	6,925.88	5,513,000
Type315	77.00	7,585.71	584,100
Type319	507.00	9,124.26	4,626,000
Type324	17.50	15,720.00	275,100
Average	567.07	8,146.56	3,941,885.71

Note: Type3 comprises concrete office canteen, toilets, training rooms, lodging for teachers and for students, dormitory with facilities, sport and playground, water tanks, fences etc.

Source: Ministry of Education, Thai Government

Table 4.13: Hypothetical Physical Space Required by Basic and Vocational Education (Square Meters)

Year	Primary Education (sq. Meters)	Lower Secondary (sq. Meters)	Upper Secondary Vocational Stream (sq. Meters)	Upper Secondary General Stream (sq. Meters)
2016	48,851,854	33,062,109	6,415,682	18,193,782
2017	48,099,776	32,477,224	6,499,717	17,947,024
2018	47,345,749	31,907,832	6,576,414	17,735,247
2019	46,747,964	31,383,091	6,652,061	17,531,245
2020	46,252,969	30,818,899	6,726,308	17,335,569
2021	45,808,711	30,330,889	6,903,010	16,880,158
2022	45,350,480	29,935,273	7,020,822	16,592,070
2023	44,933,224	29,593,521	7,142,549	16,304,397
2024	44,572,736	29,304,430	7,273,798	16,004,793
2025	44,266,449	29,064,720	7,421,938	15,678,836
2026	43,784,312	28,784,305	7,520,966	15,469,639
2027	43,280,171	28,517,124	7,594,739	15,317,897
2028	42,756,582	28,256,018	7,652,355	15,201,690
2029	42,207,654	28,000,363	7,691,214	15,124,495
2030	41,625,217	27,753,771	7,705,040	15,097,307
2031	41,004,283	27,422,956	7,766,836	14,976,224
2032	40,376,791	27,086,914	7,834,742	14,845,285
2033	39,741,058	26,740,876	7,911,880	14,699,125
2034	39,095,542	26,381,314	7,999,496	14,536,346
2035	38,439,874	26,005,036	8,098,959	14,355,606
2036	37,774,333	25,609,713	8,211,894	14,155,426
2037	37,100,045	25,208,248	8,327,042	13,956,937
2038	36,418,759	24,799,596	8,445,964	13,757,613
2039	35,732,756	24,384,013	8,569,923	13,555,696
2040	35,044,823	23,962,662	8,700,233	13,349,574

Table 4.13: Hypothetical Cost and Saving of Investment in Physical Investment (Million Baht)

Year	Primary Education (Million Baht)	Lower Secondary (Million Baht)	Upper Secondary Vocational Stream (Million Baht)	Upper Secondary General Stream (Million Baht)
2016-2040	-99,726	-65,724	16,501	-34,989

The *pro rat*a estimated space required for basic education has shown declining needs, given the required space per person ratio. The change in space needs, if *positive* means incremental investment need if *negative* means cost saving in physical investment. This cost saving can be diverted to other educational facilities such as science lab, computer lab, big data, software, etc. for general education stream. For the vocational education, we still need to build new building inclusive of workshop facilities for training and each discipline. Using the average unit cost of construction of buildings cum facilities, we have found that it can be cost saving in investment if 're-allocation of budget' in basic education can be managed. We propose that schools can be managed in the same location. Schools assets and management can be consolidated for nearby location not beyond the assumed distance for feasible commuting of students. That is to say, in a selected location, the new school would be built with proper size and facilities which served for the 21st Century Skills. Thus, school assets would be kept to match with a number of declining students, and teachers, but more of technology and modern mode of educational types of equipment.

The foregoing analysis concentrates heavily on the physical capital development and related facilities. The social infrastructure investment has centered on physical capital. It is, however, necessary but not sufficient to lead Thailand to sustainable development target. In fact, the investment in human capital is a binding constraint for Thailand. This is pointed out by PISA that the material resource, spending on education, human resource, and time resource are four dimensions of the necessary resources in education development. Here, the human resource weights significantly in Thai social infrastructure. The time resources utilized by both students and teachers, instructors are not less important in Thailand. This would be future study.

4. Demand for Social Infrastructure: The General Public Services

4.1 Introduction

In this section, we would like to estimate the demand for social infrastructure to facilitate the service provision by the general government. The analysis is confined to the physical space needed central and regional government excluding the local government dimension. The Office of Civil Service Commission (OCSC) has started to formalize the modern civil service structure to turn from personal's Rank Classification in 1975 to be 'Position Classification, PC' in 2008. In other words, the single classification has been turned to a multi-classification scheme after evaluation of ability consistent with the private human resource market.

In this section, we would like to test the hypothesis that declining population growth, rising trend of human quality needs in Thailand, rising wage in the private sector has put a constraint to the Thai civil servant for the future intake and brain drain from the public sector to private sector in the labor market.

4.2 Brief Structure of Supply of Civil Servant System in Thailand

In 2013, there are 2.19 million persons (5.56% of total labor force and 3.38% of total population) who are private employees. In addition, 1.27 million persons or 58.09 percent are civil servants, permanent and temporary employees are 8.83 and 18.67 percent respectively. The rests are wage earners 14.41 percent respectively.

The civil servant of 2.17 million persons comprises educational instructors and related personnel of 34.36 percent and those belong to respective ministries of 28.86 percent (excluding those who belong prime minister office); police officers 16.57 percent; high education instructors and personnel 2.5 percent; parliament officers 0.24 percent; judicial related personnel of 0.62 percent; personnel from independent bureau under the constitution 1.35 percent; personnel under the BMR 2.84 percent and local autonomous government 12.66 percent respectively.

The distribution of civil servants 823,689 persons who belong to the central and regional government in 2013 was altogether 366,955 persons (44.5 %), while the rest belong to the local government respectively. It is noted that ministry of agriculture and agricultural cooperative has a number of personnel 16.89 percent, while the ministry of health has its personnel of 46.27 percent accordingly. This means most of government services deliveries to her citizens are located in the provincial area as well as localities.

However, as Thai population is aging while agricultural GDP is declining, it can be postulated that size of the civil servant of the ministry of agriculture would be declined as well. The social infrastructure for conducting health services will be on the contrary increased along with aging. But as we have shown in other chapters that health service will be covered by the universal health care service from the demand side other than the supply provided by the ministry of health, we can postulate that the number of health personnel under the ministry of health would be declining as well.

The health personnel demand may be shifted to local hospital and local sanitary centers, automated and long distance health consultation etc. In short, the number of personnel of central government would be reduced while it is not clear if the regional hospital would be privatized or belong to local government entities. In the meantime, regional and provincial health supply would still be dominance in Thailand. Thus, the modern hospital system would still be needed to be built with modern medical equipment and facilities.

The age distribution of civil servants are as follows: those with under 35 years old was 21.56 percent; while 50.57 percent has an age range of 35-49 year old, and 27.87 has aged over 50 years old respectively. The aging ministry which has its personnel with age over 50 years old is the ministry of agriculture 44.77 percent, the ministry of education 43.42 percent ministry of social development and human security 41.42 percent accordingly. The rest of ministries have their personals with age 35-49 and less than 35 years old. It is without a doubt that these ministries will have aging personnel concentration if no new recruitment of younger generations would not be considered in the next 10 years.

The education level of 1.27 million civil servants is noted as follows: university graduation 61.17 percent, master degree 16.38 percent and lower than undergraduate degree

19.53 percent and graduation with Ph.D. degree of only 2.92 percent respectively. It may be concluded that the civil servants are knowledge intensive system as far as background is counted. The OCSC is very conscious to grade up her civil servant knowledge content by further recruiting 7.52 percent of knowledge personnel while reducing the non-knowledge personnel.

4.3 Regression Analysis of the Inverse Supply Function of Public Service

We estimate the 'earning function' or the 'Inverse Supply function of public services personnel' given the following variables' definition:

```
SALARY =C(9) + C(1)*YSCHOOLING + C(2)*WYEAR + C(3)*POSITION_CLASSIFICATION +
         C(4)*(LOCAL_UNIVERSITY) + C(5)*DAY*LOCALTRAINING*TRAIN_WORKSHOP +
         C(6)*DAY*LOCALTRAINING*TRAIN_VISIT +
         C(7)*DAY*(1-LOCALTRAINING *TRAIN_WORKSHOP +
         C(8)*DAY*(1-LOCALTRAINING)*TRAIN_VISIT
```

YSCHOOLING	Year of schooling
WYEAR	Work experiences
LOCAL_UNIVERSITY	Dummy of university location)local =1)
DA	Length of human capital investment in days
LOCALTRAINING	Dummy of Local training site (local=1)
TRAIN_WORKSHOP	Training workshop
TRAIN_VISIT	Education trip

Figure 4.6: Profiles of Determinants of Human Capital Investment

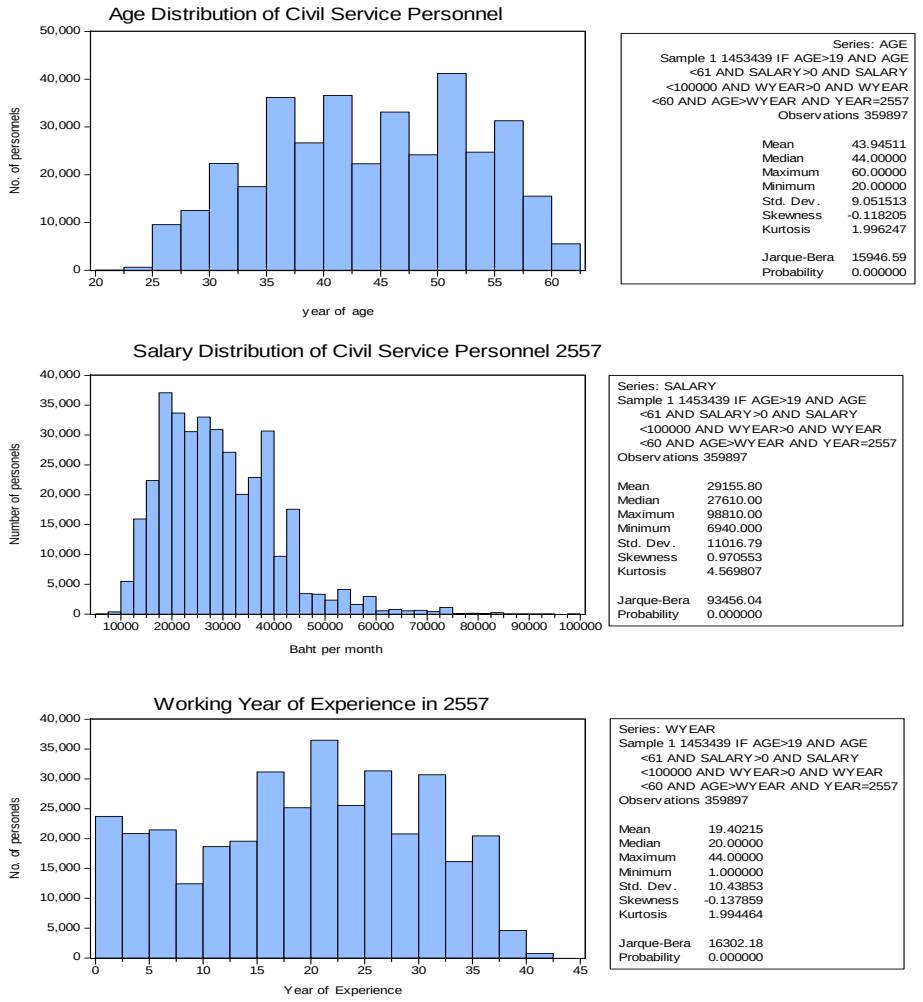


Table 4.14: Definition of Variables Used in the Model

Variables	Definition / Description	Units/Notes
SALARY	Salary of a civil servant as a proxy of return of human capital investment	Baht per month
POSITION_CLASSIFICATION	The position of civil servants as a proxy of human capital for t<= 60-year-old	Dummy with code level 12, 13, 14,
AGE	Age of civil servant	year
GENDERX; SEX	male and female gender of a civil servant	male =0 ; female = 1
YSCHOOLING	Years of schooling as a proxy for human capital investment	years, such as undergraduate level =16 years
WYEAR	working experiences	years of work

Table 4.15: Covariance Analysis

Sample: 1 1453439 Included observations: 1418266 Balanced sample (list wise missing value deletion)

Covariance	POSITION_CLASSIFICATION	AGE	SEX	SALARY	WYEAR	YSCHOOLING
POSITION_CLASSIFICATION	4.386101					
AGE	1.318343	78.46727				
SEX	0.029518	-0.636577	0.229785			
SALARY	7386.763	72511.62	-440.0400	1.23E+08		
WYEAR	1.952922	80.06679	-0.425744	85949.96	98.91415	
YSCHOOLING	1.177260	-0.963311	0.004361	3821.205	-1.270954	3.086011

Correlation	POSITION_CLASSIFICATION	AGE	SEX	SALARY	WYEAR	YSCHOOLING
POSITION_CLASSIFICATION	1.000000					
AGE	0.071063	1.000000				
SEX	0.029403	-0.149915	1.000000			
SALARY	0.318368	0.738886	-0.082860	1.000000		
WYEAR	0.093760	0.908822	-0.089301	0.780064	1.000000	
YSCHOOLING	0.319989	-0.061905	0.005178	0.196343	-0.072745	1.000000

SSCP	POSITION_CLASSIFICATION	AGE	SEX	SALARY	WYEAR	YSCHOOLING
POSITION_CLASSIFICATION	6220659.					
AGE	1869760.	1.11E+08				
SEX	41865.00	-902835.1	325896.9			
SALARY	1.05E+10	1.03E+11	-6.24E+08	1.74E+14		
WYEAR	2769763.	1.14E+08	-603817.9	1.22E+11	1.40E+08	
YSCHOOLING	1669668.	-1366232.	6184.613	5.42E+09	-1802550.	4376784.

t-Statistic	POSITION_CLASSIFICATION	AGE	SEX	SALARY	WYEAR	YSCHOOLING
POSITION_CLASSIFICATION	-----					
AGE	84.84428	-----				
SEX	35.03154	-180.5759	-----			
SALARY	399.9576	1305.886	-99.01921	-----		
WYEAR	112.1533	2594.361	-106.7763	1484.716	-----	
YSCHOOLING	402.2256	-73.86453	6.167074	238.4685	-86.86252	-----

Probability	POSITION_CLASSIFICATI	AGE	SEX	SALARY	WYEAR	YSCHOOLING

	ON					
POSITION_CLASSIFICATION	-----					
AGE	0.0000	-----				
SEX	0.0000	0.0000	-----			
SALARY	0.0000	0.0000	0.0000	-----		
WYEAR	0.0000	0.0000	0.0000	0.0000	-----	
YSCHOOLING	0.0000	0.0000	0.0000	0.0000	0.0000	-----

Note: Covariance= measure of dispersion; Correlation = measure of relations; Sum of squared crossed-product (SSCP); t-statistic measure of significance; Probability of rejection Null Hypothesis

Table 4.16: Model (1) Earning function or Inverse Supply function of Civil service Personnel (data use 2011-2014)

Dependent Variable: SALARY			
Variable	**Coefficient**	**Std. Error**	**Prob.**
C	-17662.33	132.8148	0.0000
WYEAR	888.73	0.52517	0.0000
YSCHOOLING	1600.18	8.236445	0.0000
SEX	-420.81	10.98112	0.0000
Y2555	2676.26	14.6992	0.0000
Y2556	1753.66	14.71059	0.0000
Y2557	3757.17	14.69304	0.0000
ECON_MINISTRY	2779.81	162.9037	0.0000
SOC_MINISTRY	759.67	144.3563	0.0000
YSCHOOLING*ECON_MINISTRY	-159.43	10.19787	0.0000
YSCHOOLING*SOC_MINISTRY	4.13	9.035767	0.6472
R-squared	0.6895		
F-statistic	314904.10		
Prob (F-statistic)	0.000000		
Durbin-Watson stat	1.379399		

If Wyear (+) : experiences increase one year implies an increase of salary of 888.73 baht per month; YSCHOOLING (+) increases one year means salary increase 1,600.18 baht per month. Female civil servant received 420 baht per month less than male.

If he or she belongs to the ministries which administering economic development and growth 'ECON_MINISTRY' would obtain 2779.81 baht per month compared with 759.67 baht per month for social related ministries 'SOC_MINISTRY'.

Table 4.17: Model (2) Earning Function or Inverse Supply Function of Civil Service Personnel In 2557

Dependent Variable: SALARY
Method: Least Squares
Date: 08/19/15 Time: 12:53
Sample: 1 1453439 IF AGE>19 AND AGE<61 AND SALARY>0 AND SALARY<100000 AND WYEAR>0 AND WYEAR<60 AND AGE>WYEAR AND YEAR=2557
Included observations: 357434

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-25348.40	81.93187	-309.3839	0.0000
YSCHOOLING	438.1599	5.396000	81.20088	0.0000
WYEAR	765.6643	0.816798	937.3968	0.0000
POSITION_CLASSIFICATION	2088.559	4.772625	437.6122	0.0000
SEX	-667.3262	17.45822	-38.22419	0.0000

R-squared	0.798086	Mean dependent var	29177.26
Adjusted R-squared	0.798084	S.D. dependent var	11005.66
S.E. of regression	4945.401	Akaike info criterion	19.85032
Sum squared resid	8.74E+12	Schwarz criterion	19.85047
Log likelihood	-3547584.	Hannan-Quinn criter.	19.85036
F-statistic	353194.3	Durbin-Watson stat	1.830734
Prob(F-statistic)	0.000000		

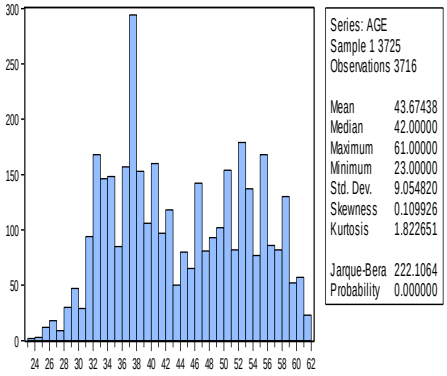
Table 4.18: Model (3) Elasticity at means of each variable (Standardized coefficients)

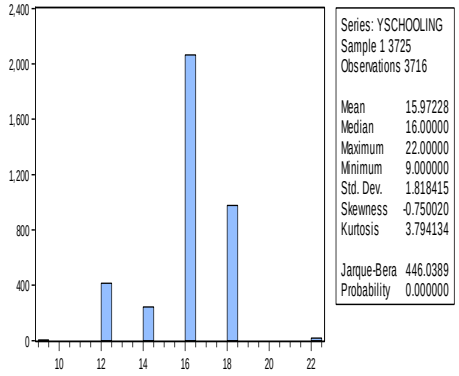
Scaled Coefficients
Date: 08/19/15 Time: 12:54
Sample: 1 1453439 IF AGE>19 AND AGE<61 AND SALARY>0 AND SALARY<100000 AND WYEAR>0 AND WYEAR<60 AND AGE>WYEAR AND YEAR=2557
Included observations: 357434

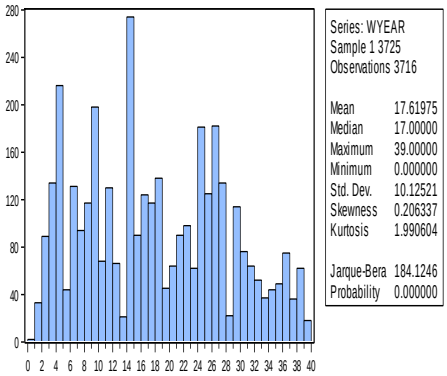
Variable	Coefficient	Standardized Coefficient	Elasticity at Means
C	-25348.40	NA	-0.868772
YSCHOOLING	438.1599	0.071625	0.239229
WYEAR	765.6643	0.725499	0.509361
POSITION_CLASSIFICATION	2088.559	0.390752	1.135041
SEX	-667.3262	-0.028928	-0.014858

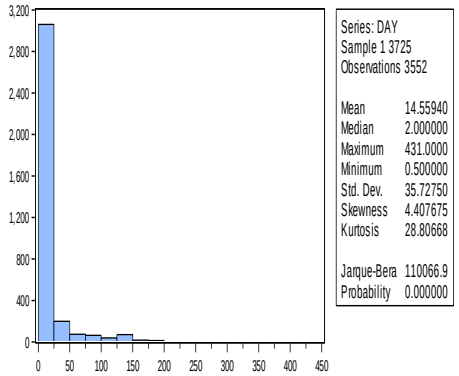
Notes: (1) standardized coefficients are point estimates of coefficients after adjusted by a standard deviation of the dependent variable.
(2) Elasticity at means is point estimates of dependent variable after scaled by mean or the regressor.

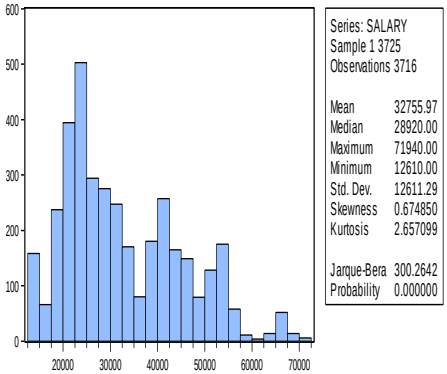
Figure 4.7: Age education Work Experiences and Salary of Civil Servant











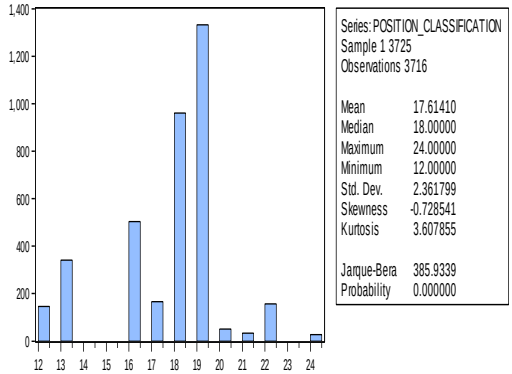


Figure 4.8: Binary Relationship between Variables of Civil Servants

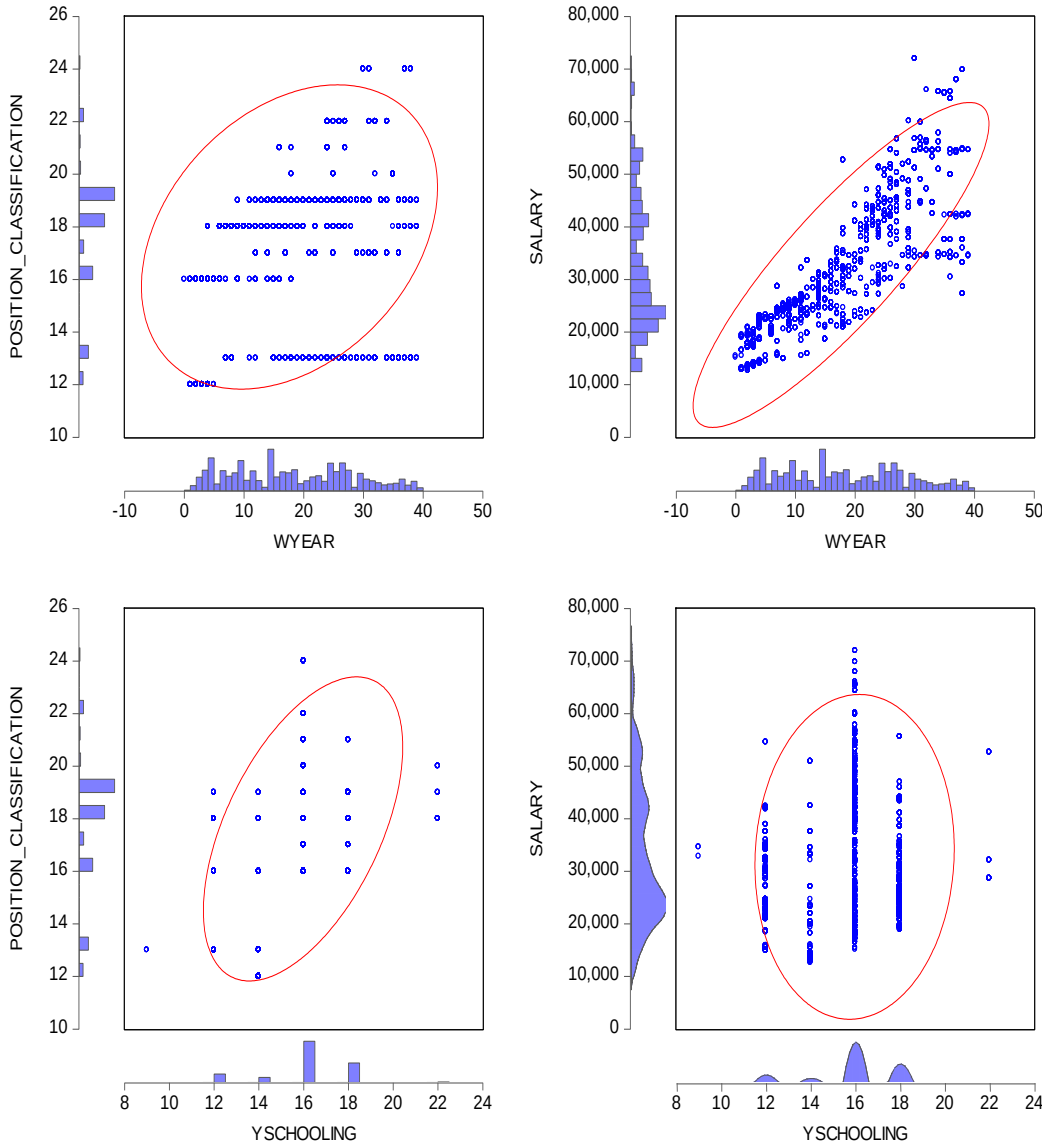


Table 4.19: Human Capital Investment

Origin of University ย				
Year of schooling		Foreign	Domestic	Total
	9	0	3	3
	12	0	414	414
	14	0	242	242
	16	205	1859	2064
	18	305	670	975
	22	18	0	18
	Total	528	3188	3716

Measures of Association: Phi Coefficient=0.360131; Cramer's V= 0.360131; Contingency Coefficient = 0.338829; Test Statistics: Pearson X2 with degree of freedom = 5, value =481.9441, Prob.=0.0; Likelihood Ratio G2 with degree of freedom=5, value = 490.3374, Prob.=0.0.

Table 4.19: Human Capital Investment (continued)

Type	Frequency	%	Accumulate	%
Training	3357	90.12	3357	90.12
Education Trip	54	1.45	3411	91.57
Seminar	273	7.33	3684	98.90
Meeting	41	1.10	3725	100.00
All	3725	100.00	3725	100.00

Table 4.19: Human Capital Investment (continued)

	Training	Education Trip	Seminar	Meeting	All
0.5	767	6	205	28	1,006
1.0	1	0	7	0	8
2.0	888	5	34	4	931
3.0	340	6	9	4	359
4.0	150	5	10	1	166
5.0	114	11	0	2	127
6.0	8	11	0	0	19
7.0	44	5	1	0	50
8.0	28	2	0	0	30
9.0	51	0	6	0	57
10.0	38	0	0	2	40
11.0	48	1	0	0	49
12.0	52	1	0	0	53
13.0	12	0	0	0	12
14.0	8	0	0	0	8
15.0	19	0	0	0	19
16.0	67	0	0	0	67
17.0	5	0	0	0	5
18.0	10	0	0	0	10
19.0	1	0	0	0	1
Total	2,651	53	272	41	3,017

Note: Phi Coefficient 507553.0;Cramer's V293036.0;Contingency Coefficient 452594.0;
Test Statistics (1) Pearson X 2with degree of freedom =57; value=2096.777; Prob.=0000.0,
(2) Likelihood Ratio G 2with degree of freedom =57; value =4120.462; Prob.=0000.0

Table 4.19: Human Capital Investment (continued)

	Destination		
	Foreign	Domestic	All
Training	56	3301	3,357
Education Trip	11	43	54
Seminar	3	270	273
Meeting	0	41	41
All	70	3,655	3,725

The civil servants have engaged in human capital investment on average 14.5 days with 84.94 percent, not over 20 days. The engagements are training, education trip, seminar, and meeting respectively. Mostly, the activities are in Thailand. We, therefore, estimate the model of human capital investment with training and other short-term

investment as follows:

Table 4.20: Result of Testing of hypothesis H0: C(i)= 0; i=1,2,3,….9

	Coefficient	Std. Error	t-Statistic	Prob.
constant	-25737.02	848.0579	-30.34818	0.0000
YSCHOOLING	1202.791	61.47796	19.56458	0.0000
WYEAR	1055.304	9.617122	109.7318	0.0000
POSITION_CLASSIFICATION	1166.349	46.70874	24.97069	0.0000
(LOCAL_UNIVERSITY)	-245.3998	225.6256	-1.087642	0.2768
DAY*LOCALTRAINING*TRAIN_WORKSHOP	19.03371	2.148968	8.857141	0.0000
DAY*LOCALTRAINING*TRAIN_VISIT	514.9100	135.9648	3.787082	0.0002
DAY*(1-LOCALTRAINING) *TRAIN_WORKSHOP	25.83331	11.11629	2.323915	0.0202
DAY*(1-LOCALTRAINING)*TRAIN_VISIT	257.4321	125.2429	2.055463	0.0399
R-squared	0.875338	Mean dependent var		33030.34
Adjusted R-squared	0.875056	S.D. dependent var		12605.60
S.E. of regression	4455.748	Akaike info criterion		19.64431
Sum squared resid	7.02E+10	Schwarz criterion		19.65999
Log likelihood	-34790.90	Hannan-Quinn criter.		19.64991
F-statistic	3101.845	Durbin-Watson stat		0.300965
Prob(F-statistic)	0.000000			

It is found that human capital investment either long-term such as years of schooling, experiences of work, a position of work have a positive relationship with salary to identify the inverse supply function of civil servants services. Interestingly, that who have graduated from local university has a negative relationship with salary (left-hand variable representing the marginal productivity of supply response to right-hand variables). This may imply that the return to human capital investment is rationally valued since the cost of investment is higher abroad.

In conclusion, the regression analysis points out clearly that the supply of public services by civil servants as shown by the 'inverse supply function of a civil servant as a function of right-hand variables'. The left-hand variable 'salary' represents the marginal productivity of civil servant. It is an index of return to human capital investment by various determents on the right-hand sides. In other words, the supply function is 'normal' and passes the test of a return to human capital investment.

As population aging will be in effect in near future for the next 10-20 years. This means that private sector would offer a higher wage to the workforce. As a result, there may be a brain drain from the civil servant workforce to the private sector. Thus, the planning strategy for Thailand on the social infrastructure demand is rather opposite to what we have firstly postulated. Thailand in the next decade would rather need the human capital investment facilities as well as the investment in the human knowledge itself. This is to meet the challenges of Skill of the 21st Century.

The planning target is therefore to reduce the number of public services personnel both civil servants and others. On the contrary, it is necessary to raise the quality of human

capability through the knowledge base investment process. Thus, on

We have applied our macro-econometric model to perform forecasting scenarios of aggregate demand components as follows:

Table 4.21: Macroeconomic Forecast 2015-2020

	2015	2016	2017	2018	2019	2020
GDPR (Baseline)	11,342,828	11,563,480	11,810,901	12,089,282	12,407,79	12,780,
(% chg.)	1.68	1.95	2.14	2.36	2.63	3
PCER (Baseline)	6,056,269	6,155,578	6,266,665	6,391,384	6,533,77	6,699,
(% chg.)	1.41	1.64	1.8	1.99	2.23	2.54
GFCFR	2,922,714	2,963,227	3,005,145	3,050,948	3,102,49	3,161,
(% chg.)	1.5	1.4	1.4	1.5	1.7	1.9
EXGSR	8,296,806	8,332,258	8,462,491	8,596,210	8,736,01	8,882,
(% chg.)	0.3	0.4	1.6	1.6	1.6	1.7
IMGSR	7,614,825	7,646,676	7,833,444	8,124,511	8,387,11	8,634,
(% chg.)	-0.7	0.4	2.4	3.7	3.2	2.9

Source: This is the Quarterly Macro econometric Model for Thailand constructed in our study.

4.4 Estimate the Demand for Social Infrastructure: Public Services Space

We use the macro model to project the employment demand 2015-2020 of the public sector services (inclusive of the defense and social security, as noted in the database of Labor Force Survey). The projected 'office space requirement' is estimated by multiplying the projected public services personnel with 'office space ratio per one officer'. The parameter assumes that each officer will require a 'cubicle space' of *80 usable square feet* (USF) following the U.S. General Services Administration. It is however proposed to be 12-14 square meters per person for business space[11].

Table 4.22: Data sources for the calculation

Data	Source	Unit
Demographic Projection	NESDB; 2013 Thailand population projection	Thousands of people
Thai Government Agency Information 2009, civil servants	Electronic Government Agency (Public Organization)	Thousands of people
Required space for officers (1)	U.S. General Services Administration = 80 USF	Usable Square Feet per person
Required space for officers (2)	http://www.realcommercial.com.au	12-14 square meter per person

[11] http://www.realcommercial.com.au

cost of construction investment	this study	8,113.94 baht per sq. meter

The office space needed for the public services in the scenarios has declined as expected. Here, the rationalization of public employees (both civil servant and defense services personnel) would give rise to the reduced office space as shown below. The cost reduction of construction investment in a government building does not mean there will be no new construction of buildings and their modern facilities. In opposite, it means the manpower reduction either by mandatory or by market forces may give rise to the reduction either way. The civil servant personals

Table 4.23: The Scenario of Public Employment Reduction and Cost Saving of Public Need of Social Infrastructure

employment in Public Admin (1,000 persons)	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
(Baseline)	1,8	1,848.	1,899.8	1,955	2,018.2	2,087.6
(Year % change.)	2.6	2.6	2.8	3	3.2	3.4
(Scenario)	1,777	1,757	1,721	1,676	1,627	1,577
(Year % change)	1.2	-1.1	-2.1	-2.6	-2.9	-3.1
Office space requirement, sq. Meter.	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
(1) Baseline in 1,000 sq. Meter	25,222	25,883	26,597	27,383	28,255	29,226
(2) Scenario in 1,000 sq.Meter	24,878	24,598	24,094	23,464	22,778	22,078
Construction *cost saving* million baht	2,794.44	10,428.04	20,310.81	31,795.29	44,438.43	58,001.69

Note: construction *cost saving* = base line office space need (1) minus the scenarios (2)

5. Conclusion and Policy Recommendations

The foregoing analysis has implied for policy formulation in the social infrastructure demand to facilitate the education and public services as follows;

(1) The education system in Thailand when benchmarking with an international standard like PISA has shown that Thailand was far behind the target of development towards the 21st Century Skills.

(2) The demand for social infrastructure has two dimensions which are modern infrastructures as necessary and human capability investment sufficient condition for a new era of economic and social development in Thailand. The current global trend has shifted social investment in human capability and skills as a necessary condition rather than the sufficient condition as mentioned. The analysis has proved that shifting priority has produced

a 'cost saving' in building investment. This can help further investment in social infrastructure. The analysis of public services is similarly assessed and arrives at the same conclusion.

(3) The present budgetary system which heavily concentrates on current expenditure, not the capital investment is not consistent with this new vision. The policy implication of this is how to redesign the budgetary system in Thailand. This is current budgetary allocation, as well as the long-term investment from financial market both domestic and world financial market. If the debt-service ratio has been proved to provide sustainable economic and social development in the long-run.

Appendix Table A1: Number Of Institutions (The Formal School System) By Jurisdiction In Whole Kingdom: Academic Year 2006-2014

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	**38,318**	**38,527**	**38,455**	**38,347**	**38,376**	**38,383**	**38,455**	**38,010**	**38,069**
Ministry of Education	**36,650**	**36,712**	**36,288**	**36,039**	**36,016**	**35,960**	**36,026**	**35,595**	**35,446**
1. Office of the Permanent Secretary	**3,798**	**3,899**	**3,915**	**3,968**	**4,025**	**4,107**	**4,167**	**4,001**	**3,951**
(Office of the Private Education Commission[1/])									
1.1 Private General Education Schools	3,306	3,371	3,367	3,401	3,450	3,679	3,709	3,543	3,506
1.1.1 General Education	3,040	3,086	3,079	3,111	3,450	3,162	3,185	3,032	
1.1.2 Islamic Teaching and General Education	266	285	288	290		517	524	511	
1.2 Private Vocational Education Schools	411	417	424	418	421	428	458	458	445
1.3 Private Special Education Schools	15	15	16	19	20	-	-	-	-
1.4 Private Welfare Education Schools	73	96	118	130	134	-	-	-	-
(General Education and Vocational Education)									
2. Office of the Basic Education Commission	**32,288**	**32,262**	**31,821**	**31,508**	**31,424**	**31,286**	**31,286**	**31,021**	**30,922**
2.1 General Education	32,200	32,169	31,728	31,415	31,331	31,193	31,193	30,927	30,828
2.2 Special Education	43	43	43	43	50	43	43	51	51
2.3 Welfare Education	45	50	50	50	43	50	50	43	43
3. Office of Vocation Education Commission	**404**	**404**	**404**	**415**	**415**	**415**	**421**	**421**	**421**
3.1 Technical Colleges	109	109	109	109	110	110	114	120	120
3.2 Industrial & Community Colleges	144	144	144	144	142	142	142	137	137

3.3 Business Administration & Tourism Colleges	3	3	3	3	3	3	3	3	3
3.4 Commercial Colleges	5	5	5	5	5	5	5	5	5
3.5 Arts and Crafts Colleges	2	2	2	2	2	2	2	2	2
3.6 Polytechnic Colleges	54	54	54	53	53	53	52	52	52
3.7 Vocational Colleges	36	36	36	36	36	36	37	37	37
3.8 Technology and Management Colleges	-	-	-	11	11	11	13	12	12
3.9 Agricultural and Technology Colleges	43	43	43	43	43	43	43	43	43
3.10 Golden Jubilee Royal Goldsmith College	1	1	1	1	1	1	1	1	1
3.11 Industrial and Ship Building Colleges	3	3	3	3	3	3	3	3	3
3.12 Fishery Colleges	3	3	3	4	4	4	4	4	4
3.13 Agricultural Engineering Training Centers	1	1	1	1	1	1	1		
Vocational Education College								1	1
3.14 Science Based Technology Vocational College	-	-	-	-	1	1	1	1	1
4. Office of the Higher Education Commission	**159**	**146**	**147**	**147**	**151**	**151**	**151**	**151**	**151**
4.1 Demonstration Schools [2/]	(41)	(52)	(60)	(60)	(60)	(57)	(57)	(57)	(57)
4.2 Community College [3/]	18	1 (18)	1 (19)	1 (18)	1 (20)	1 (20)	1 (19)	1(19)	1(19)
4.3 Institutions of Higher Education	141	145	146	146	150	150	150	150	150
4.3.1 Public Institutions of Higher Education	78	78	78	78	79	79	79	79	79
4.3.2 Private Institutions of Higher Education	63	67	68	68	71	71	71	71	71
Organizations under the supervision of the Ministry of Education :	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
5. Mahidol Wittayanusorn School									

	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Other Organizations	**1,668**	**1,815**	**2,167**	**2,308**	**2,360**	**2,423**	**2,429**	**2,415**	**2,623**
6. Ministry of Interior	**546**	**691**	**1,046**	**1,187**	**1,225**	**1,290**	**1,292**	**1,292**	**1,481**
7. Ministry of Social Development and Human Security :	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
8. Bangkok Metropolitan Administration :	**437**	**437**	**437**	**437**	**437**	**438**	**438**	**438**	**440**
8.1 Department of Education	435	435	435	435	435	436	436	436	438
8.2 Department of Medical Services	2	2	2	2	2	-	-	-	-
8.2 Bangkok Metropolitan University	-	-	-	-	-	2	2	-	-
8.2 Navamindradhiraj University	-	-	-	-	-	-	-	2	2
9. Ministry of Public Health :	**37**	**37**	**37**	**37**	**37**	**37**	**37**	**37**	**37**
Office of the Permanent Secretary :Praborommarajchanok Institute	37	37	37	37	37	37	37	37	37
10. Ministry of Transport	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
10.1 The Merchant Marine Training Centre	1	1	1	1	1	1	1	1	1
10.2 The Civil Aviation Training Centre	1	1	1	1	1	1	1	1	1
11. Ministry of Defense	**11**	**13**	**15**	**15**	**15**	**16**	**16**	**16**	**16**
12. Ministry of Culture	**16**	**16**	**16**	**16**	**19**	**16**	**16**	**16**	**16**
12.1 Bunditpatanasilpa Institute	1	1	1	1	2	1	1	1	1
12.2 Colleges of Dramatic Arts	12	12	12	12	12	12	12	12	12
12.3 Colleges of Fine Arts	3	3	3	3	5	3	3	3	3
13. Ministry of Tourisms and Sports	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**
13.1 Office of Sports and Recreation									

	28	28	28	28	28	28	28	28	28
13.1.1 Sport Schools	11	11	11	11	11	11	11	11	11
13.1.2 Physical Education Colleges	17	17	17	17	17	17	17	17	17
14. The Bureau of National Buddhism :	**396**	**396**	**399**	**400**	**410**	**414**	**414**	**405**	**403**
Scripture Schools for General Education	396	396	399	400	410	414	414	405	403
15. Organizations Under the Prime Minister	**192**	**192**	**184**	**183**	**184**	**179**	**183**	**178**	**197**
15.1 Royal Thai Police :	192	192	184	183	184	179	183	178	**197**
15.1.1 Border Patrol Police General Headquarters	191	191	183	182	183	178	182	177	196
15.1.2 Police Cadet Academy	1	1	1	1	1	1	1	1	1

1/ There is some redundant information with the number of schools that open for both general and vocational education

2/ The number of institutions under the office of the higher education commission not includes the number of demonstration schools because of the demonstration schools are considered the department of universities instead of the institutions

3/ The number of institutions under the office of the higher education commission

Note: Agricultural Engineering Training Centers the Name was Changed Vocational Education College (In the academic year 2013)

Source: Office of the Permanent Secretary, Ministry of Education

Chapter 5

Social Infrastructure Demand for Health Services

1. Introduction

In Thailand, the main organization administrating the public healthcare service is the Ministry of Public Health (MOPH). The history of public health services has been started in 1888. At the time, the main service was from the Department of Nursing, Ministry of Education. In 1918, the operation was under the Ministry of Interior, where the Public Health Department was established. In 1942, the health services have been consolidated under the Ministry of Public Health according to the Reorganization of Ministries, Sub-Ministries, and Departments Act, B.E. 2485 (1942).

The public health service philosophy has been substantially changed in 2002. The civilian government has introduced a health system with the 'Universal Coverage Scheme' (UCS). The UCS has implemented a nationwide *healthcare coverage* for the major population. The service was managed by a new organization, *National Health Security Office* (NHSO). The philosophy of management is to separate supervision of supply and demand for healthcare. The healthcare *demand* by all clients will be consolidated under the supervision of NHSO. The healthcare supply is provided by the hospitals under the MOPH and private hospital, which are additional providers. Under this scheme, the NHSO functions as a clearinghouse of all health care purchasers.

Clearly, the UCS system has empowered any Thai's accessibility to fundamental healthcare service. The government has shifted the *supply side* budgetary system allocated through the MOPH to the demand side with capitation system. Conceptually, the total cost of supply provision has been equated from the assumed equilibrium between demand and supply of health service, where 'average cost of provision=average buying price of health service per capita'. The former is basically calculated from the *ex-ante* average cost given size of hospital measured by a number of hospital beds. It is calculated by matching allocated budget to each hospital by the number of patients multiplied by a unit cost of medical care per person on the average. The capitation of medical demand price is equated with the average cost per client. Payment is agreed through the budgetary process to the providers via the UCS. Thus, it is a budgeting process of the parliamentary system where the whole feedback loop between demand and supply are determined by population's needs and cost of provisions. The demand side was calculated from the given population cohort weighted by probability of illness of in-out patients, less success rate in precautionary effort. Recently, the stochastic influence of 'non-communicable disease, NCD' has distorted the demand price and cost of supply unexpectedly. As a result, the *ex-post* demand price

and average cost has created wide *margin of gap*. This is currently a hot debate in Thailand among practitioners, NPO and general public of the UCS.

Ideally, a consolidated fraction of financial account of the UCS (fully funded by the government), Social Security (funded through a joint contribution of employee and employer), the Civil Servant Medical Benefit Scheme (CSMBS), and other programs such as private health insurances is ultimate aim of the health system in Thailand. This is still far from actualization. A consolidated demand under the UCS has been claimed to improve social welfare of the Thais households on health accessibility. Problems still remain on the supply side and personnel's welfare i.e., medical doctors and others, as well as capital investment of hospitals owing to the rising marginal cost of supply provision, uneven congestion of demand and spatial inequality of service supply.

In our study, the evolution of Thailand's healthcare service and UCS has been examined and used as the case study. Despite the hot debates of UCS, it was however quoted as "one of the most ambitious healthcare reforms ever undertaken in a developing country" in the report titled *Millions Saved: New Cases of Proven Success in Global Health*.[1] According to this report, Thailand's health care evolution offers the healthcare service covering 98% of the population and costs only $80 per person. A study in infant mortality has documented that this program succeeded in lowering the equity gap in infant health between the rich and the poor.[2]

It was cited by a famous economist such as Amartya Sen as follows.[3]

"... This includes the remarkable achievements of Thailand, which has had for the last decade and a half a powerful political commitment to providing inexpensive, reliable healthcare for all.

Thailand's experience in universal healthcare is exemplary, both in advancing health achievements across the board and in reducing inequalities between classes and regions.

Prior to the introduction of UHC in 2001, there was reasonably good insurance coverage for about a quarter of the population. This privileged group included well-placed government servants, who qualified for a civil service medical benefits scheme, and employees in the privately owned organized sector, which had a mandatory social security scheme from 1990 onwards, and received some government subsidy.

*In the 1990s some further schemes of government subsidy did emerge, however they proved woefully inadequate. The bulk of the population had to continue to rely largely on out-of-pocket payments for medical care. However, in 2001 the government introduced a "**30 baht universal coverage programme**" that, for the*

[1] http://millionssaved.cgdev.org/case-studies/thailands-universal-coverage-scheme
[2] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3998713

[3] **Amartya Sen**, Universal healthcare: the affordable dream, *https://www.theguardian.com/society/2015/jan/06/-sp-universal-healthcare-the-affordable-dream-amartya-sen*

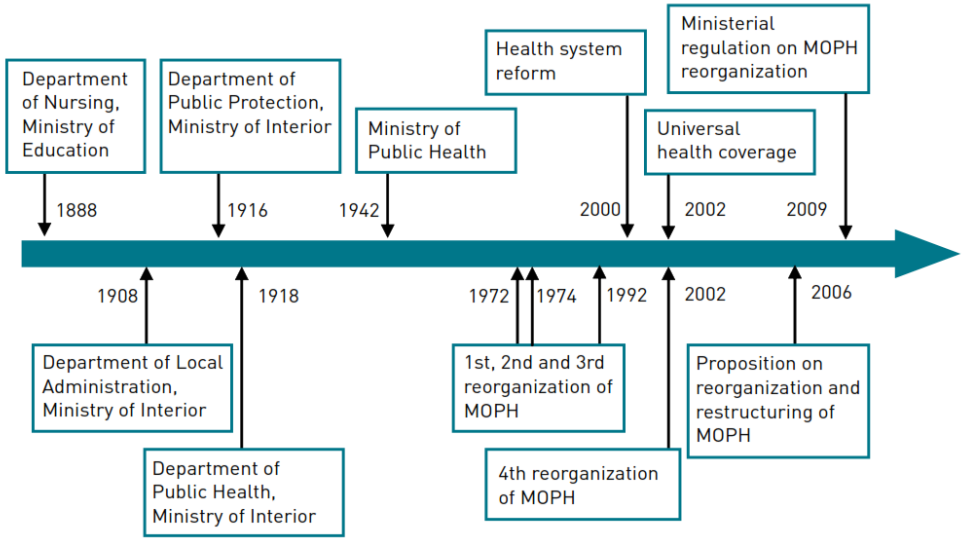
first time, covered ***all*** *the population, with a guarantee that a patient would not have to pay more than 30 baht (about 60p) per visit for medical care (there is exemption for all charges for the poorer sections – about a quarter – of the population).*

The result of universal health coverage in Thailand has been a significant ***fall in mortality*** *(particularly infant and child mortality, with infant mortality as low as 11 per 1,000) and a remarkable* ***rise in life expectancy,*** *which is now more than 74 years at birth – major achievements for a poor country.*

There has also been an astonishing removal of historic disparities in infant mortality between the poorer and richer regions of Thailand; so much so that Thailand's low infant mortality rate is now shared by the poorer and richer parts of the country. …"

Also, the report published by the World Bank indicates that UCS has reduced the number of people reporting themselves to be too sick to work.[4] Although the evolution of healthcare service in Thailand has led to substantial benefits to the nationwide population for 14 years, there still will be challenges in the future due to the aging society in Thailand. Therefore, this report aims at exploring the preparation of health infrastructure to the future change in demographics in Thailand.

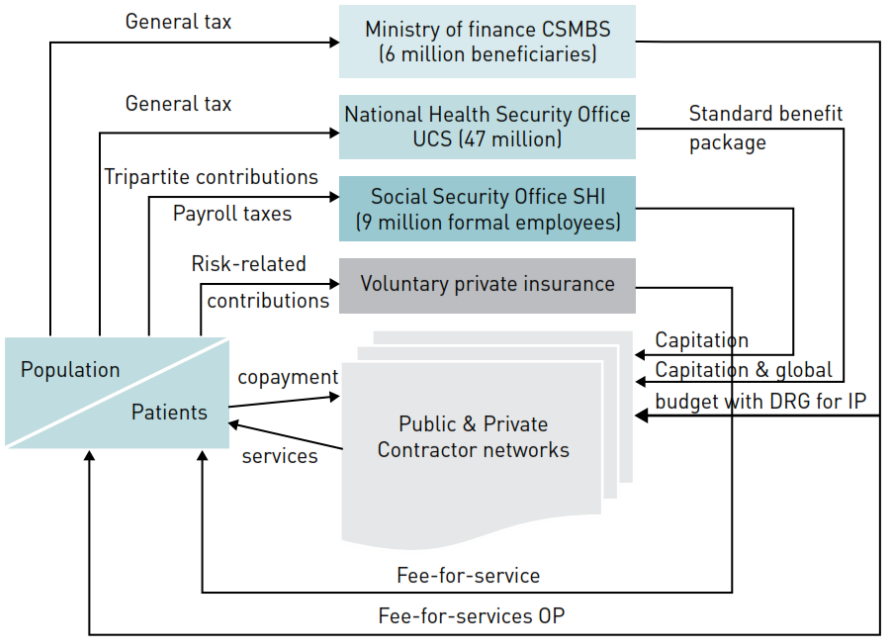
Figure 5.1 Chronology of development of public health in Thailand



Source: Tangcharoensathien et al. (2015) and Wibulpolprasert et al. (2011)

[4] http://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-6119

Figure 5.2 The structure of healthcare coverage and its sources of funds in Thailand



CSMBS: Civil Servant Medical Benefit Scheme; DRG: diagnosis-related group; IP: inpatient; OP: outpatient; SHI: Social Health Insurance; UCS: Universal Coverage Scheme.

Source: Tangcharoensathien et al. (2015)

2. Main Analytical Framework

The analysis is based on the main structure of healthcare service in Thailand. Particularly, the service has been classified into 4 broad categories of service levels, which are provided by the primary hospital, the secondary hospital, the tertiary hospital, and the excellent center. The demographic statistics is the main data source.

The next step of estimation is the computation using the ratio of *required healthcare demand per population* in each level of the hospital. The calculation generates the demand for both human resources and facilities in healthcare service for a particular category of hospital. The last step of computation is the estimate of a required total budget for both human resources and facilities.

The base case projection was obtained from the service plan (2011-2016) of Thailand's Ministry of Public Health. This plan has been formulated to estimate the nationwide demands for both facilities and human resources. In addition, the plan has been used as the main guideline for

administrating public health services which have the hierarchy of services and facilities. Thailand's Ministry of Public Health has classified hospitals into 6 categories.

The classification's criteria are the following factors:

(1) Size of a population in that area (for example, the primary hospital has the ratio of one hospital per population of 10,000)

(2) Distance (kilometers) from the center of a particular district to the hospital

(3) Traveling time (minutes) from the center of a particular district to the hospital

Figure 5.3 Main structure of estimation methodology

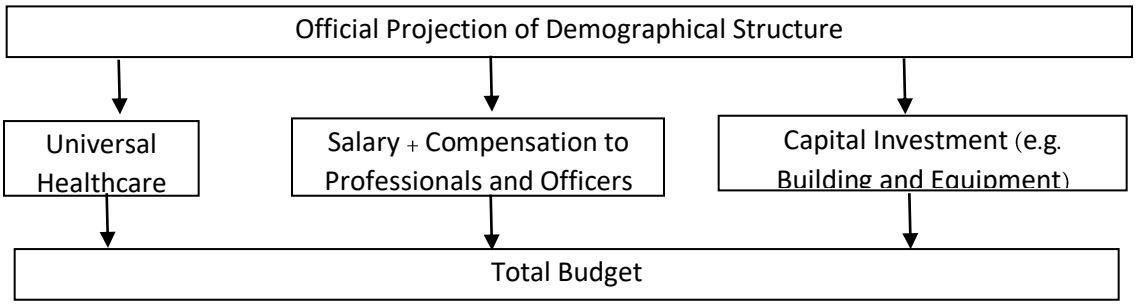
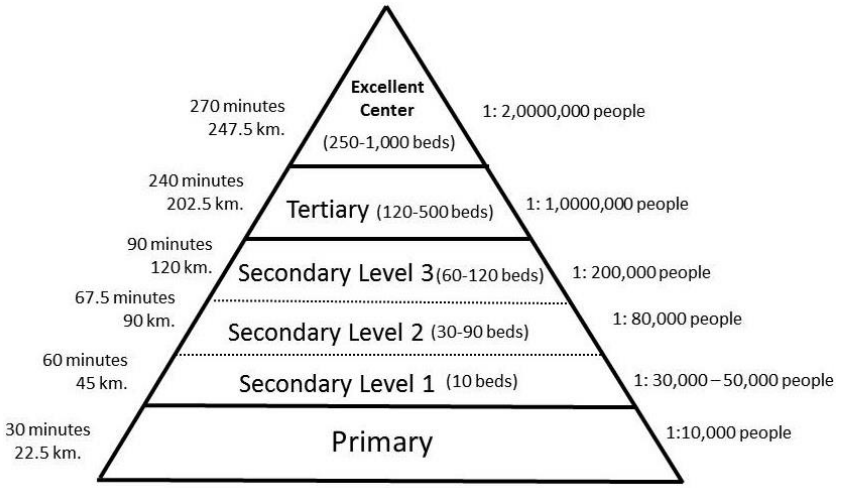


Figure 5.4: Hierarchical classification of public hospitals in Thailand



Source: Ministry of Public Health, Thailand

Among 6 categories, the primary hospital is the smallest one, having 1-2 doctors and capable of offering basic healthcare services. The higher levels are secondary hospitals, which

have three subcategories. When facing complicated symptoms or diseases, the primary hospital transfers the patient to these hospitals because they have the higher capability due to their extended facilities and human resources. However, if the treatment requires more specializations of doctor and medical equipment, the patient can be transferred to the tertiary hospitals, which have medical specialists in all fields and the higher level of medical facilities.

Table 5.1 Main requirement criteria for human resource and location at each level of public hospital

Requirement criteria of human resource demand (per population)	*Primary hospital*	*Secondary (level 1) hospital*	*Secondary (level 2) hospital*	*Secondary (level 3) hospital*	*Tertiary hospital*
Doctor	1 : 10,000		1 : 15,000	1 : 75,000	1 : 62,500
Dentist	1 : 12,500		1 : 75,000	1 : 50,000	1 : 500,000
Pharmacist	1 : 15,000		1 : 50,000	1 : 50,000	1 : 500,000
Nurse	2 : 5,000	1 : 1,500	1 : 4,000	1 : 7,500	1 : 7,500
Dentist Assistant	1 : 10,000		-	-	-
Pharmacist Assistant	1 : 10,000		-	-	-
Public Health Officer	3 : 5,000	1 : 12,500	1 : 25,000	1 : 50,000	1 : 75,000
X-ray Technologist	-	1 : 30,000	1 : 150,000	1 : 250,000	1 : 300,000
Medical Technologist	-	1 : 20,000	1 : 100,000	1 : 150,000	1 : 250,000
Physiotherapist	-	1 : 20,000	1 : 150,000	1 : 250,000	1 : 300,000
Criteria for location selection					
Population in service area	10,000	30,000 - 50,000	80,000	200,000	1,000,000
Traveling time of patient to the hospital (minutes)	30	60	90	120	240
Radius of service area (km.)	0-22.5	0-45	0-67.5	0-90	0-202.5

Source: Ministry of Public Health, Thailand

The criteria of location selection are consistent with a higher level of the public hospital which has a large coverage area of service, and also the broader and deeper capability of services. These specific details of capability and facility of each level of the hospital are described as follows:

The primary and secondary (level 1) hospitals have the similar capability, except the case of offering X-ray service and the possession of operating room which are available in the secondary (level 1) one.

In the next level, the secondary (level 2) hospital has the larger size, providing services to the larger number of both OPD (Out Patient Department) and IPD (In-Patient Department) patients.

The secondary (level 3) hospital has the augmented functions of providing treatments from medical specialties in some fields. The allocation of medical specialties is based on the area-specific demand.

The tertiary hospital is the general hospital that can offer the broad ranges of services from medical specialties in 6 fields. Details of all available areas of services from 6 medical specialties, and also indicates the ratio of one specialty per population is shown. Here, the tertiary hospital has the extended facilities which are not available in the secondary hospitals. These are main physical facilities serve the high level of medical treatments conducted by medical specialties.

Table 5.2 Capability and facility of each level of public hospital

Capability	*Primary hospital*	*Secondary (level 1) hospital*	*Secondary (level 2) hospital*	*Secondary (level3) hospital*	*Tertiary hospital*
Service capability of Out Patient Department (OPD)	0 - 100 patients / day	0 - 100 patients / day	100 - 250 patients / day	200 - 400 patients / day	300 – 500 patients / day
Service capability of In-Patient Department (IPD)	0 -10 patients / day	0 -10 patients / day	10 -50 patients / day	30 -80 patients / day	60 -100 patients / day
Number of doctors	1-2	1-2	2-5	3 -10 (including Medical Specialties in some fields)	8-20 (including Medical Specialties in 6 fields)

Facilities	- Basic Operating Room - Delivery Room - Observation Ward - Dental Clinic	- IPD Ward - Operating Room - Delivery Room - X-ray Room - Dental Clinic	- IPD Ward - Operating Room - Delivery Room - X-ray Room - Dental Clinic	- IPD Ward - Operating Room - Delivery Room - X-ray Room - Dental Clinic	- IPD Ward - Operating Room - Delivery Room - Intensive Care Unit (ICU) - Neo-natal Intensive Care Unit (NICU) - Orthopedic Operating Room - Clinical Laboratory - Radiation Room - Dental Clinic

Source: Ministry of Public Health, Thailand

Table.5.3 List Medical Specialties and requirement criteria of Medical Specialties demand (for the Tertiary hospital)

Medical Specialties	*Ratio per population*
Physician	1 : 65,000
Surgeon	1 : 90,000
Obstetrician	1 : 80,000
Pediatrician	1 : 75,000
Orthopedist	1 : 95,000
Anesthesiologist	1 : 150,000

Source: Ministry of Public Health, Thailand

The excellent center is the highest level of a hospital in the hierarchical structure. In addition to 6 areas of medical specialties, it has specialties specialized in the subfields (i.e. the sub-specialists), and it the total numbers of 205-352 doctors. Most of the excellent centers also function as the medical school at a graduate level, offering the official course of training for specialties.

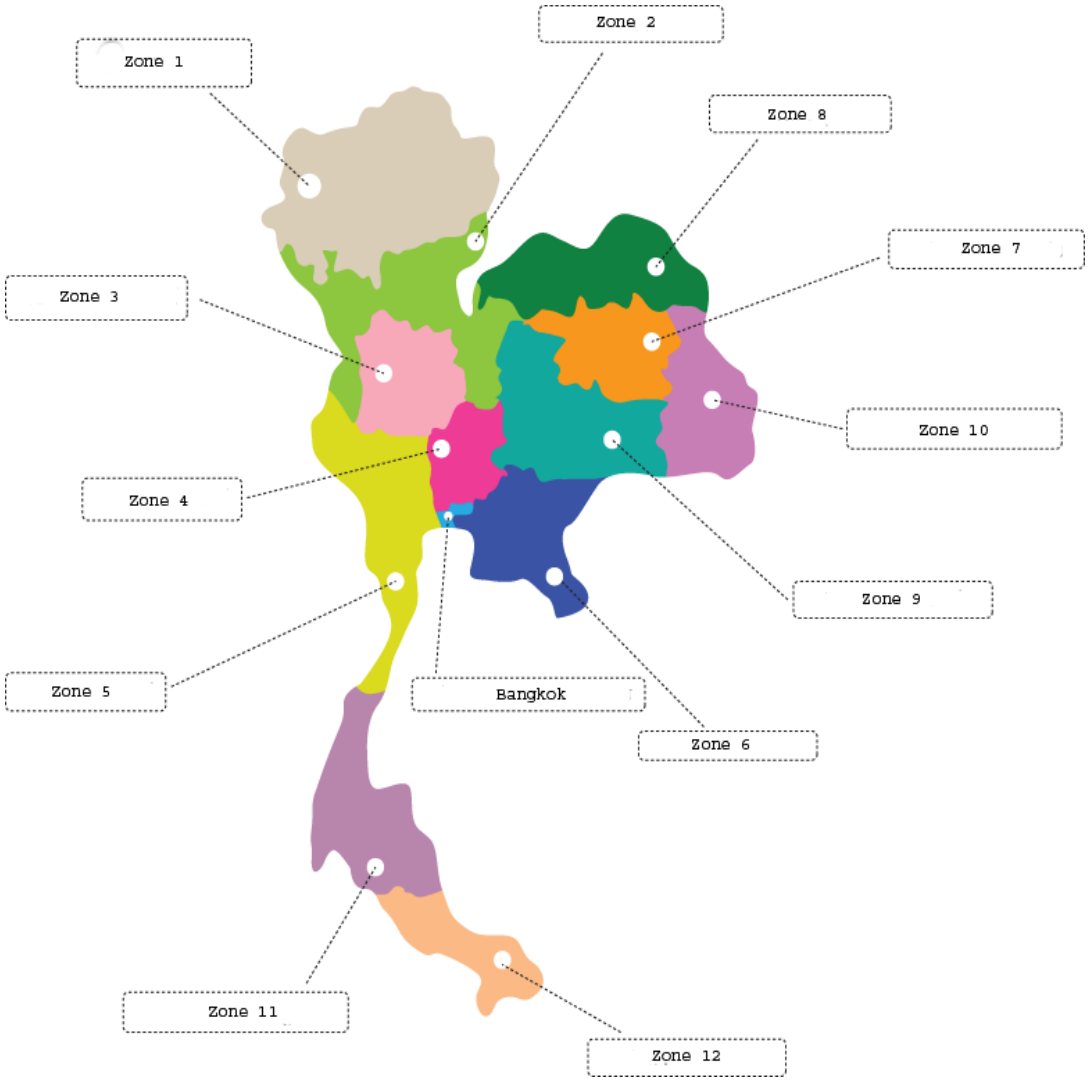
With criteria and specification indicated mention above, Thailand's Ministry of Public Health has utilized GIS (Geographic Information System) techniques to locate hospitals and allocate human resources. Specifically, the coverage of providing services has been categorized into 13 zones, as illustrated in Fig. 5.5. Each zone has its hierarchical system of hospitals, and there are approximately 3 excellent centers functioning as the highest level of services, and there is a network of primary, secondary and tertiary hospitals connected to them.

With these allocations of 13 zones and the hierarchy-network of hospitals within each zone, the table below indicates the nationwide total number of hospitals in each level. It is noted that the number of hospitals is mostly proportionate to the hierarchical system. The exception is the case of secondary hospitals because in many areas the level-2 secondary hospital is well suited for their numbers of the population.

The number of key human resources in health science in Thailand in 2016 is forecasted with a projected number of Thai population and key ratios of demands for healthcare shown in previous tables also indicates the projected demand for key human resources in 2026.

This result suggests the next step of conducting the study, which is the analysis of demand and supply of future health system in Thailand. The supply projection will be estimated based on the nationwide capability of education in health science. The outcome will identify key issues for preparation in both human capital and budget toward the sustainability of the national health system.

Figure 5.5 Map of public-health service zones in Thailand



Source: Ministry of Public Health, Thailand

Table 5.4 Number of the public hospital at each level

Level of hospital	*Number of beds*	*Number of hospitals (in the whole country)*
Excellent center	250 – 1,000	33
Tertiary hospital	120 – 500	118
Secondary (level 3) hospital	60 – 120	71
Secondary (level2) hospital	30 – 90	518
Secondary (level 1) hospital	0-10	35
Primary	0-10	9,976

Source: Ministry of Public Health, Thailand

Table 5.5 Number of public staff at each level

Occupation	*Number of public health personnel in 2016*	*Projected demand for public health personnel in 2026*
Doctor	50,573	62,800
Nurse	149,072	186,700
Dentist	11,575	17,400
Pharmacist	26,187	39,900
Medical Technologist	15,200	23,900
Physiotherapist	4,371	11,100

Source: Ministry of Public Health, Thailand and author's estimate

Table 5.6: Number of graduates in health care fields in Thailand (data as of 2016)

Occupation	*Number of educational institutes*	*Number of graduates (per annual)*
Doctor	21	3,121
Nurse	85	12,000
Dentist	13	826
Pharmacist	18	20,00
Medical Technologist	12	911
Physiotherapist	16	800

Source: Ministry of Public Health, Thailand

3. National Budget for Universal Healthcare Services

The annual budget for national healthcare has been separated into 3 categories.

(1) The annual budget for Universal Healthcare service
   a. In-Patient (IP)
   b. Out-Patient (OP)
   c. Preventive Promotion (PP)
(2) The annual budget for personnel compensation (e.g. salary and benefit)
(3) The annual budget for capital investment

The budget for Universal Healthcare is the largest portion and it has played a major role in the national scheme of public health. Specifically, there are three subcategories of budget allocation under the Universal Healthcare. Each has been estimated based on the per-capita requirement.

As shown in Fig. 5.6 and 5.7, the per-capita budget allocation has been increasing since 2003. However, its ratio as a percentage of total fiscal expenditure has been stable during 2003-2016, as exhibited in Fig. 5.8. Originally, the budget was allocated to financially support the services of *In-Patients (IP)* and *Out-Patients* (*OP*). Later, the *Preventive Promotion* (PP) has been also included in the budget because it can lower the incidences of many diseases, which will subsequently lower the demand for healthcare and the future budget burden.

In our study, the methodology of forecasting the Universal Healthcare Budget was based on the average of *cost per capita*. As earlier stated, the combination of averages of *In-Patient (IP), Out-Patient (OP) and Preventive Promotion (PP)* led to the *average total costs*. The projection of future budget of Universal Healthcare was then computed by using this average with the official projection of population.

Figure 5.6: The historical trends of budget allocated to Universal Healthcare and to Salary and Compensation

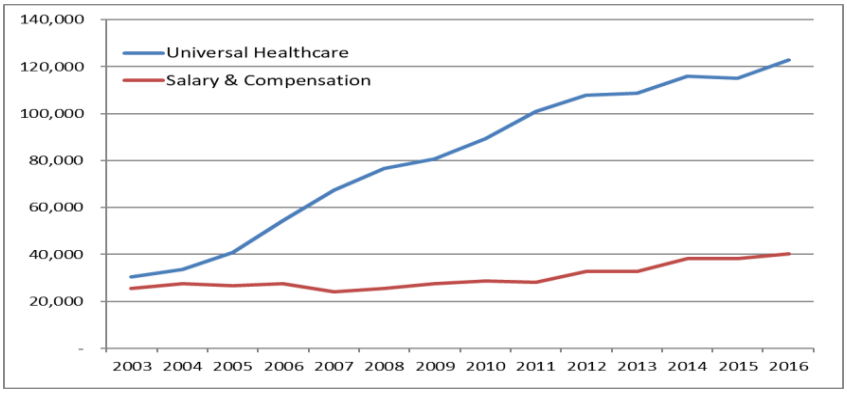
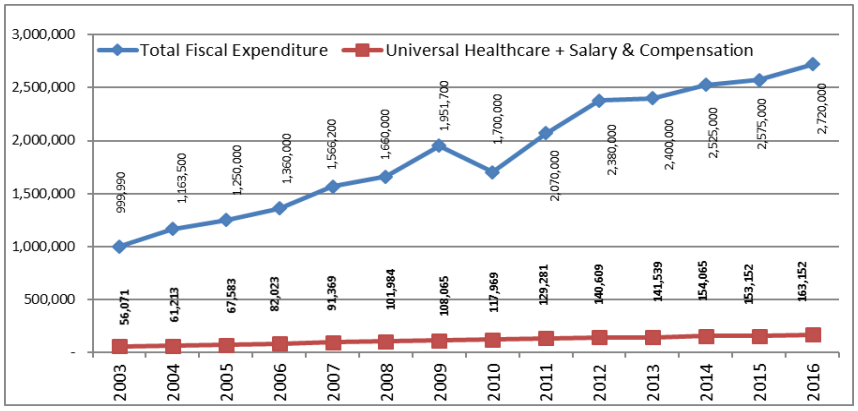


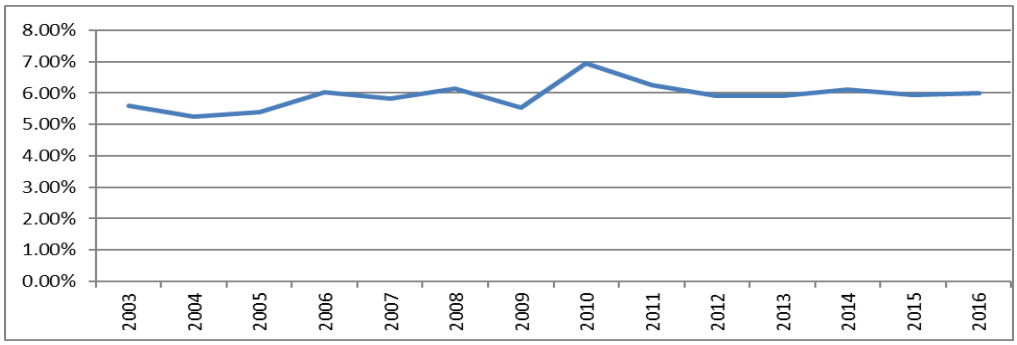
Figure 5.7: Comparison between the total fiscal expenditure and the budget allocated to Universal Healthcare and Personnel Compensation



With the details of this information classified in the *age range* and the *region* of healthcare service, the outcome of projection indicated the interesting trends and combinations of future Universal Healthcare budget. It identifies the national budget to support the future Universal Healthcare service until 2030. The future demographic structure of aging society will incur the rising budget on the healthcare of the aging population.

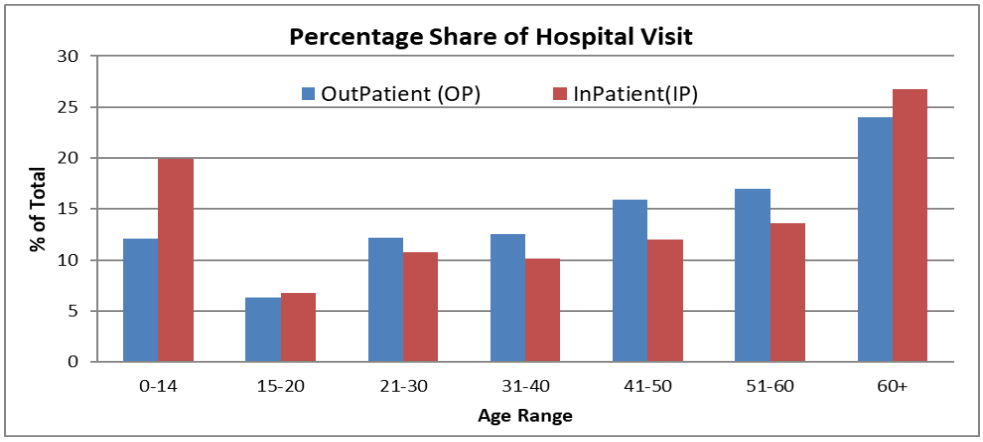
The important trends of future healthcare budget with expenditure for the aging population are likely to increase substantially. In addition, this expenditure will become the largest portion (e.g. region 1,2,3,7 and 9). This projection signifies the urgent requirement for the future allocations of all-related resources to support the region-specific characteristics.

Figure 5.8: Percentage of Universal Healthcare + Salary & Compensation per Total Fiscal Expenditure



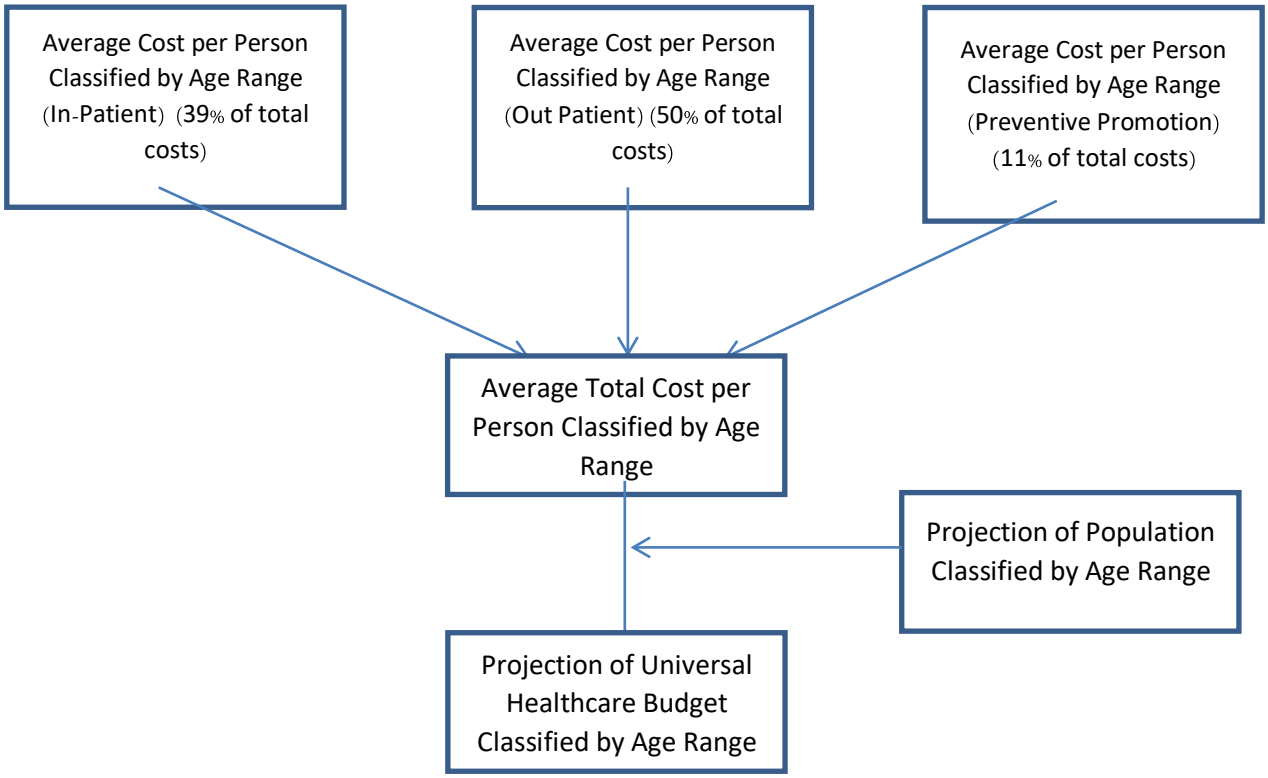
Source: National Health Security Office (NHSO)

Figure 5.9: Proportion of Hospital Visit Classified by Type of Patient and Age Range



Source: National Health Security Office (NHSO)

Figure 5.10: Method of Projecting Universal Healthcare Budget



Source: National Health Security Office (NHSO)

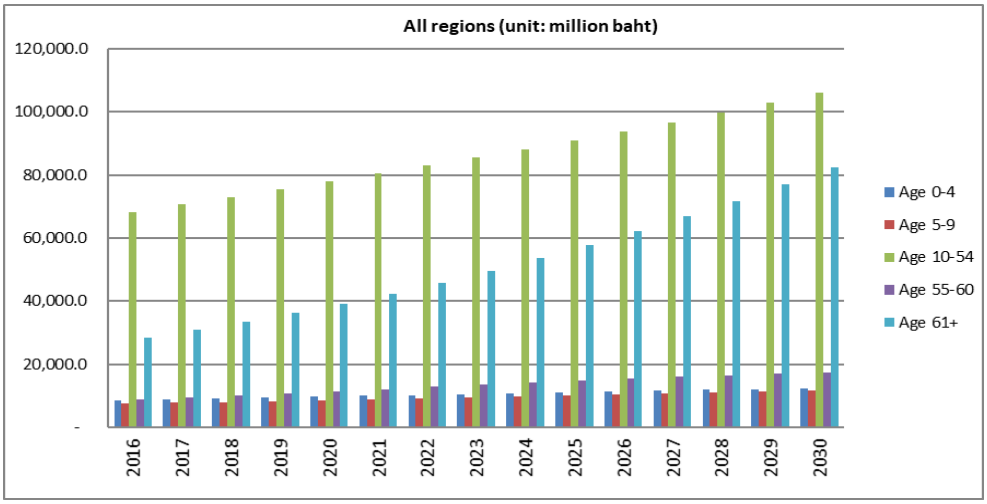
Fig. 5.9 shows that the hospital visit by age range from 15-60 year old has a positive relationship. The dependency age range of 0-14 and 60+ year old has to be mentioned here. The in-patient of the age 0-14 was 20 percent of all visits as compared with out-patient of around 10

percent. The age burden of 60+ populations has a high percentage of visits both type as expected of around 25 percent.

The average cost burden is found that the in-patient share 39 percent of total cost of UCS in Thailand land as compared with 50 percent of the total cost which is borne by out-patient. It is noted here also that the cost burden on average for the preventive promotion is 11 percent of total cost. These parameters will be applied to the cost projection and expenditure for UCS. As Thailand is entering the aging society with rising well being made by income per capita, we may expect also that the common phenomenon of rising *Non-Communicative-Disease (NCD)* would be a new cause of death and sickness among the population. It may be taken into our projection implicitly as the *shift* parameter as well as changing the slope of each cost component over time. Since this is beyond our scope of analysis, we may use the simple rule-of-thumb to account for it in our model.

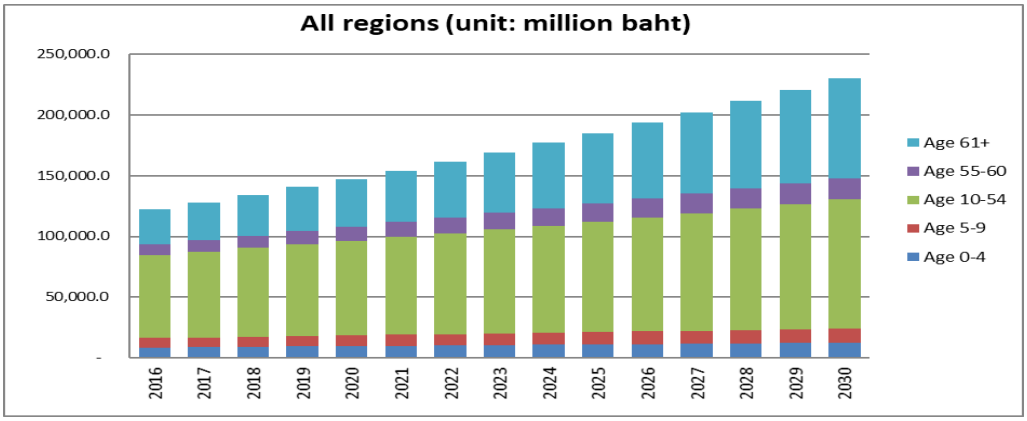
Based on the official population projection by single age and age group, it is clear that the Thai population structure is trending to aging as noted by *NESDB (2013), as graphically shown in Table 5.8. The population projection is applied as a base for* **demand projection of health care needs**. The budget needs are regarded as *inverse demand function of health care* by *region* under the MOPH. The total demand for health care most of the age group are understandable consistent with the population cohort. It is noted that the rising portion of demand for health by aging population 61+ over time 2016-2030.

Figure 5.11: Projection of Nationwide Expenditure on Universal Healthcare Budget Classified by Region and Age



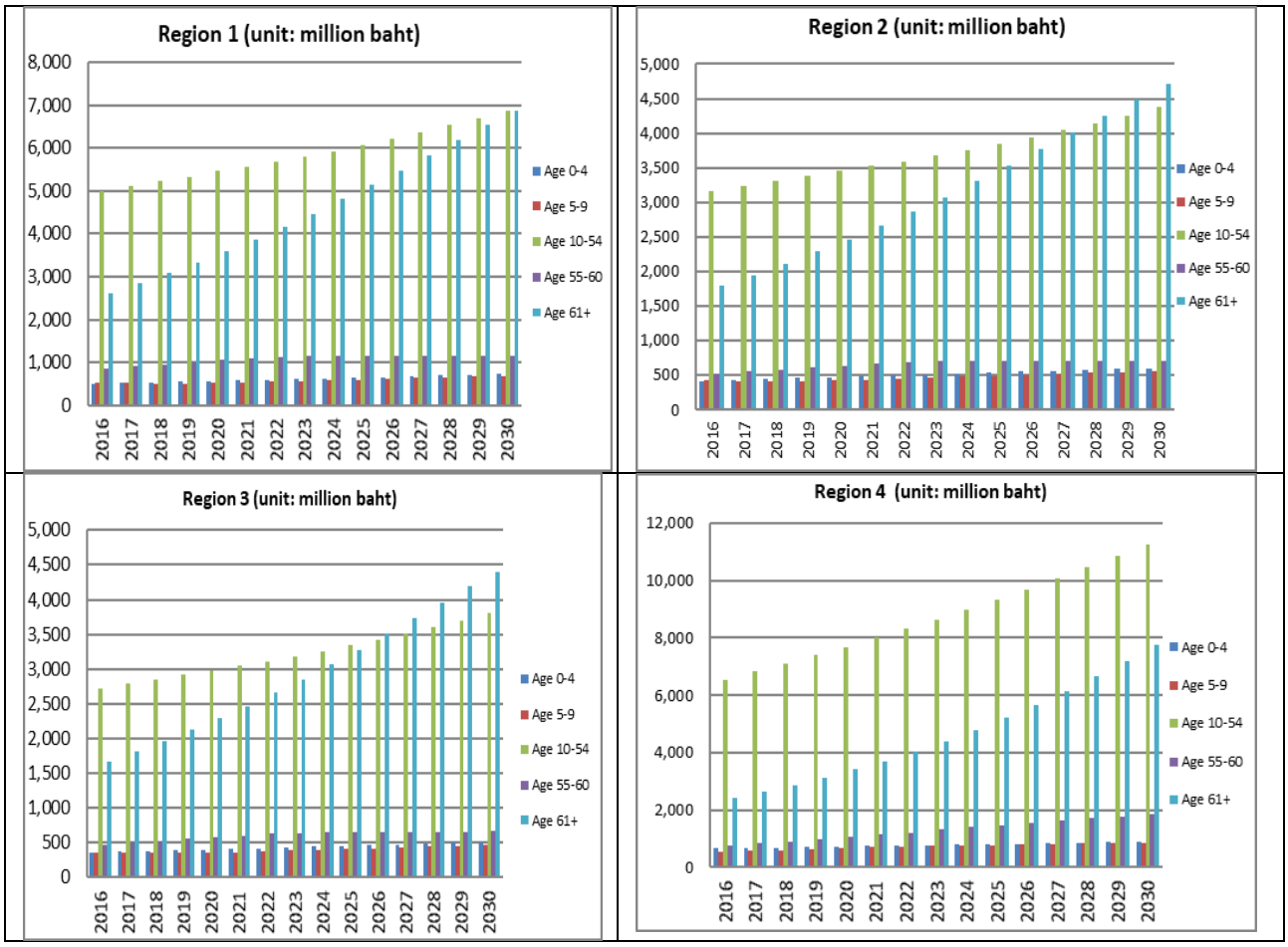
Source: Authors 'calculation (based on NESDB'

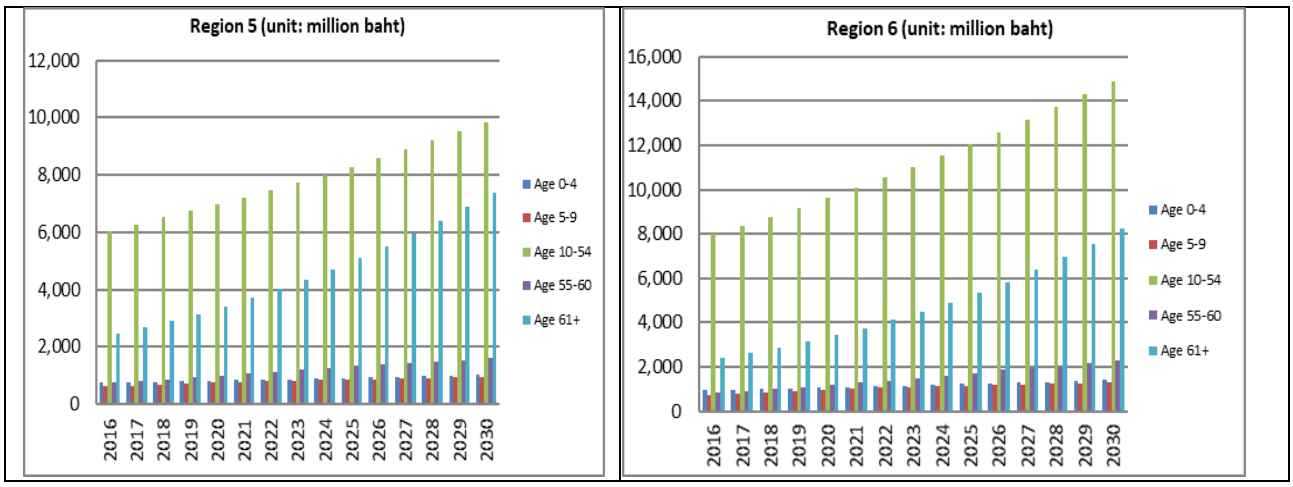
Figure 5.12: Projection of Nationwide Expenditure on Universal Healthcare Budget



Source: Authors 'calculation

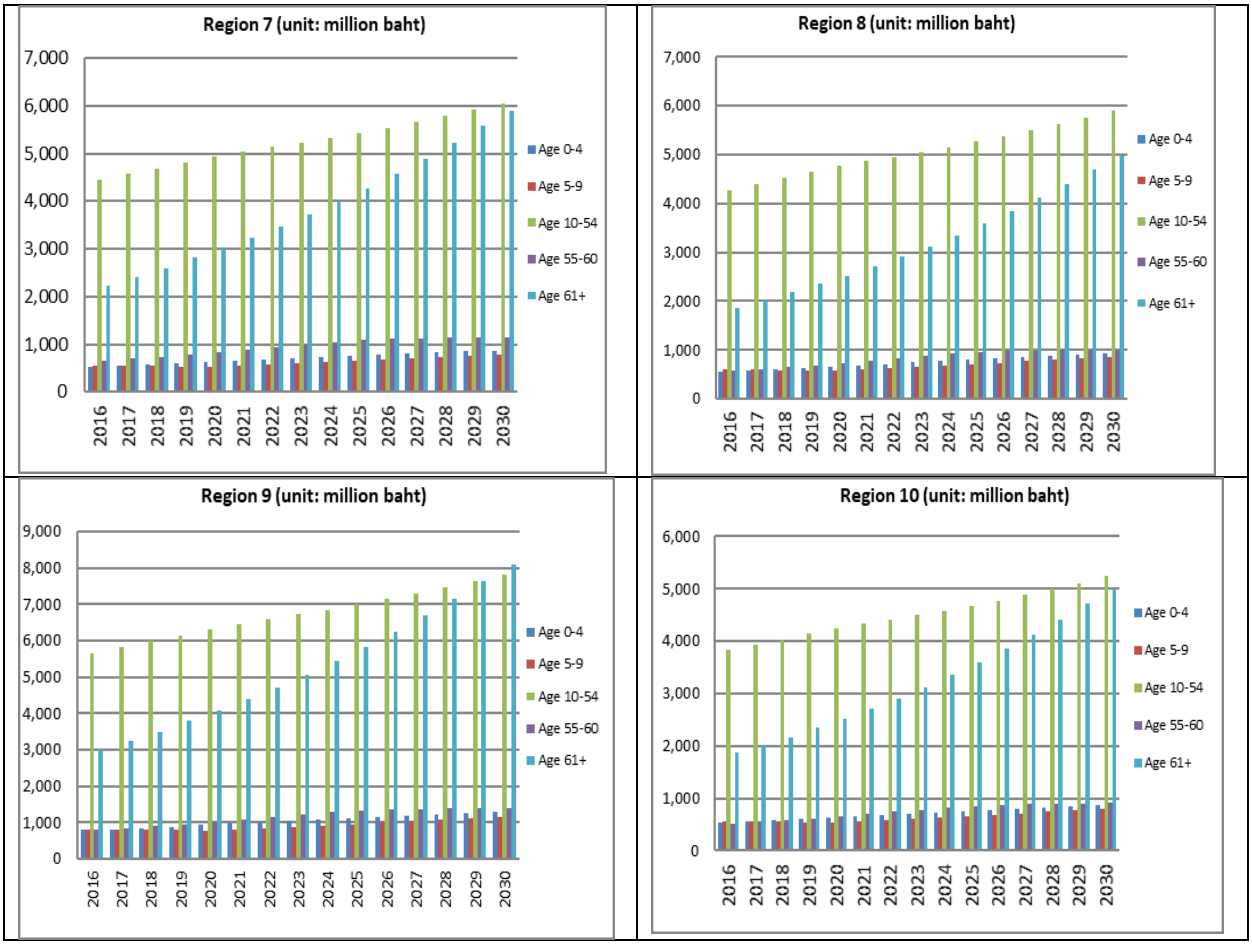
Figure 5.13: Projection of Expenditure on Universal Healthcare Budget Classified by Region and Age

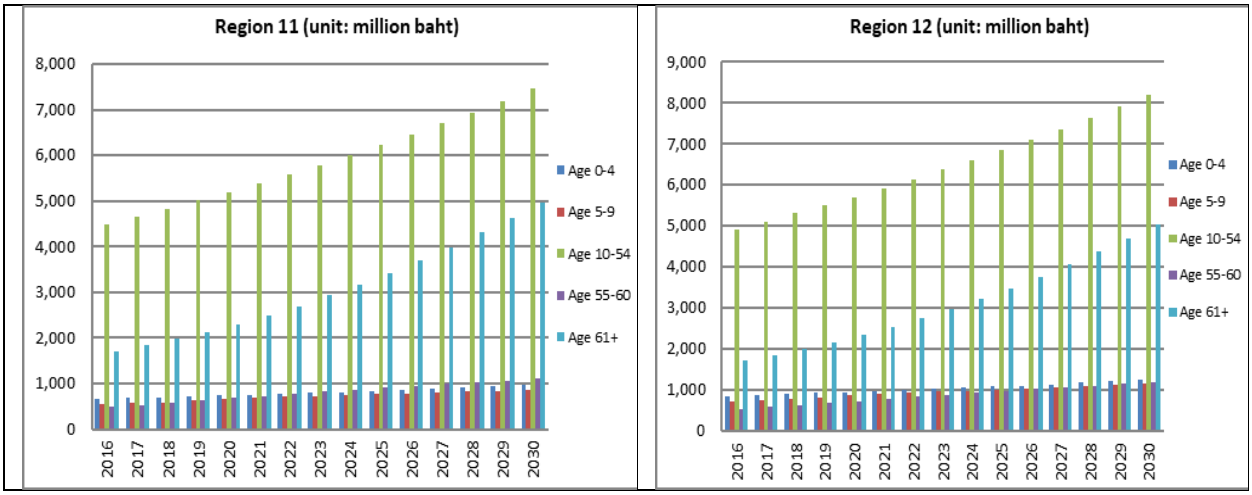




Source: Authors 'calculation

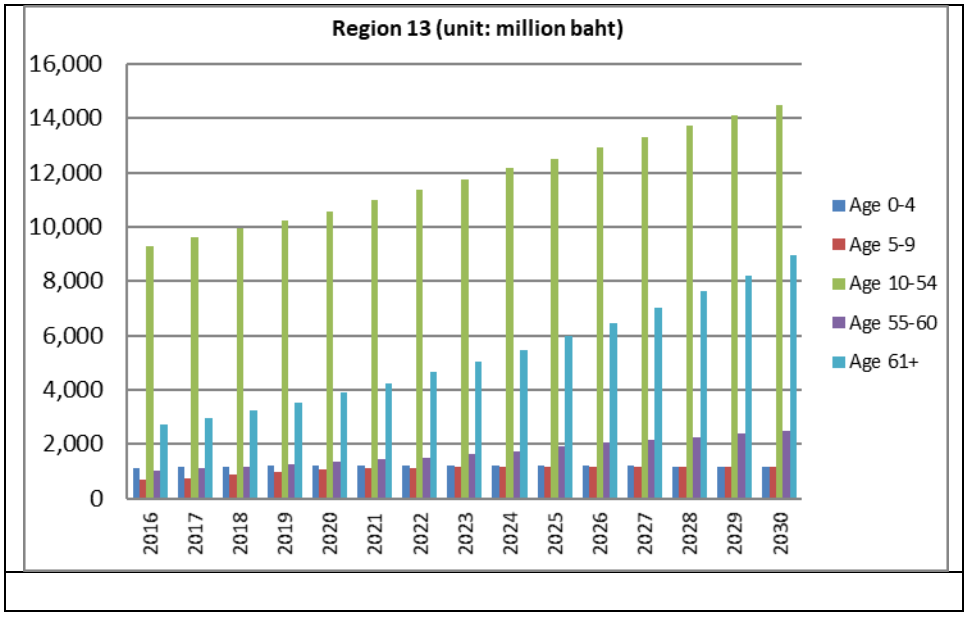
Figure 5.13: Projection of Expenditure on Universal Healthcare Budget Classified by Region and Age (Continued)





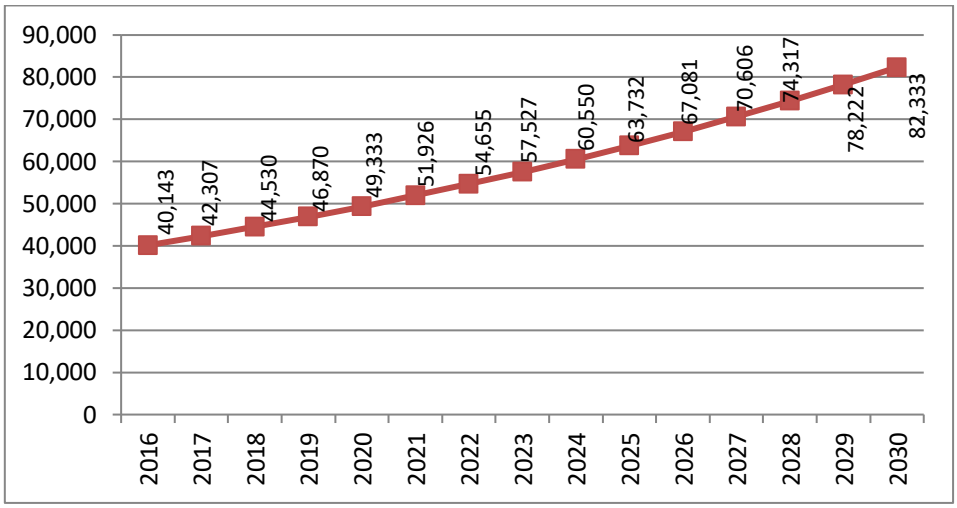
Source: Authors 'calculation

Figure 5.13: Projection of Expenditure on Universal Healthcare Budget Classified by Region and Age (Continued)



Source: Authors 'calculation

Figure 5.14: Budget on Salary and Benefit of Government Officials in Healthcare Service (unit: million Baht)



Source: National Health Security Office (NHSO)

The annual budget for personnel compensation (e.g. salary and benefit) was computed *pro rata* accordingly. The budget allocation has to be prepared under the formal parliamentary system. Fig. 5.16 illustrates the projection of expenditure which is a cost of services by government officials in healthcare service providers in public hospitals.

The last allocation of the budget is the capital investment (e.g. building and equipment and maintenance). The result of the forecasted requirement for the budget is exhibited in Table 5.9. This computation was based on the projection of future demographical structure and the estimated increment of the average of a number of beds per population, which was 5 million baht per bed. The budget was converted into US dollar value by using the exchange of 31.46 baht per US dollar.

All 3 components of the forecasted budget were summed and these total amounts were listed in Table 5.10. Also, the values converted in US dollar were listed in Table 5.11 (the exchange rate applied in this computation was 31.46 baht per US dollar).

Table 5.7: Projected Budgets for Capital Investment in Healthcare Service

Year	Total Beds	Increase of Beds	Beds per 10,000 Population	Required Budget (million baht)	Required Budget (million USD)
2017	162,373	6,245	24.782	31,225.58	992.55
2018	168,868	6,495	25.703	32,474.61	1,032.25
2019	175,623	6,755	26.667	33,773.59	1,073.54

2020	182,648	7,025	27.675	35,124.54	1,116.48
2021	189,953	7,306	28.731	36,529.52	1,161.14
2022	197,552	7,598	29.837	37,990.70	1,207.59
2023	205,454	7,902	30.995	39,510.33	1,255.89
2024	213,672	8,218	32.209	41,090.74	1,306.13
2025	222,219	8,547	33.481	42,734.37	1,358.37
2026	231,107	8,889	34.816	44,443.74	1,412.71
2027	240,352	9,244	36.217	46,221.49	1,469.21
2028	249,966	9,614	37.688	48,070.35	1,527.98
2029	259,964	9,999	39.233	49,993.17	1,589.10
2030	270,363	10,399	40.856	51,992.89	1,652.67

Source: Authors 'calculation

Table 5.8: Projected Total Budget for Healthcare (unit: million baht)

	Universal Healthcare	Salary and Compensation	Capital Investment	Total
2016	122,029.99	40,143.00	31,225.58	193,398.57
2017	127,935.77	42,307.00	32,474.61	202,717.38
2018	134,098.96	44,530.26	33,773.59	212,402.81
2019	140,531.64	46,870.36	35,124.54	222,526.53
2020	147,233.61	49,333.43	36,529.52	233,096.56
2021	154,210.91	51,925.93	37,990.70	244,127.54
2022	161,479.29	54,654.68	39,510.33	255,644.29
2023	169,034.83	57,526.82	41,090.74	267,652.38
2024	176,876.76	60,549.89	42,734.37	280,161.02
2025	185,017.60	63,731.83	44,443.74	293,193.18
2026	193,439.44	67,080.98	46,221.49	306,741.91
2027	202,180.12	70,606.13	48,070.35	320,856.60
2028	211,208.81	74,316.53	49,993.17	335,518.51
2029	220,533.59	78,221.92	51,992.89	350,748.40
2030	230,154.16	82,332.53	54,072.61	366,559.30

Source: Authors 'calculation

Table 5.9: Projected Total Budget for Healthcare (unit: million US Dollar)

	Universal Healthcare	Salary and Compensation	Capital Investment	Total
2016	3,878.89	1,276.00	992.55	6,147.44
2017	4,066.62	1,344.79	1,032.25	6,443.65

2018	4,262.52	1,415.46	1,073.54	6,751.52
2019	4,466.99	1,489.84	1,116.48	7,073.32
2020	4,680.03	1,568.13	1,161.14	7,409.30
2021	4,901.81	1,650.54	1,207.59	7,759.93
2022	5,132.84	1,737.28	1,255.89	8,126.01
2023	5,373.01	1,828.57	1,306.13	8,507.70
2024	5,622.27	1,924.66	1,358.37	8,905.31
2025	5,881.04	2,025.81	1,412.71	9,319.55
2026	6,148.74	2,132.26	1,469.21	9,750.22
2027	6,426.58	2,244.31	1,527.98	10,198.87
2028	6,713.57	2,362.25	1,589.10	10,664.92
2029	7,009.97	2,486.39	1,652.67	11,149.03
2030	7,315.77	2,617.05	1,718.77	11,651.60

Source: Authors 'calculation

4. Conclusion and Implication

In this chapter, we have shown demand oriented projection of social infrastructure needs in Thailand with respect to health services. We have our final note that social infrastructure needs here was demand oriented rather than supply initiation. Here, Thai Universal Coverage Scheme of health care services fundamentally represents the demand side or patients' needs. The needs are expressed *ex-ante* via average '*buying price = cost per head*' of in-patient and out-patients that follow probability of illness. The demand oriented approach, given pro-rata supply parameters may invoke *excess demand* in the UCS health services i.e., if buying price is lower than cost per head, *ex-post.* Nowadays, the NCD has been also unexpectedly overshooting and becoming additional cost burden to Thai population health's service provision.

It is controversial that the total cost allocated from the government to the UCS, as representative of buyer of service from providers each fiscal year cannot match with cost of health services supply provided either by public and/or private institutions. The public hospitals as the main providers, will find difficulties in allocating the receipt income to manage their capital investment as well as personnel cost. There are gaps between demand price and cost of service delivery. Lower buying price of demand than the marginal effective cost of provision per unit has created excess demand for health services in some hospitals. This has made an overload of burden in some urban public hospitals.

The budgetary needs in this study are *ex-ante* demand projection, it has been assumed to cover the cost of *total new investment, maintenance and rehabilitation of buildings, and high technology equipments.* In principle, *the gap of budget needs should be filled up by requesting additional budget by the Ministry of Public Health to parliament.* The tight fiscal policy has always a reason to suppress the request by UCS. Thus, there is outcry by public health providers,

i.e., hospital and health personnel. Especially, the hospital that raises reason that 'average buying price per capita service' is lower than their 'average cost of service' provision. As a result, some hospitals have faced congestion, overloaded of patients for current medical doctors with an inability to comply with the rapid rising demand.

In short, in our projection in this study we have some notes as follows:

(1) The annual budget for universal healthcare service which is based on the demand-side projection of rising number of the in-patient (IP), the out-patient (OP), given limited preventive promotion (PP). They are calculated from changing population structure overtime weighted by probability of illness. Our calculation has to take into account a stochastic drift over time of the demand by a rising NCD as well.

(2) On the supply-side, the annual budget for *personnel compensation* (e.g. salary and benefit) may be subjected to *sub-optimality* of lifetime earnings as compared with their human capital investment of the medical doctor who has invested longer year of schooling. In our projection, we should have benchmarked their life time earnings with international earning opportunity in par with the medical doctor in developed market. The service is tradable, as they can move to higher payment in any developed country. Thus, the gap of earnings over their career path *weighted by purchasing power parity (PPP)* should be compensated in accordance an international price. However, this is not definite in the hot debate among buyer and provider besides we do not have earnings' data of medical doctors in Thailand and in international markets. We refrain from doing so and would treat the projection of the *minimum* level of the inverse effective demand.

(3) The annual budget for new *capital investment and maintenance* is another item which has faced several dimensions of insufficiency. There are inequitable distribution of facilities and buildings of hospital across *sizes and areas*. Our estimation which is based on the demand-side has effectively covered this cost by definition. However, it may be artificially lower than the actual social investment needs. We recommend that if the data of capital stock and depreciation of hospital and incorporated medial equipments and facilities are available in detail, the new capital investment and maintenance would need to be addressed to reduce size and spatial inequalities.

The level-up of capital adequacy of the public hospital with qualified medical staffs among regions can potentially solve the overloading demand and spatial inequality. That is to say, we need to take into account both *vertical and horizontal* inequality reduction by proper

benchmark with international medical doctor's earnings, and spatial needs of new capital investment and maintenance.

Up to present, the UCS has successfully increased the vertical equity of welfare among income deciles class in Thailand. The sub-optimal demand price has created excess demand for health services. Simultaneously, it has created an overloading situation on the supply side with rising marginal cost of service. As a result, the UCS has lowered the welfare of health personnel and sub-optimal capital investment and maintenance.

Other ASEAN countries can follow this line of methodology to calibrate the social investment on health services in their own economy. This is by considering mark-up the medical doctor's human capital return as well as new capital investment and maintenance of public hospitals. The free access to health services by mass of low income population can be maintained in the public hospital services in the short-run. In the medium-run, the role of preventive health care movement of the society has to play as circuit brake to the excess demand for health care. The *true price* of the health care services will need to *converge* to its *true social cost* of health service delivery in the long-run. This is to maintain the sustainability of the UCS.

Appendix I: Projection Results of Expenditure of the Universal Healthcare

Table A1: Projection of Total Expenditure on Universal Healthcare (Classified by Age)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0–4	8,675.8	8,955.9	9,233.0	9,507.7	9,774.5	10,037.5	10,303.3	10,576.6	10,849.5	11,126.1	11,404.2	11,678.4	11,952.9	12,228.3	12,498.1
Age 5–9	7,619.7	7,856.7	8,121.4	8,420.8	8,758.2	9,050.3	9,341.4	9,631.1	9,917.8	10,201.8	10,474.0	10,755.5	11,040.3	11,327.4	11,621.8
Age 10–54	68,362.3	70,724.3	73,104.7	75,503.4	77,908.6	80,393.3	82,918.6	85,493.6	88,141.3	90,889.6	93,752.8	96,728.7	99,800.8	102,959.2	106,185.3
Age 55–60	8,857.5	9,479.5	10,131.1	10,808.7	11,505.9	12,224.6	12,964.4	13,700.9	14,406.2	15,057.0	15,627.1	16,124.0	16,569.7	17,023.5	17,532.9
Age 61+	28,514.8	30,919.4	33,508.8	36,291.0	39,286.5	42,505.3	45,951.6	49,632.7	53,561.9	57,743.1	62,181.3	66,893.6	71,845.1	76,995.1	82,316.1
TOTAL	**122,030.0**	**127,935.8**	**134,099.0**	**140,531.6**	**147,233.6**	**154,210.9**	**161,479.3**	**169,034.8**	**176,876.8**	**185,017.6**	**193,439.4**	**202,180.1**	**211,208.8**	**220,533.6**	**230,154.2**

Table A2: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 1

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	503.311	519.345	535.075	550.418	565.834	582.157	597.355	613.751	629.824	646.852	664.206	680.411	696.047	712.206	727.255
Age 5-9	519.071	516.747	515.953	516.248	521.839	538.361	554.841	572.028	588.568	604.913	620.994	638.628	655.997	673.364	692.110
Age 10-54	4,980.230	5,103.475	5,222.597	5,335.164	5,457.335	5,562.690	5,677.842	5,802.148	5,928.307	6,073.027	6,222.913	6,375.011	6,528.995	6,692.135	6,864.094
Age 55-60	869.517	915.046	962.415	1,007.296	1,053.045	1,095.350	1,130.227	1,149.001	1,158.047	1,158.197	1,150.217	1,144.684	1,151.350	1,152.081	1,167.135
Age 61+	2,626.743	2,847.531	3,080.699	3,340.376	3,595.011	3,871.907	4,161.878	4,471.401	4,806.852	5,131.728	5,481.321	5,836.107	6,183.562	6,539.421	6,881.673
TOTAL	9,498.873	9,902.144	10,316.739	10,749.502	11,193.062	11,650.464	12,122.143	12,608.328	13,111.599	13,614.717	14,139.651	14,674.841	15,215.951	15,769.207	16,332.268

TableA3X: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 2

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	418.092	431.071	443.896	457.041	469.958	482.581	495.742	509.476	522.842	537.118	550.969	565.044	578.951	591.439	603.963
Age 5-9	420.977	418.768	418.488	418.143	423.209	436.863	450.149	463.784	477.496	490.675	504.123	517.841	531.499	546.424	560.958
Age 10-54	3,164.193	3,239.365	3,313.048	3,383.984	3,457.360	3,525.068	3,595.303	3,672.340	3,753.131	3,846.359	3,943.265	4,045.104	4,149.116	4,256.967	4,373.441
Age 55-60	526.937	554.599	583.429	610.007	638.988	664.819	686.479	698.743	703.484	705.348	699.705	696.848	700.532	699.155	709.456
Age 61+	1,795.549	1,948.472	2,111.588	2,291.825	2,466.789	2,661.814	2,863.693	3,076.701	3,305.795	3,531.330	3,769.909	4,010.551	4,245.146	4,490.056	4,715.011
TOTAL	6,325.748	6,592.276	6,870.449	7,160.999	7,456.303	7,771.145	8,091.366	8,421.044	8,762.748	9,110.830	9,467.972	9,835.387	10,205.244	10,584.041	10,962.830

Table A4: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 3

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	356.414	367.318	377.745	388.405	399.021	409.559	420.283	431.504	442.279	453.883	466.041	476.583	488.346	498.664	509.828
Age 5-9	350.076	348.904	348.776	350.539	355.400	366.481	378.125	389.032	399.635	410.736	421.465	432.375	443.463	455.068	467.584
Age 10-54	2,721.241	2,789.547	2,854.812	2,919.772	2,986.332	3,047.658	3,112.615	3,182.196	3,253.739	3,337.333	3,422.251	3,512.993	3,604.049	3,701.520	3,801.433
Age 55-60	474.876	500.585	527.612	552.559	580.833	605.496	626.774	639.812	647.760	650.252	648.455	647.940	651.255	652.684	664.664
Age 61+	1,669.312	1,811.712	1,959.604	2,125.995	2,288.418	2,468.186	2,655.548	2,855.291	3,068.164	3,280.740	3,508.093	3,733.257	3,956.316	4,187.401	4,403.064
TOTAL	**5,571.919**	**5,818.066**	**6,068.550**	**6,337.270**	**6,610.004**	**6,897.379**	**7,193.346**	**7,497.836**	**7,811.577**	**8,132.944**	**8,466.306**	**8,803.147**	**9,143.430**	**9,495.338**	**9,846.574**

Table A5: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 4

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	657.977	676.767	694.193	711.100	725.996	740.900	755.488	770.320	786.709	803.808	820.969	839.641	857.293	876.161	895.949
Age 5-9	559.960	581.156	608.611	639.619	682.587	706.290	726.669	745.645	762.990	780.486	795.696	811.452	828.455	845.469	863.890
Age 10-54	6,548.092	6,825.686	7,115.568	7,410.121	7,691.120	8,002.591	8,325.640	8,653.801	8,989.064	9,334.227	9,693.276	10,073.601	10,462.497	10,852.930	11,251.195
Age 55-60	775.604	846.572	914.792	989.531	1,069.867	1,148.415	1,221.218	1,311.398	1,400.745	1,481.408	1,563.289	1,638.551	1,702.386	1,777.020	1,855.640
Age 61+	2,431.529	2,645.305	2,877.573	3,125.188	3,407.548	3,708.972	4,046.582	4,401.258	4,779.916	5,206.675	5,651.461	6,126.744	6,643.953	7,189.066	7,773.689
TOTAL	**10,973.162**	**11,575.486**	**12,210.736**	**12,875.560**	**13,577.118**	**14,307.169**	**15,075.597**	**15,882.423**	**16,719.423**	**17,606.604**	**18,524.692**	**19,489.988**	**20,494.584**	**21,540.646**	**22,640.363**

Table A6: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 5

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	749.317	769.945	788.694	807.670	824.643	842.208	859.506	877.726	896.953	917.619	938.806	959.431	981.683	1,004.526	1,026.738
Age 5-9	632.674	654.798	682.037	714.735	759.879	784.328	805.123	825.220	845.317	864.203	880.777	899.441	919.119	939.220	961.185
Age 10-54	6,057.532	6,283.893	6,518.605	6,749.428	6,973.598	7,222.683	7,478.986	7,745.825	8,016.797	8,294.357	8,588.389	8,889.256	9,202.392	9,518.273	9,838.535
Age 55-60	766.212	825.306	880.903	943.158	1,010.029	1,079.580	1,140.395	1,208.474	1,275.153	1,334.681	1,387.749	1,443.242	1,496.621	1,547.783	1,604.946
Age 61+	2,464.553	2,678.594	2,906.756	3,154.081	3,422.282	3,707.666	4,024.476	4,351.663	4,710.177	5,100.981	5,508.543	5,941.604	6,392.041	6,875.554	7,378.808
TOTAL	**10,670.289**	**11,212.536**	**11,776.994**	**12,369.071**	**12,990.430**	**13,636.464**	**14,308.486**	**15,008.908**	**15,744.396**	**16,511.841**	**17,304.263**	**18,132.973**	**18,991.856**	**19,885.356**	**20,810.212**

Table A7: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 6

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	951.772	985.480	1,017.282	1,046.565	1,075.693	1,103.125	1,130.977	1,160.803	1,190.827	1,222.359	1,255.162	1,289.685	1,325.292	1,365.628	1,407.027
Age 5-9	732.380	786.135	844.625	909.124	978.003	1,017.453	1,053.091	1,086.986	1,119.368	1,149.946	1,179.314	1,209.451	1,240.712	1,272.138	1,306.171
Age 10-54	7,997.737	8,384.053	8,782.736	9,196.264	9,611.581	10,069.595	10,543.538	11,023.440	11,527.252	12,036.728	12,568.886	13,129.023	13,707.716	14,299.814	14,897.247
Age 55-60	841.139	921.000	1,003.171	1,093.122	1,186.418	1,281.829	1,382.083	1,500.409	1,614.024	1,738.916	1,858.515	1,967.475	2,058.978	2,175.150	2,284.420
Age 61+	2,422.474	2,644.473	2,887.108	3,143.848	3,442.031	3,762.195	4,117.665	4,494.781	4,902.052	5,360.027	5,844.020	6,372.348	6,957.105	7,559.128	8,232.185
TOTAL	**12,945.501**	**13,721.141**	**14,534.921**	**15,388.923**	**16,293.726**	**17,234.198**	**18,227.353**	**19,266.419**	**20,353.523**	**21,507.977**	**22,705.898**	**23,967.982**	**25,289.802**	**26,671.858**	**28,127.050**

Table A8: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 7

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	529.913	550.977	574.153	598.835	624.024	649.983	677.023	704.561	730.935	756.925	782.398	806.836	829.267	850.168	869.291
Age 5-9	547.270	545.490	542.833	537.417	533.693	553.425	575.162	599.088	625.127	651.423	678.522	706.748	734.507	762.667	790.474
Age 10-54	4,443.670	4,572.404	4,695.957	4,819.878	4,947.118	5,044.855	5,140.724	5,237.123	5,324.847	5,438.660	5,544.023	5,662.340	5,784.053	5,912.105	6,058.161
Age 55-60	660.049	697.077	741.358	781.658	826.912	882.587	942.247	991.764	1,048.861	1,083.360	1,111.856	1,125.185	1,142.693	1,139.596	1,153.047
Age 61+	2,238.444	2,413.397	2,602.500	2,812.790	3,015.069	3,241.718	3,473.844	3,729.237	4,000.975	4,270.803	4,579.777	4,899.561	5,231.076	5,587.575	5,904.837
TOTAL	**8,419.347**	**8,779.344**	**9,156.800**	**9,550.578**	**9,946.816**	**10,372.569**	**10,808.999**	**11,261.773**	**11,730.745**	**12,201.172**	**12,696.576**	**13,200.670**	**13,721.596**	**14,252.111**	**14,775.810**

Table A9: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 8

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	561.694	584.570	608.888	634.750	661.709	689.236	717.608	747.147	775.293	803.129	829.816	855.858	880.328	902.154	922.606
Age 5-9	596.821	594.374	591.565	584.990	582.060	603.063	627.122	653.210	680.942	710.141	739.683	769.823	801.190	831.783	861.039
Age 10-54	4,274.145	4,396.497	4,515.524	4,636.301	4,763.099	4,860.477	4,957.714	5,058.481	5,150.806	5,268.288	5,379.620	5,501.925	5,626.409	5,758.285	5,910.179
Age 55-60	581.448	614.355	653.645	688.450	728.865	777.959	830.919	873.632	923.835	953.428	978.360	990.930	1,006.182	1,003.649	1,013.973
Age 61+	1,870.120	2,018.099	2,176.022	2,350.813	2,524.470	2,713.078	2,910.288	3,124.171	3,352.657	3,581.679	3,838.766	4,112.295	4,388.475	4,690.016	4,960.516
TOTAL	**7,884.227**	**8,207.895**	**8,545.644**	**8,895.304**	**9,260.203**	**9,643.813**	**10,043.650**	**10,456.640**	**10,883.533**	**11,316.665**	**11,766.244**	**12,230.832**	**12,702.585**	**13,185.887**	**13,668.313**

Table A10: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 9

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	789.573	820.702	854.844	892.001	929.940	968.625	1,008.620	1,048.699	1,088.737	1,127.914	1,165.988	1,201.224	1,235.454	1,266.455	1,294.981
Age 5-9	805.698	801.660	798.514	789.623	785.485	813.716	846.023	881.217	918.713	958.676	998.859	1,039.466	1,081.065	1,121.932	1,162.545
Age 10-54	5,667.336	5,834.074	5,994.234	6,157.440	6,326.881	6,459.339	6,588.170	6,720.180	6,841.966	6,997.072	7,140.429	7,297.707	7,459.910	7,630.356	7,826.263
Age 55-60	805.207	850.612	903.939	953.540	1,008.827	1,076.576	1,149.781	1,209.017	1,279.113	1,321.423	1,355.526	1,372.917	1,392.740	1,390.681	1,406.270
Age 61+	3,009.982	3,251.151	3,508.333	3,794.829	4,073.071	4,384.221	4,706.388	5,060.526	5,438.935	5,815.088	6,241.948	6,691.758	7,152.988	7,653.227	8,104.485
TOTAL	**11,077.795**	**11,558.200**	**12,059.863**	**12,587.432**	**13,124.203**	**13,702.477**	**14,298.982**	**14,919.640**	**15,567.464**	**16,220.172**	**16,902.750**	**17,603.072**	**18,322.158**	**19,062.650**	**19,794.543**

Table A11: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 10

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	527.323	548.034	571.088	595.643	621.253	647.097	673.415	700.490	727.347	753.188	778.859	802.782	824.660	846.169	865.542
Age 5-9	550.493	548.427	546.110	539.693	536.301	555.895	577.734	601.768	627.359	654.911	682.155	710.533	738.120	765.747	794.394
Age 10-54	3,821.543	3,928.753	4,032.859	4,139.373	4,251.367	4,333.373	4,415.666	4,500.088	4,580.772	4,681.969	4,777.855	4,883.689	4,993.208	5,111.584	5,249.951
Age 55-60	519.179	547.582	582.543	613.699	650.283	693.354	740.448	779.398	823.984	851.485	874.018	884.165	897.973	895.793	905.604
Age 61+	1,862.929	2,011.719	2,169.954	2,346.600	2,519.768	2,709.159	2,908.928	3,125.942	3,357.454	3,588.213	3,850.776	4,126.473	4,407.585	4,712.636	4,989.260
TOTAL	7,281.468	7,584.514	7,902.554	8,235.008	8,578.972	8,938.879	9,316.191	9,707.685	10,116.917	10,529.766	10,963.663	11,407.642	11,861.547	12,331.929	12,804.751

Table A12: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 11

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	661.744	681.426	700.834	719.347	737.634	755.620	774.127	794.431	815.411	837.442	860.602	884.977	910.658	938.144	965.092
Age 5-9	536.393	562.904	589.161	619.133	662.197	684.558	704.805	724.211	743.454	762.173	780.860	800.729	820.900	842.732	865.316
Age 10-54	4,475.033	4,650.473	4,826.832	5,008.725	5,184.714	5,381.073	5,583.564	5,790.595	6,005.411	6,230.632	6,463.957	6,695.839	6,940.811	7,195.124	7,453.177
Age 55-60	492.026	533.121	579.442	629.156	675.275	721.639	772.517	818.232	864.151	908.349	946.750	989.651	1,026.160	1,063.992	1,107.893
Age 61+	1,695.146	1,829.189	1,979.252	2,132.315	2,302.838	2,494.960	2,699.422	2,926.497	3,164.840	3,422.562	3,697.049	3,991.370	4,308.124	4,633.014	4,975.595
TOTAL	**7,860.342**	**8,257.112**	**8,675.521**	**9,108.677**	**9,562.659**	**10,037.851**	**10,534.435**	**11,053.966**	**11,593.268**	**12,161.158**	**12,749.219**	**13,362.567**	**14,006.653**	**14,673.006**	**15,367.073**

Table A13: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 12

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	848.426	873.422	898.518	922.595	945.180	967.760	992.385	1,017.699	1,045.358	1,073.217	1,103.000	1,133.773	1,167.117	1,201.673	1,236.251
Age 5-9	705.187	741.027	775.569	814.433	871.312	900.397	927.050	953.290	978.435	1,003.441	1,027.018	1,052.711	1,080.080	1,108.930	1,138.667
Age 10-54	4,920.237	5,111.516	5,305.484	5,504.563	5,695.878	5,913.107	6,135.882	6,365.034	6,603.746	6,849.448	7,106.823	7,363.434	7,631.456	7,908.762	8,190.811
Age 55-60	527.549	572.462	621.749	675.299	725.741	774.705	829.615	878.792	928.361	976.409	1,017.335	1,063.811	1,103.072	1,143.757	1,190.615
Age 61+	1,716.185	1,851.658	2,002.656	2,159.402	2,334.186	2,529.572	2,739.555	2,970.424	3,214.654	3,470.604	3,750.693	4,051.833	4,368.930	4,700.421	5,039.680
TOTAL	**8,717.584**	**9,150.085**	**9,603.976**	**10,076.292**	**10,572.297**	**11,085.539**	**11,624.487**	**12,185.238**	**12,770.554**	**13,373.119**	**14,004.869**	**14,665.562**	**15,350.654**	**16,063.543**	**16,796.024**

Table A14: Projection of Total Expenditure on Universal Healthcare (Classified by Age) in Region 13

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Age 0-4	1,120.202	1,146.807	1,167.802	1,183.357	1,193.604	1,198.656	1,200.812	1,200.024	1,197.021	1,192.644	1,187.407	1,182.128	1,177.843	1,174.877	1,173.560
Age 5-9	662.657	756.335	859.148	987.137	1,066.221	1,089.440	1,115.473	1,135.614	1,150.441	1,160.050	1,164.544	1,166.318	1,165.195	1,161.955	1,157.429
Age 10-54	9,291.316	9,604.564	9,926.436	10,242.416	10,562.186	10,970.756	11,362.941	11,742.315	12,165.450	12,501.545	12,901.157	13,298.753	13,710.217	14,121.390	14,470.844
Age 55-60	1,017.743	1,101.186	1,176.095	1,271.203	1,350.793	1,422.302	1,511.680	1,642.196	1,738.684	1,893.764	2,035.327	2,158.604	2,239.721	2,382.197	2,469.199
Age 61+	2,711.815	2,968.078	3,246.732	3,512.907	3,895.016	4,251.805	4,643.346	5,044.777	5,459.416	5,982.634	6,458.903	6,999.652	7,609.778	8,177.594	8,957.322
TOTAL	**14,803.733**	**15,576.970**	**16,376.214**	**17,197.020**	**18,067.820**	**18,932.959**	**19,834.252**	**20,764.926**	**21,711.012**	**22,730.638**	**23,747.339**	**24,805.456**	**25,902.755**	**27,018.013**	**28,228.353**

Chapter 6

Social Infrastructure Demand for Low Income Housing

1 Introduction

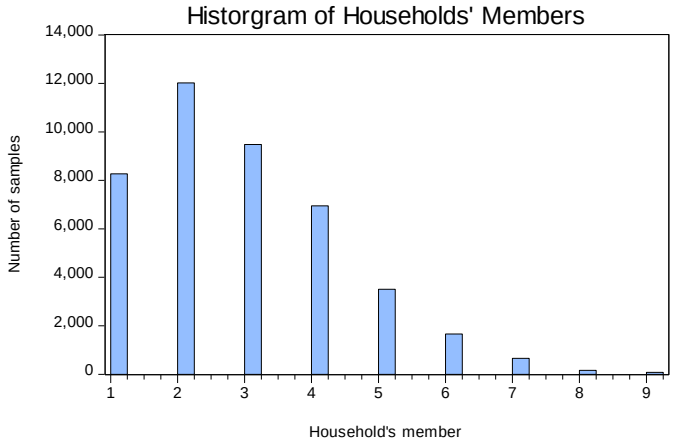
In this chapter, we would like to project the demand for low-income housing need and see whether they can be affordable with income growth in Thailand. Firstly, a simple household profile is narrated. We also show a simple regression analysis which applies surveyed data from the Household's Socio-Economic Survey (SES) to test a hypothesis of 'ownership'. Later, a comprehensive model is proposed with policy scenarios.

1.1 Household Profile

Base on Household's Socio-Economic Survey 2015, the profile of approximately 43,000 households' sample is summarized as follows:

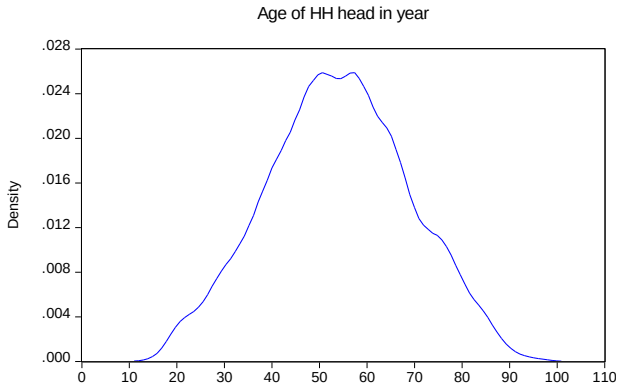
According to the SES 2015, the average household size is relatively small to 2.8 persons per household (skewness =0.817). The mean age of household head is relatively normal with mean 53.87-year-old (skewness =0.002). It should be noted that household size in Thailand has become smaller than in the past. (not shown here)

Figure 6.1: Distribution of Household Members 2015



Source: SES 2015

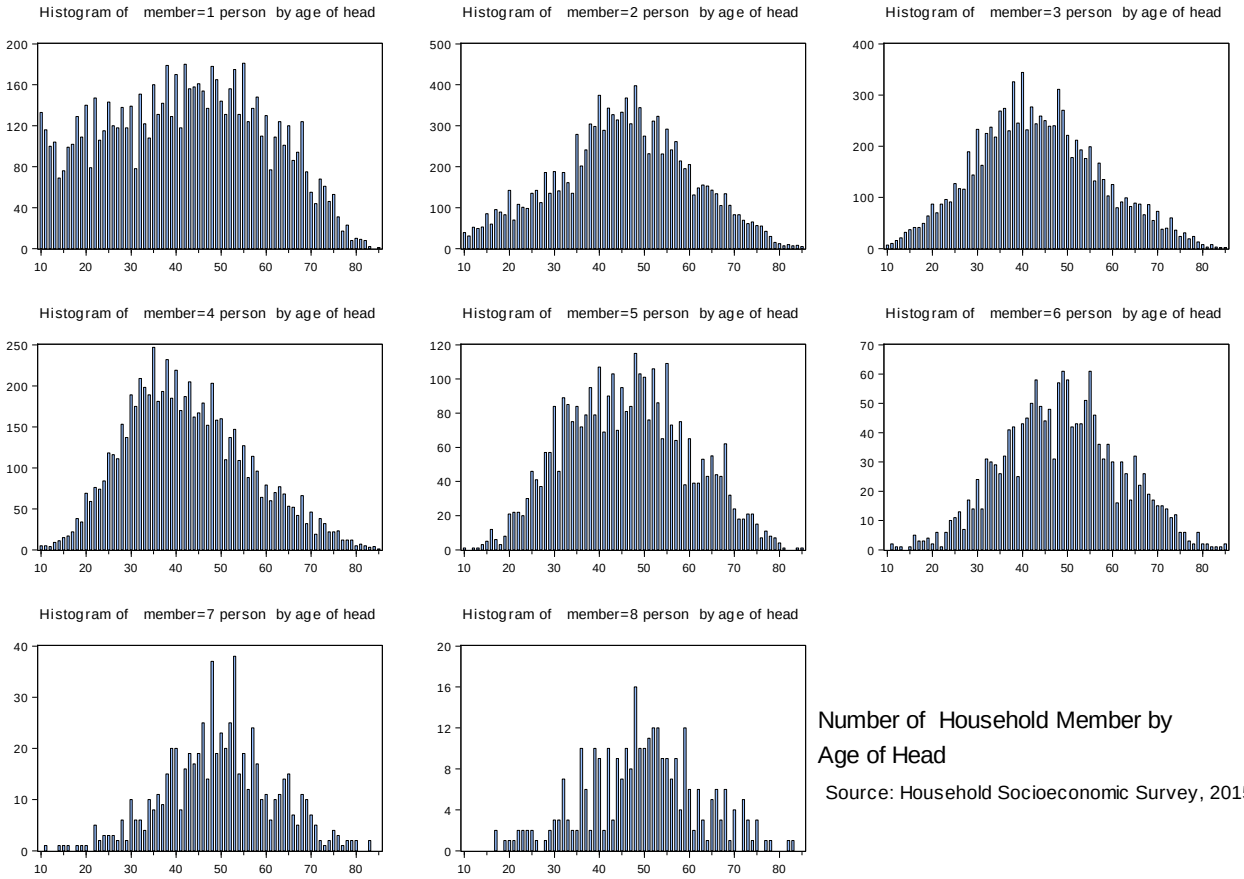
Figure 6.2: Normal Density Distribution of Age of Household's head



Source: SES 2015

We have investigated the age distribution of household's head and found that it is normally distributed as shown.

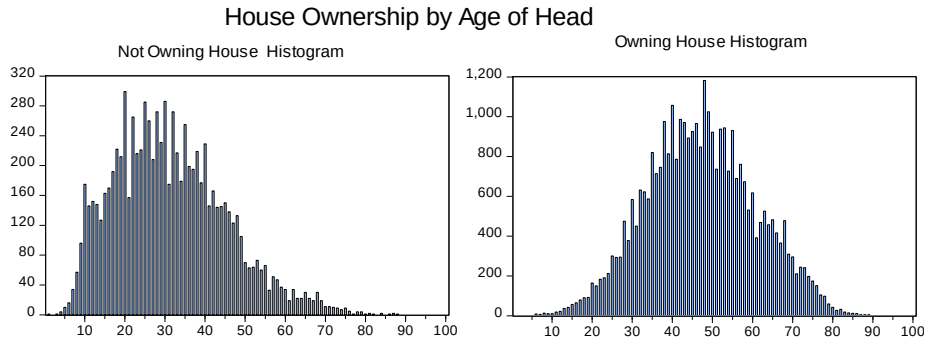
Figure 6.3: Histogram of Household Size by Age of Head



Number of Household Member by Age of Head

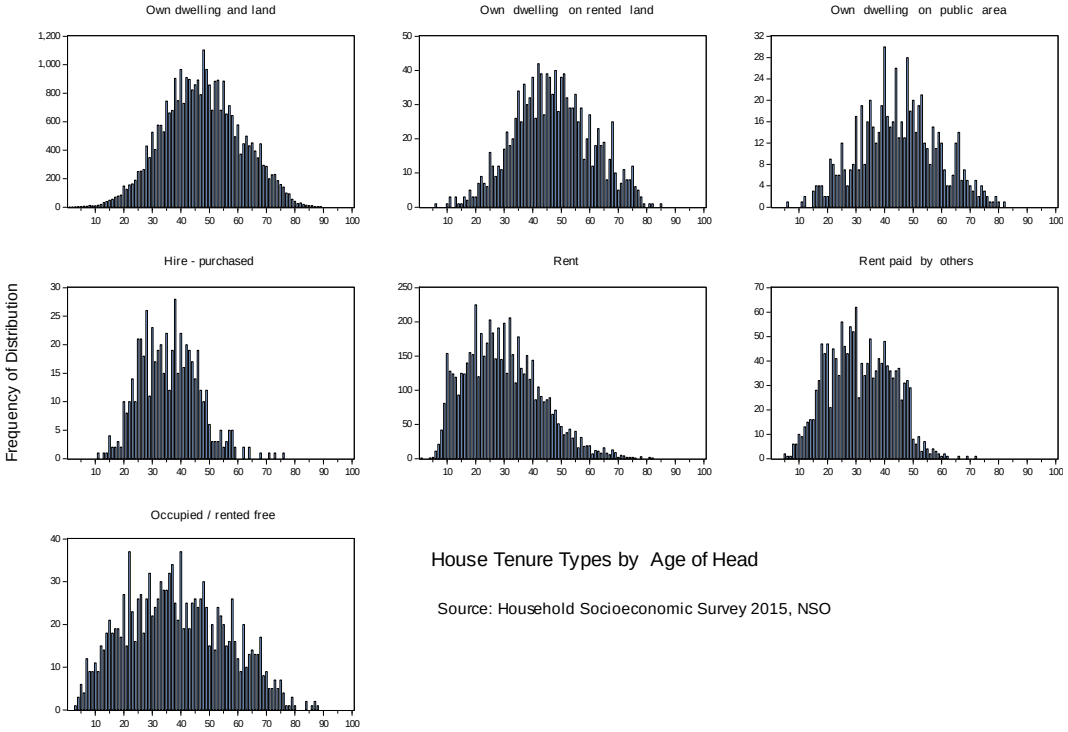
Source: Household Socioeconomic Survey, 2015

Figure 6.4: Household Ownership by Age of Head



Given the age of household head's distribution, we plot the histogram of household size by a number of members i.e., a size where the age of head is around the mean age. It is found that household member distribution in relatively normal (bell shape), except the size of 1 member household.

Figure 6.5: House Ownership Tenure Characteristics

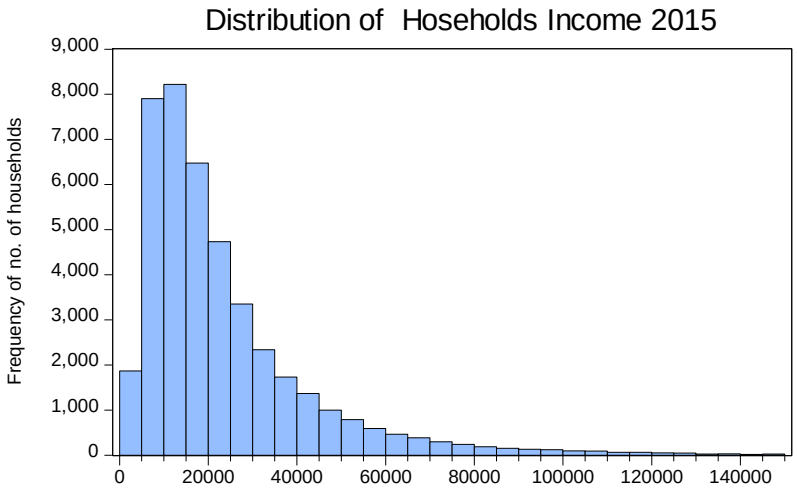


The ownership of a house is distributed normally with age of head. *A household with a younger mean age of head has a lower probability to own house*. House tenure by age of head indicates that ownership of the house by type of dwelling on own land, rented land, as well as public land, are normally distributed across age of head. Households with tenure as 'rent' and 'hire purchase' have a younger age of head.

Figure 6.6: Positive Relationship of Ownership Tenure (Scattered plot by controlled by age of head).

The household formation mentioned above can be further analyzed in terms of the *economic behavior*. The most crucial determinants of housing need are *'income' and/or 'expenditure'* of households. Households' income distribution in 2015 is approximately followed the *log-normal* distribution. This implies that most of the households belong to lower income ranges. The mean income is 23,464 baht per month while median income is 17,316 baht per month respectively.

Figure 6.7: Household Income followed the Log-Normal Distribution



Note: Mean income 23,464 baht per month
Median income 17,316 baht per month
Jarque-Bera 115828; skewness 2.24; Kertosis 9.68
No. of samples 42779
Source: SES 2015

Figure 6.8: Household Income Distribution (Histogram plot controlled by age of head)

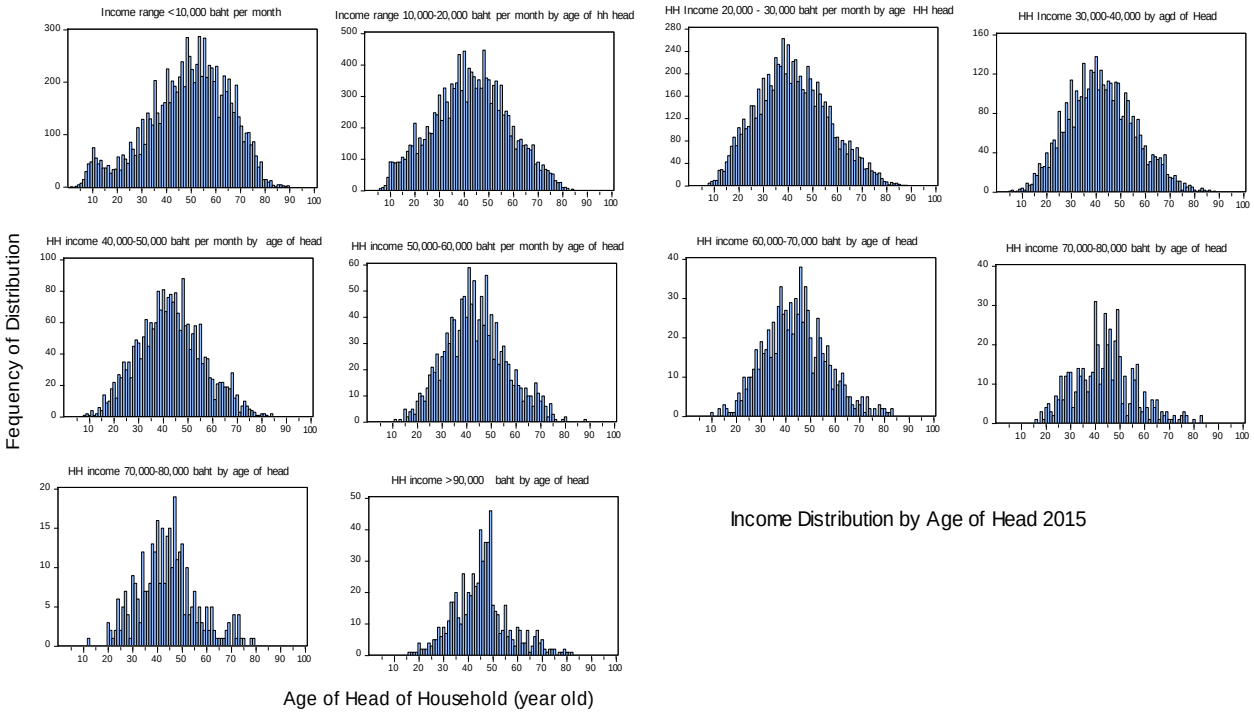
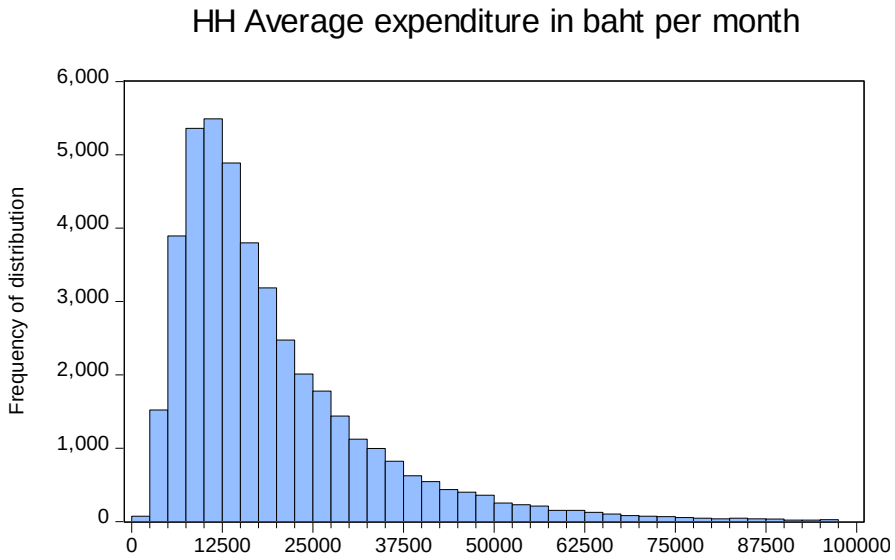
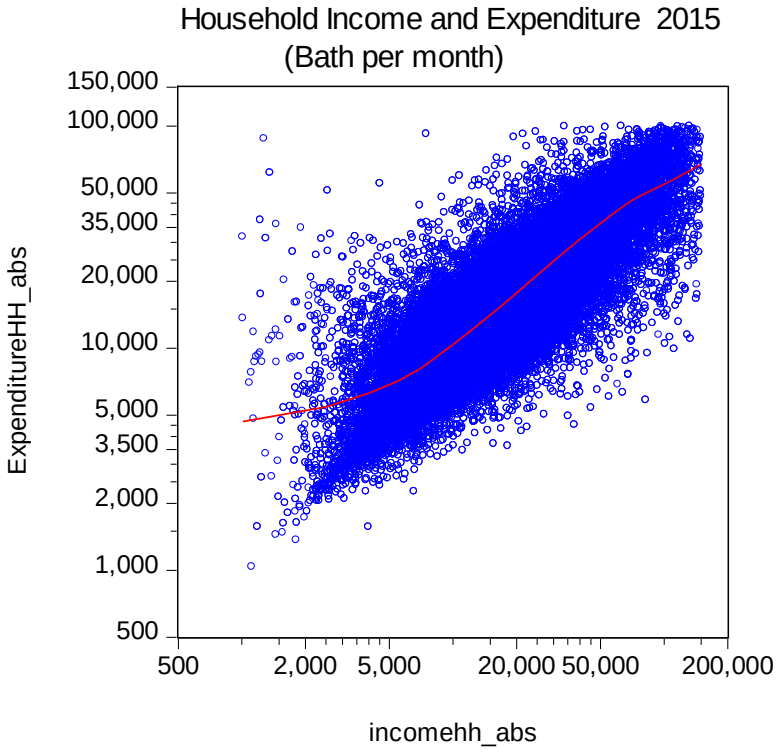


Figure 6.9: Household Expenditure followed the Log-Normal Distribution



Source: SES 2015

Figure 6.10: Relationship between Household Income and Expenditure 2015



We have estimated the determinant of ownership of a house. The 'owning ratio' or *ownership-ratio is ratio between 'number of households with status of house ownership' over the summation of households 'owning house and those with ren*tal status' is determined

from right-hand variables. These are households belong to income deciles 1- 4 and those who belong to income deciles 5-10th (ΣINC_i). (See Table 6.1).

We have applied the Generalized Method of Moment (GMM) after controlled by age of head to get rid of 'over-identification problem'. We have controlled for the 'endogenous biased' by applying instruments variables on *house types* ($TYPE_j$) as well as *member sizes* ($\Sigma MEMBER_h$).

The estimation result indicates that household with income 1- 4 classes have a significant *negative* relationship with ownership ratio. The household with income 5-10 classes show a significant *positive* relationship with the ownership ratio.

An uncontrolled version of regression applying 'logistic model' which included the dimension of location has found similar results. For the municipal area, the model indicates that *probability* of being house ownership has a *positive* relationship *with total income and age* but *negative relationship with members of the family* of an individual. *These mean as total income, age or a percentage change in age increase, a person will have higher tendency to own a house.* In addition, as the number of members in family increases, a person will have lower tendency to own a house for municipal area.

For Bangkok area and vicinities, the probability of owning a house has a *positive* relationship with total income and age but *negative* relationship with members of the family of an individual. In addition, as the number of members in family increases, a person will have lower tendency to own a house for Bangkok area and vicinities.

In conclusion, as people become older, they want to purchase their own houses for observations from the entire country, municipal area, and Bangkok area and vicinities. However, the higher total income of an individual induces purchasing a house only in the municipal area, and Bangkok area and vicinities. Surprisingly, a number of members in a family is significantly associated with lower tendency to purchase houses for all 3 groups of observations.

Table 6.1: Determination of House Ownership (Ratio of Owning House – Rental House Status)

Dependent Variable: OWNING_RATIO
Method: Generalized Method of Moments
i=income class by deciles i=1,2,…10 open ended; j= house type j= 1…7; and h=household member h=1,..8 and over
Instrument specification: TYPE1 TYPE2 TYPE3 TYPE4 TYPE5 TYPE6 TYPE7 MEMBER1 MEMBER2 MEMBER3 MEMBER4 MEMBER5 MEMBER6 MEMBER7 MEMBER8_OVER
A 'Constant' term is added to instrument list
Lagged dependent variable & regressors added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.004455	0.040335	24.90311	0.0000
INC1+INC2+INC3+INC4	-9.30E-05	3.30E-05	-2.816813	0.0064
INC5+INC6+INC7+INC8+INC9+INC10_OPEN	0.000489	0.000174	2.809408	0.0065
AR(1)	0.955577	0.008733	109.4258	0.0000

R-squared	0.990279	Mean dependent var	0.745002
Adjusted R-squared	0.989844	S.D. dependent var	0.266097
S.E. of regression	0.026817	Sum squared resid	0.048182
Durbin-Watson stat	2.518718	J-statistic	11.93173
Instrument rank	18	Prob(J-statistic)	0.611786

Inverted AR Roots	.96

Source: this study, applying SES 2015.

Table 6.2: Logistic Regression Output of House Ownership for Entire Country

Variable	*Full*	*l_full*	*drop_members*	*drop_age*
ttlinc	-5.50E-07		4.19E-07	6.208e-06**
members		-.27902681***		-.30645988***
age		.08957908***		.09061646***
l_ttlinc			-.22138641***	
l_members			-.68900411***	
l_age			3.4675945***	
_cons	-3.8485078***	-11.106518***	-4.760824***	-.42335504***
N	5376	5375	5376	5376
aic	15873848	15937594	16232632	18433407
bic	15873874	15937621	16232652	18433426

*Note: 1) legend: * p<.1; ** p<.05; *** p<.01*

1. Full model "full", which includes all independent variable 2. Log full model "L_full",

2. which includes natural log of all independent variable. 3. "Drop members", which excludes a number of the family member from the model.

Table 6.3: Logistic Regression Output of House Ownership for Municipal Area

Variable	*full*	*l_full*	*drop_members*	*drop_age*
ttlinc	7.970e-06**		8.122e-06**	.0000148***
members	-.09741994*			-.11781796***
age	.09581992***		.09577326***	
l_ttlinc		0.0915607		
l_members		-0.13988323		
l_age		3.8909211***		
_cons	-5.3455629***	-16.623346***	-5.6475818***	-1.6136944***
N	2538	2537	2538	2538
aic	5046903.9	5068449.9	5063470.7	5919845.9
bic	5046927.3	5068473.3	5063488.2	5919863.4

Table 6.4: Logistic Regression Output of House Ownership for Bangkok Area and Vicinities

Variable	*full*	*l_full*	*drop_members*	*drop_age*
ttlinc	.00001377***		.00001382***	.00001935***
members	-.14121318**			-.11503283*
age	.10279559***		.10134006***	
l_ttlinc		.61156397***		
l_members		-0.32601779		
l_age		4.2479191***		
_cons	-5.9516206***	-23.080995***	-6.3428299***	-2.0298528***
N	1635	1635	1635	1635
aic	2597053.9	2542555.6	2613837.1	3077564.5
bic	2597075.5	2542577.2	2613853.3	3077580.7

*legend: * p<.1; ** p<.05; *** p<.01*

2. Low-Income Housing Needs and Affordability Model

The model starts with the population projection 2015-2030. Here also, given the population by single year age ***'a'*** (assuming fertility *rates*), gender ***'s'*** (*male, female*), we project the household **h** (*intact*, *one person*, *single head*, and *other* household types) respectively. The brief description of the projection modules used in this study is as follows:

1) Population Module

The number of households by type ***h*** and age ***a*** is determined from the population by single age *population* multiplied by *headship rate.*

$$HH_{a,h} = (hs_{a,h,s})\, PoP_{a,s}$$

Number of household by type *'h'* is a summation of household by single age *a*

$$HH_h = \sum_a HH_{a,h}$$

Total number of household

$$HH = \sum HH_h$$

HH = total number of households,

HH_h = number of household formation by type *h*,

$HH_{a,h}$ = number of household formation by age *a*, type *h*, and

$hs_{a,h,s}$ = headship rate to form household type *h* i.e., the rate of family formation

$PoP_{a,s}$ = Population with single age *a*, and gender *s*, over the forecasting horizon (t=2015-2030)

2) Housing need from the household formation (demand side)

Housing inventories at a point in time (HI) are determined by the number of households, assuming one household would need one house unit. Since there are vacancies of house units during the forecasting horizon, the gross house inventory stock is the summary of 'basic need' of house stock equivalent to a number of households adjust by vacant house unit ($0<\boldsymbol{av}<1$) at a point in time. The result is net house inventory stock.

In reality, households may reside together in one house unit. We, therefore, adjust the number housing need with 'doubling up rate' ($0<af<1$) to get the adjusted number of net house inventory.

$$HI = (af)\ (1+av)HH$$

HI = adjusted house inventor stock (net)

af = doubling up rate, ($0<af<1$)

av = vacancy rate, $0<av<1$

We are interested in the housing need at each time period t (year). The change in housing inventory or incremental housing need in each sub-period (year) is therefore

$$\Delta HI_t = HI_t - HI_{t-1}$$

Housing withdrawal owing to replacement age of house stock is determined by withdrawal rate aw at each time t, from existing house inventory HI_t.

$$WH_t = (aw)\ HI_t$$

The *housing 'start'* would be constructed to replace the withdrawal units and to fulfill the inventory change. This new *housing needs* or *housing start* (HSS_t) is determined as

$$HSS_t = WH_t + \Delta HI_t$$

3) Affordability of housing need

The household's affordability of housing need is not automatic. Normally, the low-income household is not able to access the private housing market. Low-income household such as those belonging to income deciles 1-5th class may face with income and saving constraint. A low-income household cannot do monthly mortgage service with the short-term loan, high market interest rate, high down payment, and high market's house price. The following affordability module will be used in our study to arrive at feasible public policy on social infrastructure investment of Thailand in the next decades.

GDPR = Gross Domestic Product at Constant Price

PGDP = GDP deflator or general price e=level

Ym = Average monthly mean income from SES

Ym_h = monthly mean income of household *h-th* (h= intact, single head, one person, and others type of households)

$Ym_{h,i}$ = monthly mean income of household *h-th*, income class *i-th* (i=1,2,….10)

$YD_{h,i}$ = Disposable income of household *h-th*, income class *i-th* (i=1,2,….10)

@ = Adjustment coefficients between monthly income survey by the NSO and estimated by the National Accounts (NESDB)

d_h = Coefficient of *total* average income and average income of each household *h-th*

d_{hi} = Coefficient of income distribution of household h-th by income class i-th, (i=1,2,3,…. 10)

P_{hi} = Probability that any household belongs to income class i-th in household type h-th

$N(Z; 0,1)$ = standard normal distribution with mean and variance (0,1)

Z_{hi} = Standard score of random variable of income of the function $N(Z; 0,1)$ of household h-th

U_h = Mean income of household h-th which has income distribution function as a log-normal Distribution function

SD = standard deviation of income of household h-th

Step 1: Household Income Projection by income class

This module identifies the income of household *h-th* by income class *i-th*. Note that (1) time subscript is omitted for sake of simplicity. (2) The growth of income per head projected by Macro-econometric model or published by official sources (NESDB, BOT) over the planning horizon (2015-2030) can be used for projection of the left-hand side variables.

$Ym = @GDPR * PGDP$

$Ym_h = (d_h)Ym$

$Ym_{h,i} = (d_{h,i})Ym_h$

$HE_{h,i} = (e_{h,i})(Ym_{h,i})$

$HSE_{h,i} = (she_{h,i})(HE_{h,i})$

$HE_{h,i}$ = Income of class *i-th* (i=1,2,3,…10) of Household *h-th*

which can be disposed for household expenditure

$HSE_{h,i}$ = Income of class *i-th* (i=1,2,3,…10) of household *h-th*, which can be disposed for *housing* expenditure

$e_{h,i}$ = Ratio of income in each class *i-th* (i=1,2,3,…10)

which can be disposed in general by household *h-th*,

$she_{h,i}$ = Ratio of expenditure of household *h-th* in income class *i-th* (i=1,2,3,…10)

disposed for housing expenditure

Step 2: Projection of household expenditure on housing acquisition

$NHE_{h,i} = (1\text{-}re_{h,i})(HSE_{h,i})$

$NHE_{h,i}$ = Household expenditure on housing by household h-th, income class *i-th* (i=1,2,3,…10). This expenditure is inclusive of household's saving for down payment in hire purchase of house.

$re_{h,i}$ = recurring expenditure by household *h-th*, income class *i-th* (i=1,2,3,…10)

Step 3: Projection of housing affordability through monthly mortgage service. Service can be allocated from household saving after recurring expenditure.

$MGS_{h,i} = (NHE_{h,i}/HE_{h,i})(Ym_{h,i})$

$MGS_{h,i}$ = monthly mortgage service of household *h-th* in each income class *i-th* (i=1,2,3,…10)

The capitalization factor (CF) is found to be

$CF = \{1 - (1+r)^{-T}\}/r$

We can evaluate the capital value of house of household h-*th* in each class *i-th* (i=1,2,3,…10)

$AF_{h,i} = \{(CF)(MGS_{h,i})\}/\{1-dp/100\}$

Given the post finance parameters as follows:

r = annual rate of interest in mortgage service which government subsidy can be intervened,

T = term loan (in year)

dp = Percentage of 'down payment' before mortgage service.

4) Government Low-income housing Policy

$$NH_{h,i} = (p_{h,i})\ NH_h$$

$NH_{h,i}$ = Number of household type h-th which belong to deciles class of i=1,2,3,4 where i-th is lower than affordability level with probability $p_{h,i}$

Given the availability of data from government and private sources as

(1) Household data surveyed by the National Statistical Office, namely Household Socio-Economic Survey several years to estimate the necessary parameters mentioned above.

(2) The official population projection 2015-2040 is from National Economic and Social Development Board.

(3) We apply our macroeconomic model to forecast the GDP growth and derive the mean income of households at a national level.

(4) The mean income is transformed to the monthly income of household to match with a month income baseline from SES.

(5) House price data is randomly selected from private housing market sources.

(6) Other financial data are from government sources like Government Housing Bank, Government Saving Bank and the Bank of Thailand etc.

The government (NHA) can propose the Ministry of Human Security and Social Welfare the number of housing needs of the low-income group. The simulation of policy instruments can be tried to arrive at possible solution and cost of social infrastructure investment as well as the cost of policy intervention.

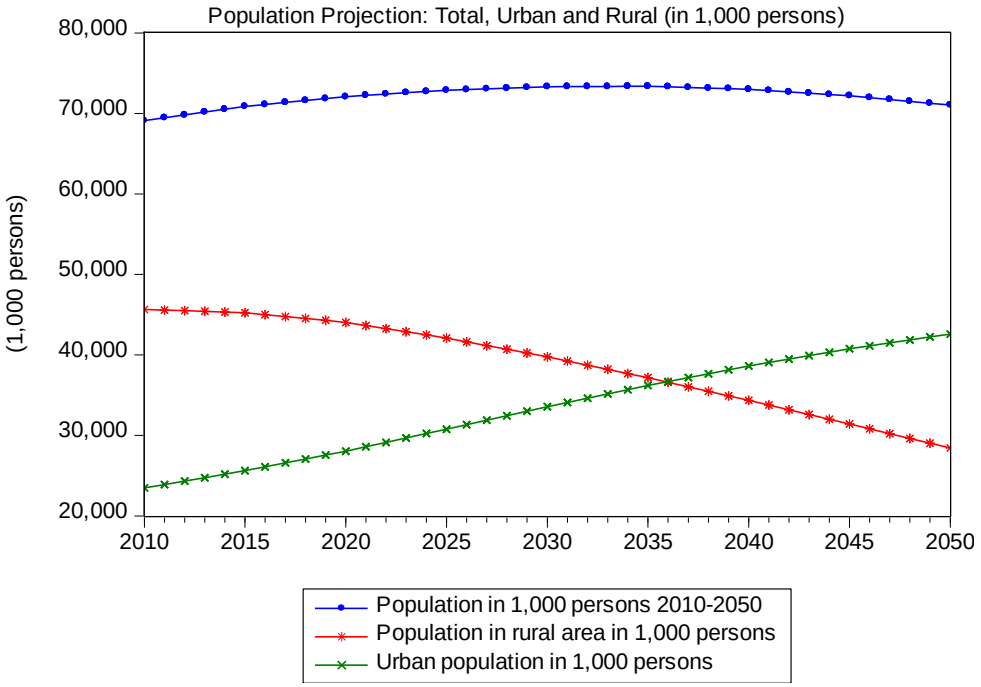
3. Low-Income Housing Needs and Affordability, Model Simulation

Population Projection

The changing structure of household and income distribution in Thailand determines the demand for housing. Firstly, we applied an official number of the population projected by NESDB[1]it's under the assumption of declining fertility.

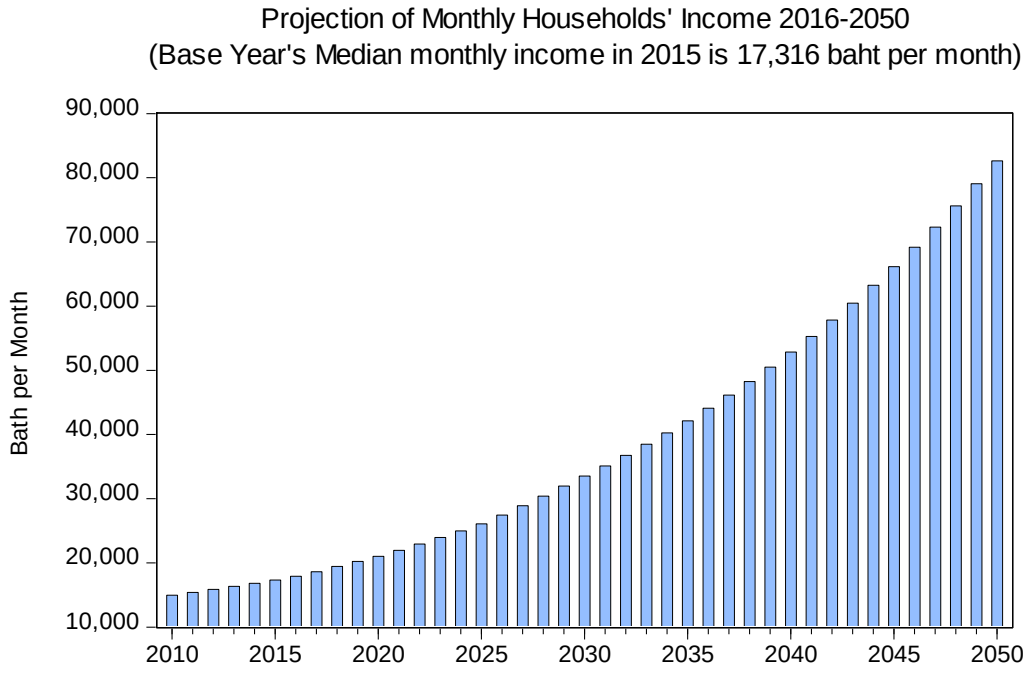
The population projection series from the NESDB is shown in the graph below. It is clearly shown that the urban household is growing to substitute for the rural household in the coming decades. Thus, urban housing policy is a very crucial issue. Secondly, we have drawn a number of households by types i.e., 'Intact', 'Single head', 'One person', and 'Others' from the Population Census 2010 and related reports of NESDB 2015-2050. Given *headship rates* the parameters to signify the probability to be household head over the total number of households, we obtain the household by types of household' s head. The number of households by types is shown in tables 6.5 below.

Figure 6.11: Population Trend in Thailand, Urban and Rural Area 2010-2050



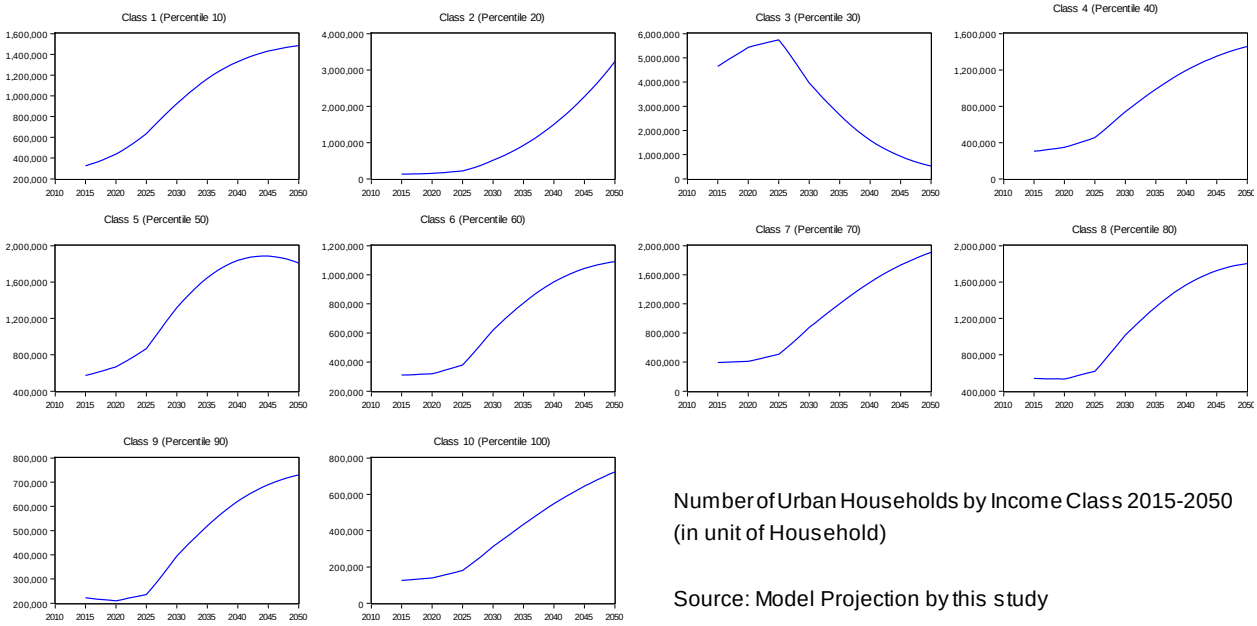
[1] The National Economics and Social Development Board, Population Projection Thailand.

Figure 6.12: Projection of Monthly Households' Income 2016-2050



From the macro-econometric model, we have forecasted the real and nominal GDP and other macro variables. From the reference path of income at the national level, household numbers, we have estimated the mean income per month earned by an average household. From this information, we use the probability model to estimate the distribution of households by income percentiles. A number of households in all classes accepts class3th are projected to increase over time 2015-2050. From a policy point of view, poorest class 1st and 2nd are not able to mobilize to higher classes and need to be continuously taken care by the public residential system. The rest of households may be able to enter the housing market via rent, hire purchase if with public debates and subsidies. For class 6th – 10th, we expect that their demand for housing will be borne by own savings and private house market with market base financial cost.

Figure 6.13: Household Distribution by Income Class in 2015-2050



Number of Urban Households by Income Class 2015-2050 (in unit of Household)

Source: Model Projection by this study

Assumptions of Model Parameters:

(1) Doubled up rate trend is different among household types and between HH urban and total HH. (2) Distribution of household's types change over time i.e., lower share of 'intact household' and replaced by the rising share of 'Single head' as well as 'One person and Others' households respectively. (3) Withdrawal rate and vacancy rate are assumed as its past trend. (4) Total household's mean income is consistent with national GDP's growth trend. This is obtained from macroeconomic model forecasting. (5) The mean income by percentile income class is obtained from applying SES household income distribution in 2015.

We start from the household formation into 4 types as mentioned above. The household would need at least one dwelling. It can be doubled up with other households i.e., more than one household in one dwelling. Households can own various types of houses either single house, twin house, flat, condominium etc. They can have many ownerships status from owning a house, having rental status, live on own land plot but build own house or rent land and house or build a house on government land etc. The most serious urban problem is however urban poor has to encroach on public land e.g., state enterprises' land property like national railway land around the railway station or along the rails on both sides. They once were a construction labor in public project and decided to settle down on public land along the canal. How to provide both dwelling and jobs to these urbanites are serious social issues in every developing country. Thus, housing needs in case of developing countries are not totally congruent with the definition in developed countries. Therefore, in

model forecasting it is difficult to find proper parameters like 'housing withdrawal' 'vacancy rates' as well 'doubled up rate' etc.

In our study, we have applied the simple model of housing needs and affordability believed to be consistent with the situation in Thailand and many other Asian countries. Firstly, the projection of housing inventory would be sufficed to calculate using a spreadsheet as below. The changing of housing inventory adjusted by housing withdrawal and vacancy rate can be projected. With further calculate the change in inventory; we finally obtain the housing start to be built to fulfill house need from the population and human settlement concept. We are interested in the settlement in the urban area. The housing starts to be planned for human settlement in the urban area as incremental from the past inventory stock is found in the row of Table 6.5, it is in the magnitude of 400-500 thousand units approximately for each sub-period. Bear in mind that these housing starts are for all income classes either rich or poor households. We are interested only in the low-income housing provision namely those who cannot enter the private housing market. They may have to either rent government house or heavily subsidized for hire purchase with lengthy of mortgage services say 30 years with affordable lower than market interest rates, and down payment.

In order to match household needs with affordability, we need a projection of future mean income. From official projection at the national level, it can be translated into the level of mean income of household by income class. Next step is to follow the matching of mortgage services per month with housing expenditure for house payment as shown in the system of equations above.

Table 6.5: Total Households by Types and Housing Inventory and Housing Start 2009-2037

	2009	2015	2020	2025	2030	2035	2037
Total household (1,000 units)	**19,579**	**21,326**	**22,535**	**23,599**	**23,603**	**23,882**	**23,991**
Intact household	13,848	13,917	13,851	14,387	12,501	10,380	9,708
one person household	1,442	2,492	3,268	3,540	4,721	5,851	6,238
single head household	4,281	4,909	5,408	5,664	6,373	7,642	8,037
others household	9	8	8	8	8	9	9
Intact household share	100.00	100.00	100.00	100.00	100.00	100.00	100.00
one person household share	70.73	65.26	61.46	60.96	52.96	43.46	40.46
single head household share	7.36	11.69	14.50	15.00	20.00	24.50	26.00
others household share	0.05	0.04	0.04	0.03	0.03	0.04	0.04
Urban household (1,000 units)	**6,485**	**7,572**	**8,648**	**9,839**	**10,671**	**11,649**	**12,045**
Rural household (1,000 units)	**13,094**	**13,754**	**13,887**	**13,761**	**12,932**	**12,233**	**11,945**
1 Intact household (1,000 units)							
intact household: *urban*	4,587	4,941	5,382	6,063	6,151	5,823	5,717
AF = doubling rate	0.42	0.42	0.45	0.50	0.65	0.75	0.75
AF Urban	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AV = vacancy rate	0.02	0.02	0.02	0.02	0.02	0.02	0.02
adjusted house inventory stock (HI) :intact = = (AF)(1-AV)*(sumHH at t)	5,670	5,698	6,093	6,741	7,858	7,586	7,089
change in adjusted house inventory stock (delta_HI) :intact	-	146	(26)	179	465	(158)	(161)
adjusted house inventory stock (HI) :*urban* intact = (AF)(1-AV)*(sumHH at t)	4,518	4,867	5,301	5,972	6,059	5,736	5,631

change in adjusted house inventory stock (delta_HI) : *urban* intact	-	102	107	300	34	24	13
withdrawal rate (aw)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
No. of housing withdrawal (WHt) : intact = aw*HI		114	122	135	157	152	142
No. of housing withdrawal (WHt) : *urban* intact = aw*HI		4	6	7	11	14	16
housing start (HS) : intact = WHt + delta_HI		**260**	**95**	**314**	**622**	**(6)**	**(19)**
housing start (HS) : urban intact = WHt + delta_HI		***216***	***229***	***435***	***191***	***175***	***155***
2 One person household (1,000 units)							
withdrawal rate (aw)		0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
No. of housing withdrawal (WHt): one person = aw*HI		12,396	16,256	17,611	23,485	29,109	31,032
No. of housing withdrawal (WHt): *urban* one person = aw*HI		4,401	6,238	7,342	10,618	14,198	15,581
housing start (HS) : one person = WHt + delta_HI		***552***	***166***	***(182)***	***259***	***280***	***164***
housing start (HS) : urban one person = WHt + delta_HI		***193***	***81***	***(51)***	***148***	***176***	***126***
3. single head household (1,000 units)							
single head household: *urban*	1,411	1,734	2,065	2,349	2,867	3,709	4,015
AF = doubling rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AF Urban	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AV = vacancy rate	0.01	0.01	0.01	0.01	0.01	0.01	0.01
adjusted house inventory stock (HI) :single head = (AF)(1-AV)*(sumHH at t)	4,260	4,885	5,408	5,664	6,373	7,642	8,037
change in adjusted house inventory stock (delta_HI): single head	-	258	176	(414)	236	257	138

adjusted house inventory stock (HI) : *urban* single head = (AF)(1-AV)*(sumHH at t)	1,411	1,734	2,065	2,349	2,867	3,709	4,015
change in adjusted house inventory stock (delta_HI): *urban* single head	-	84	96	(132)	149	177	125
withdrawal rate (aw)		0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
No. of housing withdrawal (WHt): single head = aw*HI		24,424	27,042	28,319	31,864	38,211	40,184
No. of housing withdrawal (WHt): *urban* single head = aw*HI		8,672	10,326	11,747	14,334	18,545	20,075
housing start (HS) : single head = WHt + delta_HI		***283***	***203***	***(386)***	***268***	***295***	***178***
housing start (HS) : urban single head = WHt + delta_HI		***92***	***106***	***(120)***	***164***	***196***	***145***
4. other household (1,000 units)							
others household: *urban*	8.64	7.81	8.02	8.40	8.40	8.50	8.54
AF = doubling rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AV = vacancy rate	0.01	0.01	0.01	0.01	0.01	0.01	0.01
adjusted house inventory stock (HI) : *urban* others = (AF)(1-AV)*(sumHH at t)	8.59	7.77	7.98	8.36	8.36	8.46	8.50
change in adjusted house inventory stock (delta_HI): *urban* others		162	95	79	0	20	19
withdrawal rate (aw)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
No. of housing withdrawal (WHt): *urban* others = aw*HI		0.16	0.16	0.17	0.17	0.17	0.17
housing start (HS) : urban others = WHt + delta_HI		***0.32***	***0.25***	***0.25***	***0.17***	***0.19***	***0.19***
Housing start (HS) :Total = 1+2+3+4 (1,000 units)		**1,094.73**	**463.94**	**(253.79)**	**1,149.23**	**569.51**	**323.91**
Housing start (HS) :urban = 1+2+3+4 (urban) (1,000 units)		**501.28**	**415.53**	**264.20**	**503.57**	**547.64**	**426.13**

Note: (..) indicates negative numbers. Housing inventory is stock adjustment annually, while housing start is regarded as the changing of inventory each period after taking into account the housing withdrawal owing to dismantle or causing fire etc., and has to be cleared from the inventory.

We have developed low-income housing need and affordability model, on a spreadsheet to project the housing inventory and housing starts for all households and urban households. The housing start is a change in housing inventory which is an adjustment between demand and supply of housing. It can be regarded as the *excess demand* at equilibrium which can exhibit market signal either *positive or negative* value given that the house *price is always positive.* This is because even though the change in inventory is negative the price can never be zero since there is still stock of house in the market to be cleared by demand side.

The foregoing analysis has shown that urbanization that would take place in Thailand in the coming decades has expressed housing demand in urban area of 415.53 thousand units in 2020. The housing demand would be 503.57 thousand units in 2030 and 426.13 thousand units in 2037 respectively. As we have shown in Table 6.1 that low income household (deciles 1-4) could not afford to buy house from the private housing market. It is therefore a government role to provide housing for low income in urban area. We will see the affordability of low income in the next analysis concerning the house price and inverse housing demand.

4. Estimation of Inverse demand for house and Affordable House Price

In this section, we are going to estimate the *Inverse demand for house* applying a logistic estimation method. The demand represents the affordable power of existing house ownership by households, *ex-post.* The analysis covers three areas *entire country, municipal area, and Bangkok metropolitan* and *vicinities* respectively.

This analysis is to find the factor which affects the house price. It is, in fact, an '*inverse housing demand relationship*' *applying data from SES* 2007. Our hypothesis is whether the income of household affects the *imputed value of house or price* of a *house* (inverse demand for a house). Total income in this study consists of an average wage per month, overtime pay, bonus, an average money receipt from goods and products per month from all businesses, and an average operational expenditure per month from all businesses. The regression model is

$$Imputed\ House\ Price\ \ = \propto_i + Log(Total\ Income)_{\ i} + Age_i\ + Members_i + u_i$$

Data	**Data Sources**
Sales of Real Estate, and National Housing Authority's Housing Project	Real Estate Information Center (REIC)
Total income, age, members of a family, homeownership, housing expenditure, and house price of survey respondents	Socio-Economic Survey (SES) in 2007

Table 6.6: Determination of House Price and Housing Expenditure for Municipal Area

	Municipal Area	*BMR and Vacilities*
Variable	**housepricemuni**	**housepricebkk**
l_ttlinc	197953.47***	235392.91***
members	-3442.1383	-17488.975
age	11751.579***	16658.14***
_cons	-2037330.2***	-2511575.8***
N	2538	1635
r2	0.11458855	0.13149135

*legend: * p<.1; ** p<.05; *** p<.01*

It is found that higher percentage change in income level has a positive relationship with house price for both municipal area and BMR and vicinities area. Higher income growth may result in higher purchasing power to acquire for luxury or a bigger house. It seems that growing age of head will also accumulate more assets and wealth. The household can afford to buy a house with the higher price range.

This also means that low-income household may find difficulty in acquiring a house with a higher price and/or a large number of mortgage services a month. The poor households who belong to deciles 1-5 cannot access to the housing market even. Without proper housing policy for the poor, they will not be able to find a proper resident. In an urban area, the government may consider launching subsidies such as reducing interest rates for a home loan and assisting construction costs.

Firstly, we experiment with the hypothetical assumption of reducing the interest rates. Average of 6 major banks *floating mortgage rate* in 2016 is in the range of 6.69% to 6.85% per year according to information from the Real Estate Information Center (REIC). The mortgage interest rate of 7% is set with monthly payment such that the net income ratio does not exceed 33%[2] for major banks. The affordable monthly payment in the next 30 years, given the monthly income of ฿15,000 and annual interest rate of 7% can be estimated. As a result, the *affordable price* of a house by the assumed mortgage condition amounts to ฿760,456 a unit. If government

[2] http://www.reic.or.th/RealEstateForPeople/Topic-AdviceHomeLoan02.asp

subsidies are assumed, it would help lower the interest rates from 7% to be 6% and 5% , the affordable price of houses would increase to ฿839,879 - ฿933,865.0054 respectively.

Table 6.7: The projection of affordable price of houses given an income of ฿15,000

Scenario	No government subsidy	Subsidy with rate - 1%	Subsidy with rate - 2%
Monthly income	15,000		
Monthly payment to net income ratio	0.33		
Monthly payment	4,950		
Down payment	0		
Loan term(months)	360		
Annual rate	0.07	0.06	0.05
Monthly rate	0.005654145	0.004867551	0.004074124
Mortgage amount	760,456.7049	839,879.2775	933,865.0054

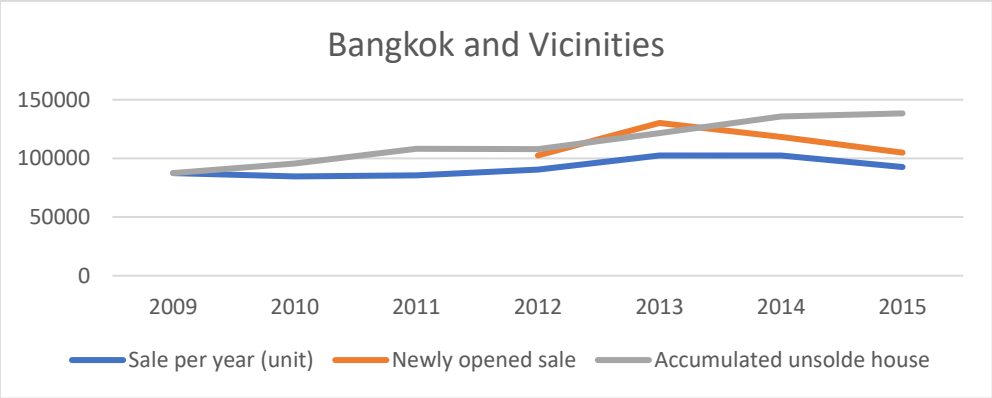
By varying income-level of household and interest rates, the affordable price of houses is higher as the interest rates are lower and individual monthly income increases as shown in Table below.

Table 6.8: The hypothetical affordable price of houses given income of ฿15,000-20,000 baht per month

	Monthly income		
Interest rates	฿ 10,000	฿ 15,000	฿ 20,000
7.00%	฿ 506,971.14	฿ 760,456.70	฿ 1,013,942.27
6.00%	฿ 559,919.52	฿ 839,879.28	฿ 1,119,839.04
5.00%	฿ 622,576.67	฿ 933,865.01	฿ 1,245,153.34

Our analysis has found that government may need to assist the low-income household with a monthly income of 15,000 baht to access to government low-income housing provision at 650,000 baht a unit of 24 square meters (Flat type) by NHA. A mortgage service amount is approximately 4,500 baht a month for 30 years of housing loan with 7 percent interest rate. The low-income household is facing hard burden to make a mortgage service if without government assistance.

Figure 6.14: Sale, Newly Opened Sale and Accumulated Unsold Houses from 2009 to 2015



While low-income urbanites could not access the government housing market, the private provision of a house in the BMR has shown a slacked demand. The unsold units have accumulated during 2009 to 2015. According to the Real Estate Information Center (Thailand), the private supply in the housing market has started to show excess supply as result of economic slowdown. The newly opened sale has reduced sharply from 2013 to 2015 by 9% and 11%, respectively.

As a matter of fact, the house types that poor to lower middle class can access to the mortgage market are such as 'low price condo size 28 square meter' and 'medium price condo size 43 square meter' respectively. The Condo of size 28 square meters was unrealistically low as it was an average of both government and private house price. They may be located in the remote area of the province where the cost of land was still cheaper than the urban area. The size of 28 and 43 square meters Condo have shown *policy intervened trend* as compared with low-medium price townhouse. The former was a supply provisioned by a public organization like NHA while the latter's from the private market provision. They have a normal trend of rising cost of construction.

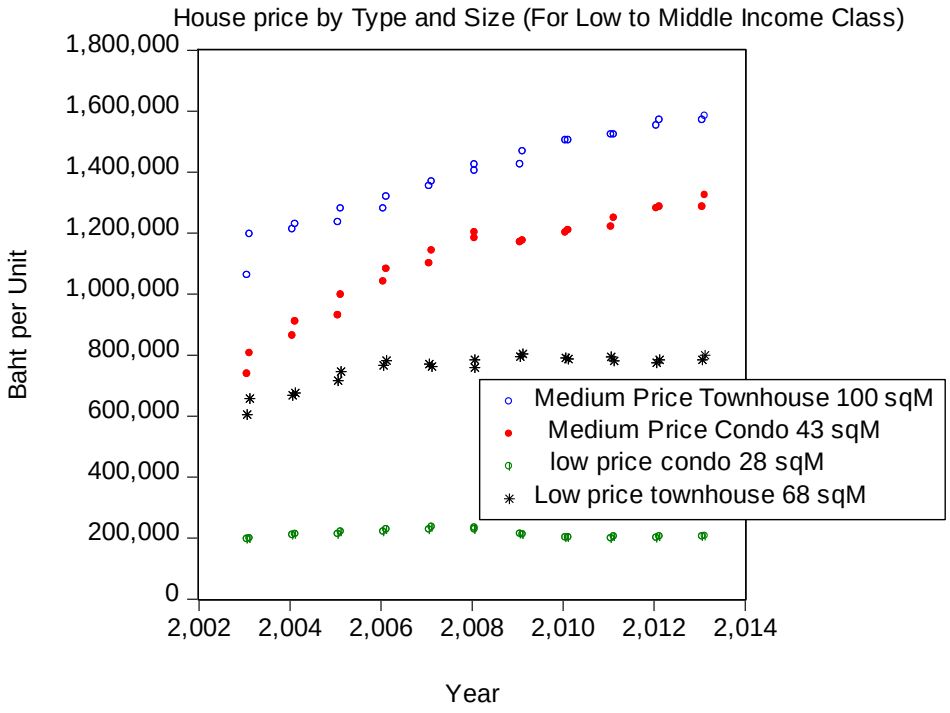
We have shown the price per square meter which determined the cost of construction, management, and sale, interest cost as well profit making etc. The housing policy in Thailand has put balance in the housing market. The low-income housing policy in Thailand may balance the rinsing sale price of houses in Thailand to some extent.

While luxury condo and luxury detached house are beyond the reach of middle-income class, the medium price townhouse and condo are still good alternatives. For low-income household, the choice is still open for low price townhouse of 68 square meters and perhaps medium price condo 43 square meters as well. Our model projection for housing needs and

affordability in the whole country and in particular the urban area has the following policy implications:

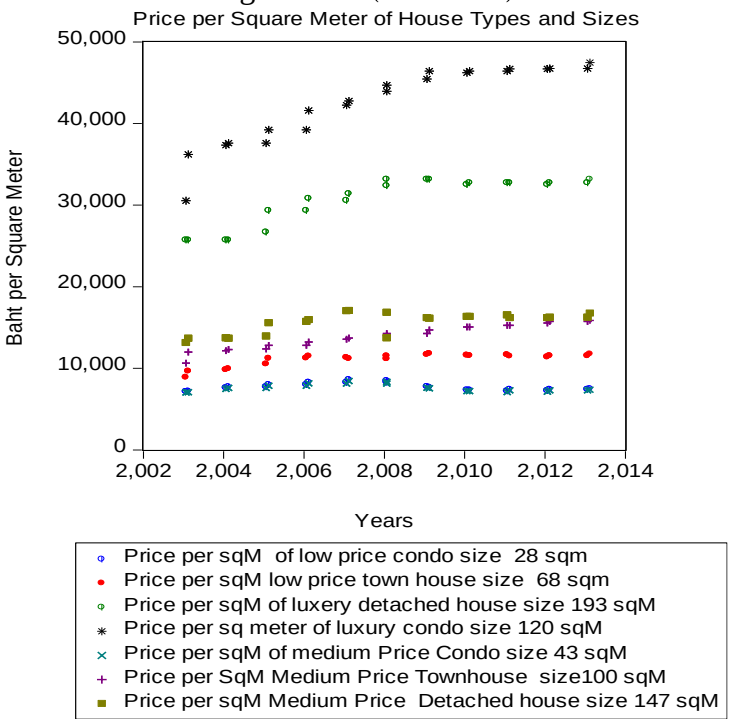
1) Most of households belong to medium-high income class (deciles 5-10th) can enter the private housing market in various types from detached house, Condo, and Townhouse with larger size and pricing. On the contrary, low income households (deciles 1-4th) cannot access to housing market by themselves and need assistance from government.
2) The role of government is therefore scoped down to concentrate in social investment role i.e. the provision of house for low income households.
3) The type of housing can be ranged from low price Condo of 28 square meters, Townhouse for those who can afford to service the mortgage (deciles 4th) to rental house for low income in various forms.(deciles 2-3rd).
4) The lowest income deciles households may need special treatment by the government.

Figure 6.15: House price by type and size



Source: Agency for Real Estate Affairs 2013 (www.area.co.th)

Figure 6.15: (continued)



The study here would like to propose how the government can perform social investment in dwelling for low income households as our main purpose. We have therefore to investigate the government plans on this social investment in the following section.

5. Government Effort in Residential development

The government project to assist the low-income households has been established by The National Housing Authority (NHA), Ministry of Social Development and Human Security under several governments. Currently, a project named '*Baan*[3] *Pracha Rath*' and '*Baan Thanarak Pracharat* housing projects' provides loan for low-income people to own house with a price which does not exceed 1.5 million baht. The loan is provided by Government Housing Bank (GHB) and Government Savings Bank for buying, constructing, or fixing with a specified amount of money respectively.

Recently, the Cabinet has also announced an adjustment in criteria for low-income people without property in their possession. It is granted for housing loan that does not exceed 1.5 million baht. The project is eligible for employees who earn 20,000 baht a month or less.

[3] 'Baan' literally means 'house'

In fact, every government has initiated a similar project for low-income housing. For example, a program which has launched in 2003 aimed to solve housing problem of poorest urban citizens named as the '*Baan Mankong*[4] Collective Housing Program'. It has provided subsidies and soft loan for housing and land. So far, a total number of 858 projects has been approved for 90,813 families.

We would like to note the following 'Stylized Facts':

(1) Ownership of House

In 2013, among the total of 20.17 million households reported by the socio-economic survey (NSO) only 15.01 million households (75.19 percent) has owned house and land. The rest 5.01 million households have no ownership in one way or another. Some households own house but not land, other build house in public land, rent, hire purchase, reside with others free conditions etc.

(2) Income Distribution and Affordability

The NESDB has reported that only 1.931 million households (41 %) with average monthly income of 20,700 baht per month (or percentile 60) and can afford to buy a cheap house. The rest of households 2.751 million households (59 %) with income less than 20,700 baht a month (or lower than percentile 60) desperately need government support. This amounts to 2.726 million households.

The NSO reports further that household with monthly income 13,701 - 20,700 baht *cannot* afford a house in the housing market. They have to rely on a rental house from the market or public provision. Here, 1.579 million households with monthly income lower than 13,700 baht are facing the difficulty of settlement. The Community Organization Development Institute (CODI) has reported further 47% of the low incomes or 791,647 households residing in the slum area.

In fact, the accessibility to a standard qualified house for a low-income household is the most concern of any government. Based on a report by the NESDB, 80 percent of land ownership belongs to highest income group. The lowest income group of 20 percent owns only 0.3 percent of the land asset. This implies that low-income housing is constrained by land price as well.

(3) Government Policy

The current government by the Ministry Human Security and Social Welfare has put effort to mobilize a 10-year strategic housing development plan (2016-2025). They have tried to execute a 3-year low-income housing development plan (2016-2018) and achieved an immediate plan in 2016. The cabinet has decided to allow public-private investment for low-income

[4] Literally 'housing security'

households including low salary government officials as well. The plan would also help finance squatter community along a canal, raising the quality of life of homeless by the non-governmental organization.

Following the guideline of SDG (2016-2030), the government has written up the 'The 10 Years Strategic Housing Development Plan (2016-2025)'. This plan aims to promote housing security that can raise a quality of life of low-income households. The plan has aimed to provide standard dwelling unit with proper environment for the community, equipped with basic infrastructure for 2.72 million low-income households.

The provision of 567,691 units on 27,241 *rai* of land with a planned budget of 569,524.70 million baht has the following features:

1) The housing provision for 'low-income' 1.707 million units by **NHA** and in cooperation with related agencies. They comprise rent and hire-purchase sub-groups: (1) rental house of 91,657 units for low income, with planned budget of 102,662.21 million baht (2) hire-purchase for low income 1.615 million units, consist of (2.1) 421,034 units for low income, with planned budget of 422,465.49 million baht (2.2) civil servant house 55,000 units, with planned budget of 44,497 million baht (2.3) the public-private cooperation (rent and hire purchase) or '*Ban Pracharat*' 1,139,746 units respectively.

2) The housing provision for 1.044 million low-income households in both urban and rural area by **CODI** 1.044 million units for 'rent'. These comprise (1) urban squatter community and low-income earners 692,510 households, with a planned budget of 126,725.84 million baht. (2) Rental house for rural low-income household 352,000 households, with a budget of 20,349 million baht.

3) Target Group by income-area-types of needs

The low-income without the property right which can be divided by area and income level such as

A. The household in Bangkok area and perimeter

(1) Rental household with 15,301 – 22,900 baht per month

(2) Rental household with 22,901 – 32,800 baht per month

B. Household in provincials' area

(1) Rental household with 8,801 – 13,500 baht per month

(2) Rental household with 13,501 – 19,900 baht per month

C. the low income in slum, trespassing community and homeless; the rural low income with a residential problem; and the low-rank government officers who need a house.

4) Implementation Target by Agencies

Dwelling security for 2,725,924 households comprises

4.1) *NHA* 1,707,437 housing for low incomes

(1) Rental group 91,657 households

(2) Hire purchase 1,615,780 households

4.2) the low income in slum trespassing community and homeless implement by CODI 692,510 household

4.3) the rural low income with residential problem Implement by *CODI* 352,000 household

5) Project Format

The 10 years Housing Development Plan (2016-2025) has set project format in response to target groups' need for affordable ability.

5.1) The residential development plan for the common low-income implement by NHA by cooperation with a related organization in private sector and government sector in an amount of 1,707,437 household consist of 4 categories:

(1) Quality of life improvement plan (rental) is developing a rental unit in an amount of 91,657 units in Bangkok and perimeter area 45,359 units and in a rural area 46,298 units.

This project format is a rental apartment for the low income with the 3-5 floors residential area has one bedroom with 28-32 square meters the ground floor of the building is 'Universal' design for the elderly and handicapped.

(2) Strengthening the housing security plan (hire purchase) in an amount of 421,034 units in the Bangkok and perimeter 161,248 units and rural area 259,786 units. This project format in the Bangkok area is condominium with 4-35 floors. In the rural area is a single house double house townhouse and condominium depend on the suitable of the local area the design is using a universal design with the infrastructure

(3) Government officer housing project in an amount of 55,000 units in a format of a house for government officials in an amount of 30,000 units and official residence in an amount of 25,000 units.

5.2) low-income housing (urban and rural) implement by CODI in cooperation with the local government for the low income in the amount of 1,044,510 units consisting of

5.2.1) Housing for the slum dwellers and urban low income in the amount of 692,725.84 household consist of 3 projects

(1) *Baan Man Khong* project in the amount of 680,808 households, managed in form of cooperative by community

(2) Canalside housing project in an amount of 11,004 units, for solve the trespassing of the canal side communities in Bangkok

(3) Homeless' quality of life improving project, 698 households 1,395 people to support the homeless center which managed by a homeless network, to promote their quality of life

5.2.2) Rural low-income housing implement by CODI in co-operating with the local government in the amount of 352,000 households which support the renovate the old house in a rural area or rebuild the old and damage house

5.3) land donated by Department of Social Development and Welfare for the aforementioned projects in the amount of 960 *rai*[5]

6) Investment Budget

The Ministry of Finance will seek fund for the 10 years Residential development plan (2016-2025). See detail below in Table 6.9 which is planned figures.

[5] 1 *rai* = 1,600 square meters or 0.16 hectare.

Table 6.9: 10 Years Housing Development Strategic Plan of National Housing Authority, Thailand 2016-2025

A: Immediate Plan 2016-2018

Plan	Project	Units	Immediate Plan			3 Years
			2016	2017	2018	2016-2018
1.1 Low Income Quality of Life by Rent	1. Rental housing for low income	10,107 26,000	5,261 2,490.40	3,240 1,617.15	1,606 787.85	10,107 4,895.40
	2. Rental Housing in Economic Zone	24,000		4,000 2,392.00	4,000 2,512.00	8,000 4,904.00
	3. Housing Improvement 1	20,292	334.00 613.76		1,247 1,849.01	1,581 2,462.77
	4. Housing Improvement 2	8,255				
	5. Housing Improvement 3	3,003				
	Sub Total	**91,657**	**5,595**	**7,240**	**6,853**	**19,688**
	Investment Source of Fund		**3,104.16**	**4,009.15**	**5,148.86**	**12,262.17**
	•Subsidy from Government		**2,103.90**	**3,299.58**	**2,742.07**	**8,145.55**
	• Loan		**386.5**	**709.57**	**557.78**	**1,653.85**
	• Borrow from Government		**613.76**	**0**	**1,809.83**	**2,423.59**
	•Own Revenue		**0**	**0**	**39.18**	**39.18**
1.2 Low Income Housing by Hire Purchase	1. Housing Development 1	24,901	13,314 8,975.27	11,587 8,936.80		24,901 17,912.07
	Housing Development	9,133	9,133 5,989.42			9,133 5,989.42
	2. Housing Development 2	35,000			35,000 29,960.00	35,000 29,960.00
	3. Housing Development 3	30,000				
	4. Housing Development 4 (period 1-6)	170,000				
	5. New town 5	48,000				

	6. Housing Development along the Train Route BMR First period	12,000 12,000		4,000 3,260.00	4,000 3,424.00	8,000 6,684.00
	7.New Town along the Speed Train Route Economic Corridor Economic Corridor	80,000				
	Sub Units	**421,034**	**22,447**	**15,587**	**39,000**	**77,034**
	Investment Source of Fund		**14,964.69**	**12,196.80**	**33,384.00**	**60,545.49**
	•Subsidy from Government		**2,174.51**	**2,054.49**	**8,871.00**	**13,100.00**
	• Loan		**10,981.65**	**8,767.82**	**21,174.60**	**40,924.07**
	• Borrow from Government		**0**	**0**	**0**	**0**
	•Own Revenue		**1,808.53**	**1,374.49**	**3,338.40**	**6,521.42**
1.3 Housing for civil servants	1. Hire purchase (unit cost :baht)	30,000	3,000 2,328.00 (776,000)	3,000 2,445.00 (815,000)	3,000 2,568.00 (856,000)	9,000 7,341.00
	2. Government house for civil servant (unit cost :baht)	25,000	5,000 2,845.00 (569,000)	10,000 5,980.00 (598,000)	10,000 6,280.00 (628,000)	25,000 15,105.00
	Units	**55,000**	**8,000**	**13,000**	**13,000**	**34,000**
	Investment Source of Fund		**5,173.00**	**8,425.00**	**8,848.00**	**22,446.00**
	•Subsidy from Government		**3,449.80**	**6,628.00**	**6,974.20**	**17,052.00**
	• Loan		**1,490.40**	**1,552.50**	**1,617.00**	**4,659.90**
	• Borrow from Government					**0**
	•Own Revenue		**232.8**	**244.5**	**256.8**	**734.1**
1.4 Public -Private Partnership Housing Development	**1. Government-Private Housing**	1,139,746				
Grand Total	**Units**	**1,707,437**	**36,042**	**35,827**	**58,853**	**130,722**
	Investment Source of Fund		**23,241.85**	**24,630.95**	**47,380.86**	**95,253.66**
	•Subsidy from Government		**7,728.21**	**11,982.07**	**18,587.27**	**38,297.55**
	• Loan		**12,858.55**	**11,029.89**	**23,349.38**	**47,237.82**
	• Borrow from Government		**613.76**	**0**	**1,809.83**	**2,423.59**
	•Own Revenue		**2,041.33**	**1,618.99**	**3,634.38**	**7,294.70**

Table 6.10: 10 Years Housing Development Strategic Plan of National Housing Authority, Thailand 2016-2025
B: Medium-Long-term Plan 2016-2025

Plan	Project	Units	3 Years	Medium Plan (5 years 2016-20)		Long-Term Plan(10 years 2016-2025)					Total Investment (million baht)
			2016-2018	2019	2020	2021	2022	2023	2024	2025	
1.1 Low Income Quality of Life by Rent	1. Rental housing for low income	10,107 26,000	10,107 4,895.40		4,000 2,768.00	4,000 2,908.00	4,000 3,052.00	4,000 3,204.00	5,000 4,205.00	5,000 4,415.00	4,895.40 20,552.00
	2. Rental Housing in Economic Zone	24,000	8,000 4,904.00	7,000 4,925.00	3,000 2,403.00	3,000 2,523.00	3,000 2,649.00				17,404.00
	3. Housing Improvement 1	20,292	1,581 2,462.77		5,943 9,754.57		12,768 25,243.37				37,460.71
	4. Housing Improvement 2	8,255						4,445 9,186.74		3,810 8,563.36	17,750.10
	5. Housing Improvement 3	3,003				490 626.30		2,513 3,973.70			4,600.00
	Sub Total	**91,657**	**19,688**	**7,000**	**12,943**	**7,490**	**19,768**	**10,958**	**5,000**	**8,810**	
	Investment Source of Fund		**12,262.17**	**4,925.00**	**14,925.57**	**6,057.30**	**30,944.37**	**16,364.44**	**4,205.00**	**12,978.36**	**102,662.21**
	•Subsidy from Government		**8,145.55**	**3,696.00**	**3,694.00**	**3,880.40**	**4,073.80**	**2,353.60**	**3,088.00**	**3,242.00**	**32,173.35**
	• Loan		**1,653.85**	**1,229.00**	**4,897.53**	**1,550.60**	**23,109.12**	**4,824.10**	**1,117.00**	**9,736.36**	**48,117.56**
	• Borrow from Government		**2,423.59**	**0**	**5,116.95**	**626.3**	**2,339.69**	**9,186.74**	**0**	**0**	**19,693.27**
	•Own Revenue		**39.18**	**0**	**1,217.09**	**0**	**1,421.76**	**0**	**0**	**0**	**2,678.03**
1.2 Low Income Housing by Hire Purchase	1. Housing Development 1	24,901	24,901 17,912.07								17,912.07
	Housing Development	9,133	9,133 5,989.42								5,989.42
	2. Housing Development 2	35,000	35,000 29,960.00								29,960.00
	3. Housing Development 3	30,000		30,000 26,970.00							26,970.00
	4. Housing Development 4 (period 1-6)	170,000			25,000 23,600.00	25,000 24,775.00	30,000 31,200.00	30,000 32,760.00	30,000 34,410.00	30,000 36,120.00	182,865.00
	5. New town 5	48,000			20,000 18,880.00	28,000 27,748.00					46,628.00

Plan	Project	Units	3 Years	Medium Plan (5 years 2016-20)		Long-Term Plan(10 years 2016-2025)					Total Investment (million baht)
			2016-2018	2019	2020	2021	2022	2023	2024	2025	
	6. Housing Development along the Train Route BMR First period	12,000 12,000	8,000 6,684.00	4,000 3,596.00	3,000 2,832.00	3,000 2,973.00	3,000 3,120.00	3,000 3,276.00			10,280.00 12,201.00
	7.New Town along the Speed Train Route Economic Corridor Economic Corridor	80,000					20,000 20,800.00	20,000 21,840.00	20,000 22,940.00	20,000 24,080.00	89,660.00
	Sub Units	**421,034**	**77,034**	**34,000**	**48,000**	**56,000**	**53,000**	**53,000**	**50,000**	**50,000**	
	Investment Source of Fund		**60,545.49**	**30,566.00**	**45,312.00**	**55,496.00**	**55,120.00**	**57,876.00**	**57,350.00**	**60,200.00**	**422,465.49**
	•Subsidy from Government		**13,100.00**	**8,262.00**	**12,287.00**	**15,285.80**	**16,601.00**	**17,783.00**	**18,148.00**	**19,414.00**	**120,880.80**
	• Loan		**40,924.07**	**19,247.40**	**28,493.80**	**34,660.60**	**33,007.00**	**34,305.40**	**33,467.00**	**34,766.00**	**258,871.27**
	• Borrow from Government		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	•Own Revenue		**6,521.42**	**3,056.60**	**4,531.20**	**5,549.60**	**5,512.00**	**5,787.60**	**5,735.00**	**6,020.00**	**42,713.42**
1.3 Housing for civil servants	1. Hire purchase (unit cost :baht)	30,000	9,000 7,341.00	3,000 2,697.00 (899,000)	3,000 2,832.00 (944,000)	3,000 2,973.00 (991,000)	3,000 3,120.00 (1,040,000)	3,000 3,276.00 (1,092,000)	3,000 3,441.00 (1,147,000)	3,000 3,612.00 (1,204,000)	29,292.00
	2. Government house for the civil servant (unit cost :baht)	25,000	25,000 15,105.00								15,105.00
	Units	**55,000**	**34,000**	**3,000**	**3,000**	**3,000**	**3,000**	**3,000**	**3,000**	**3,000**	
	Investment Source of Fund		**22,446.00**	**2,697.00**	**2,832.00**	**2,973.00**	**3,120.00**	**3,276.00**	**3,441.00**	**3,612.00**	**44,397.00**
	•Subsidy from Government		**17,052.00**	**743.4**	**794.4**	**850.2**	**910.2**	**975**	**1,042.80**	**1,115.40**	**23,483.40**

Plan	Project	Units	3 Years	Medium Plan (5 years 2016-20)		Long-Term Plan(10 years 2016-2025)					Total Investment (million baht)
			2016-2018	2019	2020	2021	2022	2023	2024	2025	
	• Loan		4,659.90	1,683.90	1,754.40	1,825.50	1,897.80	1,973.40	2,054.10	2,135.40	17,984.40
	• Borrow from Government		0								0
	• Own Revenue		734.1	269.7	283.2	297.3	312	327.6	344.1	361.2	2,929.20
1.4 Public -Private Partnership Housing Development	1. Government-Private Housing	1,139,746		Operated by Ministry of Finance with Cooperation by NHA							
Grand Total	Units	1,707,437	130,722	44,000	63,943	66,490	75,768	66,958	58,000	61,810	
	Investment Source of Fund		95,253.66	38,188.00	63,069.57	64,526.30	89,184.37	77,516.44	64,996.00	76,790.36	569,524.70
	• Subsidy from Government		38,297.55	12,701.40	16,775.40	20,016.40	21,585.00	21,111.60	22,278.80	23,771.40	176,537.55
	• Loan		47,237.82	22,160.30	35,145.73	38,036.70	58,013.92	41,102.90	36,638.10	46,637.76	324,973.23
	• Borrow from Government		2,423.59	0	5,116.95	626.3	2,339.69	9,186.74	0	0	19,693.27
	• Own Revenue		7,294.70	3,326.30	6,031.49	5,846.90	7,245.76	6,115.20	6,079.10	6,381.20	48,320.65

Source: Ministry of Social Development and Human Security (2016), National Housing 10 Years Strategic Plan (2016-2025)

6. Synthesis and Implications on Social Investment Needs

The foregoing section is a planned supply provision by the National Housing Authority. Our housing needs model is a micro-based projection from population and households' survey (SES) as sources of parameterization. It has applied a base-line forecast of population as referenced path for housing needs and affordability of the low income household deciles.

The value of social investment needs for low cost housing in Thai in urban area can be estimated by synthesizing with average unit cost of public housing provision government plan as follows:

In order to estimate the cost of social investment from our micro-analysis low income housing needs in urban area during 2020-2037, we estimate the unit value of house price by extrapolating from Table 7.8, it assumes government's unit cost of house on average is 0.99 million baht in 2020. It increases to 1.86 and 2.23 million baht per unit in 2035 and 2037 respectively. Total cost of investment during 2020-2037 is in sum 3.487 trillion baht for all urban households.

Now, if we assume proportion of poor urban households to be 30 percent, we arrive at the cost of investment for low income housing in urban area of 1.046 trillion baht. If the proportion of low income households is 16 percent, the social cost of investment is 558.04 billion baht respectively. The methodology can be repeated with the foregoing example for other ASEAN countries.

Table 6.11: Estimated Cost of Social Investment on Urban Low Cost Housing

Cost of Social Investment (1,000 Million Baht)									
Year	Urban Housing Start (Units)	Unit Cost (Million Baht)	Value of Urban House (thousand Million Baht)	Assumptions on Poor Household Proportion					
				poor 40%	poor 30%	poor 25%	poor 20%	poor 15%	poor 16%
				Value of Urban House (thousand Million Baht)					
2020	415.53	0.99	409.85	163.94	122.96	102.46	81.97	61.48	65.58
2025	264.2	1.24	327.61	131.04	98.28	81.90	65.52	49.14	52.42
2030	503.57	1.55	780.53	312.21	234.16	195.13	156.11	117.08	124.89
2035	547.64	1.86	1,018.61	407.44	305.58	254.65	203.72	152.79	162.98
2037	426.13	2.23	951.12	380.45	285.34	237.78	190.22	142.67	152.18
All	2,157.07	1.57	3,487.73	1,395.09	1,046.32	871.93	697.55	523.16	558.04

Note: 1) unit cost is extrapolated from Table 6.9; 2) Urban housing start is from our model; 3) value of urban house is (3)=(1)x(2); 4) value of urban house by proportion of poor (4)= proportion x (3) respectively.

Chapter 7
Summary and Recommendations

1. The significance of the Study

The ADB in her publication on the "Infrastructure for a Seamless Asia" in 2009[1] has pointed out high investment demand for Asia's economic infrastructure (power, water, and sanitation, transport, and telecommunication) from 2010 to 2020. The costs of hard and technical infrastructure for Asia are estimated to be 8 trillion USD approximately. Following the Sustainable Development Goals (SDGs) and updates on the social and economic environment of the region, the ADB has extended the estimate for the period from 2016 to 2030. An updated figure on the demand for hard and technical infrastructure needs in a report *"Bridging the Gap: Infrastructure Needs in Asia"* in February 2017, has pointed large gap of infrastructure needs. It has provided strong policy recommendations as a basis for financial needs for investment.

JICA has started in consultation with the ADB to conduct a research on *Asia's social infrastructure demand* from 2016 to 2030 to complement ADB's demand estimate for economic infrastructure. Social infrastructure, such as school and hospital, is a key capital investment to maintain social services and secure economic development of the region where the population is expected a rise. The domestic public financial gap of these public investments in each Asian country would be enormous.

The problem of finding out *the financial source* for infrastructure renovation would be crucial to developing country where domestic saving is still lower than needs. Besides, some countries such as Thailand are facing with aging trend following Japan. Thailand will be facing population aging in the next decades. Thailand is ahead of other Asian countries, Thailand has declining birth rates owing to declining total fertility rates and declining death rate owing to health standard improvement in the last decades. The longevity of population was owing to better public health services.

Approaching aging society, Thailand may need a new type of social infrastructure. Not only the housing and health services and facilities for the aged citizens but also Thailand would need a new supply of skilled labor supply via capable human resource investment to compensate for the declining saving capacity of the household. This

[1] ADB cited the methodology by Fay and Yepes "Investing in infrastructure: what is needed from 2000 to 2010?" World Bank Policy Research Working Paper 3102, July 2003.
http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-3102

comprehensive social infrastructure investment would be a crucial policy of Thailand as well.

The purpose of our research is to estimate the investment demand of social infrastructure in Thailand up to 2030. This is to find appropriate research methodology on social infrastructure demand estimation and forecasting to be learned by other Asian countries.

The scope of research thus covers mainly the social infrastructure for education and health system in Thailand. In addition, we would also estimate the demand for low-income housing needs and affordability to serve for the long-term urbanization in Thailand. In our research, we have intention to add estimation on the demand for government facilities alongside with the urbanization and decentralization in Thailand as well. This is to serve for the decentralization of service provision from the central and regional government to local government in the coming decades.

We have followed the guideline of JICA and ADB for the "micro" and "macro" approaches and make it suitable for Thailand's economic and social context. For macro approach, we have learned from ADB[2], applying multiple regression models by Fay and Yepes[3] (2003). We have linked the equations with human development's hypothetical target noted by the UNDP (2016) for our macro approach in Chapter 3.

We have described the economic development and growth of Thailand as a basis for estimation and report. Thereafter, we have estimated the demand for social infrastructure if the Human Development Index's target of 'years of schooling and expected years of schooling', 'life-expectancy' as well as Gross National Income per capita is set to obtain the target level of HDI. With model simulation, we have applied the projected social investment need to evaluate Thailand's macroeconomic impact.

Chapter 3 describes Social Infrastructure Needs and Its Determinants at the macro level. A regression analysis together with a counterfactual macro-economic model simulation and forecasting will be used to project the gross investment needed for total social infrastructure for human capital development and welfare improvement for low-income housing. This is a methodology developed by this study.

For social infrastructure demand for physical space to conduct education, health services, and government services we have applied 'micro' approach. The social infrastructure needs in the education system and their facilities have been benchmarked

[2] ADB (2009), Seamless Asia

[3] Fay and Yepes "Investing in infrastructure: what is needed from 2000 to 2010?" World Bank Policy Research Working Paper 3102, July 2003 http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-3102

with international standard i.e., PISA report. We later come up with a projection for social infrastructure need as well its 'cost saving'. This is owing to shifting of the importance from physical alone towards human capital investment. We have added the similar demand and its cost saving in the case of public services by applying data from the Office of Civil Servant Commission (OCSC).

We have applied data from the health service system in Thailand, known as the 'Universal Coverage Scheme' (UCS). It is the demand side approach to the health services. It may be one of the successful implementations in the world. The projection of social infrastructure need is projected from the supply provision

Finally, we have constructed our own micro model with a spreadsheet-based on 'Low Income Housing Needs and Affordability' model for Thailand. We are interested in the low-income households' demand for housing. Their demand projection is to qualify the level of needs for future urbanization and communities' welfare improvement.

In this chapter, we would make an overall conclusion of projection result as a sample of our methodology. This may be a basis for a further application for other Asian countries.

2. Findings of the Study on the Social Investment Cost of Infrastructure

2.1 Macro Approach

The macro approach shown in Table 7.1 below has concentrated in the construction of residential investment. The amount of social infrastructure of this category will cost 333.8 billion baht in 2020 and tend to increase substantially to 386.9 billion baht in 2025 and 444.7 billion baht in 2030 respectively. Schools and hospital are lower in their investment cost as far as construction is concerned. However, we have found that the non-construction social investments are still needed to be fulfilled in the schooling and hospital system services. The modern classrooms, laboratory, and modern medical types of equipment are needed in our simulation for schools and hospital. This will be allocated from the public source of non-construction investment in capital formation. The magnitude of non-construction for schooling system would be 10.25 billion baht in 2525 and 20.98 billion baht in 2030 respectively. This is what we have termed it as social infrastructure investment in knowledge for human capital built up towards 21st Century Skills.

Table 7.1: Macro Approach to Social Infrastructure Investment Need 2020-2-30, measured in current price (Billion baht)

Description	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gross fixed capital formation: Construction (scenario1)	**1,318.15**	**1,358.48**	**1,399.70**	**1,441.63**	**1,484.30**	**1,527.79**	**1,572.05**	**1,617.04**	**1,662.74**	**1,709.10**	**1,756.07**
Social Infrastructure RESIDENTIAL	333.8	344.0	354.4	365.1	375.9	386.9	398.1	409.5	421.0	432.8	444.7
Social Infrastructure SCHOOL	36.3	37.4	38.5	39.7	40.9	42.1	43.3	44.5	45.8	47.1	48.4
Social Infrastructure HOSPITAL	20.1	20.7	21.3	21.9	22.6	23.3	23.9	24.6	25.3	26.0	26.7
OTHER building	32.0	32.9	33.9	35.0	36.0	37.1	38.1	39.2	40.3	41.5	42.6
Other Non-Building	896.0	923.5	951.5	980.0	1,009.0	1,038.5	1,068.6	1,099.2	1,130.3	1,161.8	1,193.7
Change in Gross fixed capital formation: Construction Changed from baseline	18.84	39.00	61.70	86.18	110.77	135.81	162.11	189.69	218.24	247.62	277.84
Social Infrastructure RESIDENTIAL	4.77	9.88	15.62	21.82	28.05	34.39	41.05	48.03	55.26	62.70	70.36
Social Infrastructure SCHOOL	0.52	1.07	1.70	2.37	3.05	3.74	4.46	5.22	6.01	6.82	7.65
Social Infrastructure HOSPITAL	0.29	0.59	0.94	1.31	1.69	2.07	2.47	2.89	3.32	3.77	4.23
OTHER building	0.46	0.95	1.50	2.09	2.69	3.29	3.93	4.60	5.29	6.01	6.74
Other Non-Building	12.81	26.51	41.94	58.58	75.30	92.32	110.20	128.95	148.35	168.33	188.87
Social Infrastructure Investment Need, (scenario 1)	**1,244.07**	**1,282.14**	**1,321.05**	**1,360.62**	**1,400.89**	**1,441.94**	**1,483.71**	**1,526.18**	**1,569.30**	**1,613.05**	**1,657.39**
Non-construction											

Public	**248.81**	**256.43**	**264.21**	**272.12**	**280.18**	**288.39**	**296.74**	**305.24**	**313.86**	**322.61**	**331.48**
Education	99.53	102.57	105.68	108.85	112.07	115.35	118.70	122.09	125.54	129.04	132.59
Health	119.43	123.09	126.82	130.62	134.49	138.43	142.44	146.51	150.65	154.85	159.11
Residential	4.98	5.13	5.28	5.44	5.60	5.77	5.93	6.10	6.28	6.45	6.63
Social Infrastructure Investment Need, Additional	**17.78**	**36.81**	**58.23**	**81.34**	**104.54**	**128.17**	**153.00**	**179.03**	**205.97**	**233.71**	**262.23**
Non-construction,											
Public	**3.56**	**7.36**	**11.65**	**16.27**	**20.91**	**25.63**	**30.60**	**35.81**	**41.19**	**46.74**	**52.45**
Education	1.42	2.94	4.66	6.51	8.36	10.25	12.24	14.32	16.48	18.70	20.98
Health	1.71	3.53	5.59	7.81	10.04	12.30	14.69	17.19	19.77	22.44	25.17
Residential	0.07	0.15	0.23	0.33	0.42	0.51	0.61	0.72	0.82	0.93	1.05

Source: Model simulation in this study; see system model and applying national accounts of Thailand

2.2 Micro Approach

2.2.1 Human capital investment in a schooling system

We have followed the guideline in micro approach as well as schooling space needed in basic education and vocational education in Thailand. We have found that the space requirement is projected to be 197.56 million square meters in 2020. The declining population and school intake in Thailand are foreseeable to have less demand for space. It would decline to 81.05 million square meters in 2040 respectively. This is very clear for a general stream of education except for the vocational education. The spacious laboratory, workshops, as well real-world situation of training on modern industrial machinery, mechanical cum electronic, applied electronics, powers, motors vehicles and etc. are very important to raise the labor productivity for the industry. More importantly, the pneumatics and robotics etc would be new to Thailand to make a serious investment. The rail system engineer and technicians are badly needed in Thailand for her drive to be center of communications and transportation of the CLMV and Thailand.

Table 7.2: Hypothetical Physical Space Required by Basic and Vocational Education (Square Meters)

Year	Primary Education (sq. Meters)	Lower Secondary (sq. Meters)	Upper Secondary Vocational Stream (sq. Meters)	Upper Secondary General Stream (sq. Meters)	Total space requirement for Basic and Vocational Education (sq. Meters)
2020	46,252,969	30,818,899	6,726,308	17,335,569	197,565,688
2025	44,266,449	29,064,720	7,421,938	15,678,836	188,613,278
2030	41,625,217	27,753,771	7,705,040	15,097,307	179,080,810
2035	38,439,874	26,005,036	8,098,959	14,355,606	167,956,767
2040	35,044,823	23,962,662	8,700,233	13,349,574	81,057,292

In such situation, we can conclude that the cost of construction investment in building and facilities as physical periphery would have to be reduced. Instead, the construction investment for new building and facilities should gear towards the modern building which serves for the grooming of skills for the 21st Century for every class from pre-primary up to the higher education.

The model simulation result in Table 7.3 has indicated that Thailand can re-allocate the cost saving in construction investment in building and facilities if properly managed. Cost of investment can be used for maintenance of some building but most of the aged buildings more than 40 years may have to be dismantled. New building with modern technology as well computer system would be needed for both BMR and provincial areas. This is after some reconciliation of consolidation of unusable building and classrooms. The schools within the same district in a reachable distance may need to be replaced by new and modern building and facilities after consolidations of assets and management system.

The consolidating source of funds is in consultation with the Treasury Department, Ministry of Finance. Land asset after consolidation would be returned to the kingdom for other purposes. In exchange for that consolidation willingness, the ministry of finance would issue the long-term bond for an investment fund. The fund is collateralized by the benefit of return assets to the Ministry. Below is the cost saving estimate if the consolidation of the asset is assumed (negative investment) while vocational education would still need the investment of 16,501 million baht in modernizing school systems.

Table 7.3: Hypothetical Cost and Saving of Investment in Physical Investment (Million Baht)

Year	Primary Education (Million Baht)	Lower Secondary (Million Baht)	Upper Secondary Vocational Stream (Million Baht)	Upper Secondary General Stream (Million Baht)
2016-2040	-99,726	-65,724	16,501	-34,989

2.2.2 Space needed for Public Services

In this analysis, we have tested the hypothesis of the human capital model. That is to say, the return on human capital investment in education and training of Thai civil servants personnel are normal and well defined. This is to use the model to project the declining civil servants workforce under the trend of aging population. The model of human capital was refutable and solid for further projection. We finally arrive at the

conclusion that civil service personnel who are providing public services from various ministries are subjected to aging fragility as well if no recruitment of young ones. The demand for qualified manpower from the private labor market is also a severe constraint to new recruitment with current salary and fringe benefit. We foresee a further brain drain of civil servants in central and regional governments. The local government cannot, however, create significant job opportunities for the young personnel either. We, therefore, foresee the declining need for space for working and conducting services for the people at large. Table 7.4 depicts the scenario of declining needs for space in the face of declining employment in the public administration in general. We further project the office space requirement for service tasking. It is found that the magnitude of space needed is 22.078 in 2020; 23.203 and 24.388 million square meters by end of 2025 and 2030. This implies that we would have a cost saving of 58.00 billion baht owing to declining civil servants and public personnel in 2020. We, however, would need to invest in office space of 9.135 billion and 1.401 billion baht that would be needed in excess of previous periods as shown below.

Table 7.4: The Scenario of Public Employment Reduction and Cost Saving of Public Need of Social Infrastructure

Scenario	**At end of 2020**	**At end of 2025**	**At end of 2030**
employment in Public Admin 1,000 persons	1,577 reduced from a baseline of 2,087	1,657	1,742
(Year % change.)	-3.1	1.0	1.0
Office space requirement, (1,000) sq. Meter.	22,078	23,204 or + 1,126 from 2020	24,388 or + 1,184 from 2025
Construction investment needed in million baht	-58,001.69 (negative sign is *cost saving)owing to reduction in*	valuation at 8,113 baht per sq. meter = + 9,135 million baht of investment	valuation at 8,113 baht per sq. meter = +1,401 million baht of investment cost

Note: construction *cost saving* = base line office space need (1) minus the scenarios (2)

2.2.3 Social Infrastructure Needed For Health Services

In this study, we propose the projection model of healthcare services in Thailand. We base our data on the 'Universal Coverage Scheme' (UCS). It is a well known medical service program most of developing countries are dreaming for it. Thailand is one of few countries that could possibly overcome resistance from the ministry of health who are the main health provider in Thailand. Rather, during some years till now, the UCS has acted as a representative of demanders or patients whiles the ministry of health would be acting as the main suppliers to the system. The capitation of cost upon patients' headcount has turned health system in Thailand to be demand-oriented system. The budgetary system has been shifted from supply side where ministerial request yearly budget upon the size of hospital or beds numbers to be patients numbers realized by actual services. Table 7.5 and 7.6 depict the size of social infrastructure need in this scheme in the coming decades. The clear methodology and database have transparent such that health budget is 233.096 billion baht in 2020 and 366.559 billion baht in 2030 respectively. Here, the capital investment is projected to be 36.52 and 54.07 billion baht in two mentioned periods. In fact, the UCS budget of 147.233 billion baht is, in fact, the demand side investment in human health. They compose of payment in lump sum amount for patients. The amount of payment is finally paid to cost medicines, treatments in the hospital and etc. The supply side salary and compensation are prepared for medical staffs in the public hospital many positions. The figure of capital investment seems at first glance to be the lowest amount, in fact, with proper management and consolidation types of equipment usage etc, the total cost of health investment can be covered by the capitation from the demand side. Currently, there is missed management between demand and supply provision in health care system in Thailand. The UCS is accused to be an obstruction of the capital insufficiency of a hospital. Medical personnel of public hospital complain of hard burden and not sufficient payment like before. However, to increase capitation budget per patients is also an alarming bell to the budget bureau and government despite blessing from international community's especially the WHO. It is beyond this report and needs further study.

Table 7.5: Projected Total Budgets for Healthcare (unit: million baht)

	Universal Healthcare	Salary and Compensation	Capital Investment	Total
2020	147,233.61	49,333.43	36,529.52	233,096.56
2025	185,017.60	63,731.83	44,443.74	293,193.18
2030	230,154.16	82,332.53	54,072.61	366,559.30

Source: Authors 'calculation

Table 7.6: Projected Total Budget for Healthcare (unit: million US Dollar)

	Universal Healthcare	Salary and Compensation	Capital Investment	Total
2020	4,680.03	1,568.13	1,161.14	7,409.30
2025	5,881.04	2,025.81	1,412.71	9,319.55
2030	7,315.77	2,617.05	1,718.77	11,651.60

Note: 1) The projected budget covers new capital investment and maintenance as well. 2) This is a minimum demand for health services under UCS. It can be inflated further with international wage of medical doctor and personnel to represent its shadow rate of return to human capital investment in par with international price. Services of the medical doctor and nurse are 'tradable services' in part with developed countries. It can be adjusted by a 'PPP' weight to arrive at the 'true cost' of medical personnel's wage in foreign currency and bath respectively. This is left for further analysis.

Source: Authors 'calculation

2.2.4 Urban Low Income Housing

The excess demand for a house in the urban area (95 percent of total excess demand) during 2020-2037 amounts to 2,157.07 thousand units. With the assumption of poor households shares 30 percent of the demand (based on our model forecast), the low-income housing need would be 647.121thousand units over the mentioned period. In other words, excess demand for low-income housing is 38,065.94 units per year on average. It is an extension of the NHA's long-term plan for low-income housing during 2019 which is 44,000 units. Assuming low-income townhouse price of 600,000 baht a unit we would require an investment cost of 22,839.56 million baht per year.

Table 7.7: Total Households, Housing Inventory and Housing Start 2009-2037

	2020	2025	2030	2035	2037
Total household (1,000 units)	**22,535**	**23,599**	**23,603**	**23,882**	**23,991**
1. Intact household share	100.03%	103.90%	90.28%	74.96%	70.10%
2. one person household share	23.60%	25.56%	34.09%	42.25%	45.04%
3. single head household share	39.06%	40.90%	46.02%	55.19%	58.04%
4. others household share	0.06%	0.06%	0.06%	0.06%	0.06%
Urban household (1,000 units)	**8,648**	**9,839**	**10,671**	**11,649**	**12,045**
Rural household (1,000 units)	**13,887**	**13,761**	**12,932**	**12,233**	**11,945**
Housing start (HS) :Total = 1+2+3+4 (1,000 units)	**463.94**	**(253.79)**	**1,149.23**	**569.51**	**323.91**
Housing start (HS) :*urban* = 1+2+3+4 (urban) (1,000 units)	**415.53**	**264.20**	**503.57**	**547.64**	**426.13**

Note: (...) indicates negative numbers. Housing inventory is stock adjustment annually,
While housing start is regarded as the changing of inventory each period after taking into account
The housing withdrawal owing to dismantle or causing fire etc. and has to be cleared from the inventory.

Table7.8: Estimated Social Investment Cost of Low Income Housing

Cost of Social Investment (1,000 Million Baht)

Year	Urban Housing Start (Units)	Unit Cost (Million Baht)	Value of Urban House (thousand Million Baht)	Assumptions on Poor Household Proportion					
				poor 40%	poor 30%	poor 25%	poor 20%	poor 15%	poor 16%
2020	415.53	0.99	409.85	163.94	122.96	102.46	81.97	61.48	65.58
2025	264.2	1.24	327.61	131.04	98.28	81.90	65.52	49.14	52.42
2030	503.57	1.55	780.53	312.21	234.16	195.13	156.11	117.08	124.89
2035	547.64	1.86	1,018.61	407.44	305.58	254.65	203.72	152.79	162.98
2037	426.13	2.23	951.12	380.45	285.34	237.78	190.22	142.67	152.18
All	2,157.07	1.57	3,487.73	1,395.09	1,046.32	871.93	697.55	523.16	558.04

Note: 1) unit cost is extrapolated from Table 6.9; 2) Urban housing start is from our model; 3) value of urban house is (3)=(1)x(2); 4) value of urban house by proportion of poor (4)= proportion x (3) respectively.

In order to estimate the cost of social investment from our micro-analysis low

income housing needs in urban area during 2020-2037, we estimate the unit value of house price by extrapolating from Table 7.8, it assumes government's unit cost of house on average is 0.99 million baht in 2020. It increases to 1.86 and 2.23 million baht per unit in 2035 and 2037 respectively. Total cost of investment during 2020-2037 is in sum 3.487.7e billion baht for all urban households. Now, if we assume proportion of poor urban households to be 30 percent, we arrive at the cost of investment for low income housing in urban area of 1,046.32 billion baht. If the proportion of low income households is 16 percent, the social cost of investment is 558.04 billion baht.

3. Consolidation of Social Investment Cost

The final consolidation of social infrastructure investment's cost is shown below to be at the 5-6 percent of GDP in the case of construction. We have estimated the non-construction elements like modern technology facilities for schooling system at all level, the high technology of health equipment and machinery, the modern housing facilities for aged citizen and modern office machinery and human facilitation etc. Besides, as we have noted in the study, the human capital built-up in Thailand would desperately need the non-physical capital but rather to raise the skills of our human resource towards the 21st Century Skills. Thus, the total investment would amount to 1-2 percent in addition to the physical building and facilities. This amounts to a social cost of the infrastructure of 6-7 percent of GDP on average 2020-2030.

Table 7.9: Consolidation of Social Infrastructure Investment, Thailand 2020-2030

(measured in current prices, billion baht)						
Descriptions	2020	2021	2022	2023	2024	2025
(1)Gross domestic product	18,933.31	19,953.09	21,037.56	22,169.57	23,346.01	24,600.05
(2) Social Investment (construction)	**1,318.15**	**1,358.48**	**1,399.70**	**1,441.63**	**1,484.30**	**1,527.79**
as % of GDP	6.96	6.81	6.65	6.50	6.36	6.21
(3) Social investment (non construction)	**248.81**	**256.43**	**264.21**	**272.12**	**280.18**	**288.39**
as % of GDP	1.31	1.29	1.26	1.23	1.20	1.17
(4) Total social investment	1,566.96	1,614.91	1,663.91	1,713.75	1,764.48	1,816.18
as % of GDP	8.28	8.09	7.91	7.73	7.56	7.38
	2026	2027	2028	2029	2030	

(1)Gross domestic product	25,897.94	27,256.47	28,676.89	30,139.08	31,643.02	
(2) Social Investment (construction)	**1,572.05**	**1,617.04**	**1,662.74**	**1,709.10**	**1,756.07**	
as % of GDP	6.07	5.93	5.80	5.67	5.55	
(3) Social investment (non construction)	**296.74**	**305.24**	**313.86**	**322.61**	**331.48**	
as % of GDP	1.15	1.12	1.09	1.07	1.05	
(4) Total social investment	1,868.79	1,922.28	1,976.60	2,031.71	2,087.55	
as % of GDP	7.22	7.05	6.89	6.74	6.60	

4. Macroeconomic Impacts of Investment in Social Infrastructure

We have applied the CGE model showing the macroeconomic impact of the hypothetical investment in social infrastructure on Thai Macro Economy 2020-2030. In model simulation, the growth of HDI's component is estimated to raise the Total Factor Productivity or a shift parameter in the production function in the model.

In addition, the labor productivity is assumed to grow as HDI component like mean years of schooling, expected years of schooling, life expectancy is assumed to grow and will drive the productivity shift in the production. The HDI target will give rise to the solution to replace the unskilled labor from neighboring countries in the long-run. *The physical capital investment in couple with human capital investment will hypothetically raise the labor productivity towards sustained growth in the long-run 2020-2030. The investment in social infrastructure has positive impacts on the Thai macroeconomic growth.*

Table 7.10: Impact of Hypothetical Investment in Social Infrastructure on Thai Macro Economy 2020-2030

Macro Variables (measured in billion baht)					
Descriptions	2020	2021	2022	2023	2024
Change in Real Gross Domestic Product	8.6	17.8	28.7	41.0	54.9
Change in Real Export	3.2	6.8	11.2	16.3	22.2
Change in Real Government Expenditure	1.7	3.3	5.1	7.0	9.0
Change in Gross Fixed Capital Formation	2.4	5.0	8.1	11.8	16.1
Change in Real Import	2.8	6.0	9.8	14.3	19.5
Change in Private Consumption Expenditure	3.8	8.0	12.9	18.6	25.1
	2025	2026	2027	2028	2029

Change in Real Gross Domestic Product	70.4	87.9	107.7	129.9	155.0
Change in Real Export	28.9	36.7	45.8	56.2	68.2
Change in Real Government Expenditure	11.1	13.3	15.6	18.0	20.7
Change in Gross Fixed Capital Formation	20.9	26.5	32.9	40.2	48.6
Change in Real Import	25.5	32.5	40.5	49.8	60.6
Change in Private Consumption Expenditure	32.3	40.5	49.8	60.4	72.3
	2030				
Change in Real Gross Domestic Product	183.1				
Change in Real Export	82.0				
Change in Real Government Expenditure	23.5				
Change in Gross Fixed Capital Formation	58.1				
Change in Real Import	72.9				
Change in Private Consumption Expenditure	85.7				

Note: Direct summation of right -hand real expenditure change is not matched to change in real GDP owing to the study did not add the change in investment in the table. Besides, the change has to be weighted by GDP share.

5. Methodological Notes for Further Analysis by Other Asian Countries

We have our final notes for further applications of these proposed methodologies by other Asians fellows as follows:

(1) The study should start with clearing all data at the macroeconomic level. Especially, researchers have to request the time series data on capital stock and gross fixed capital formation (GFCF) or investment by construction types. What we need is the GFCF on social investment especially the school, hospital, resident construction value in current prices. If this is not available, the researcher may try to use published data from developing countries that have a higher epoch of development and re-estimate as a proxy.

(2) It is recommended that estimation would be started from the Investment demand function as done in our study and by ADB. The simultaneous equation system can be tried to link the investment with HDI. The scenarios can be tried to estimate the social infrastructure. See Chapter 3 in this study.

(3) The micro approach can be benchmarked with an international study such as PISA for the education. The health system study researcher has to study the

current supply-side oriented first. The researcher can try to estimate the demand-side approach following the experience of the Universal Health Coverage in Thailand as a case study.

(4) Data on population forecast can be obtained from the international organization like the WPF, IMF, and WB etc. Most of developing Asians have their own projections. The data on household types would be needed as well. Data on income growth can be estimated from national level using the National accounts data and translating it to the household level at a monthly frequency. The data at micro level on housing stock, inventory, schools building by types and age is not easy to find in developing countries. However, the ratio method can be a guess using projection number of students by level.

(5) This study does not require high-level econometric knowledge. On some skills to manage the readymade econometric software is sufficient to do the task. In the low-income housing need and affordability, it runs on MS Excel or any spreadsheet just to understand the notation and get ready for data inputs. In fact, all micro approach can be managed on spreadsheets without difficulty. Only some impact analysis using the counterfactual as 'what if we need HDI to reach this target level, then what will be the macroeconomic impact?' this can be done easily with any macroeconomic model where the current state of the art is easily done and explained by and 'tube' lesson in the standard media or even hand telephone.

(6) Only some researchers who are really serious to get through with full strength, they can consult with us to decide whether to go on with such modeling to get a result from the large-scale macro-econometric model and/or the Dynamic General Equilibrium Model (CGE). It has been used in part of this study. But not knowing techniques and complications will not depress the willingness to do simple estimate and projection of the social infrastructure by any Asian's countries.

Executive Summary

1. The Significance of the Study

The ADB in her publication on the "Infrastructure for a Seamless Asia" in 2009[1] has point out high investment demand for Asia's economic infrastructure (power, water and sanitation, transport and telecommunication) from 2010 to 2020. The costs of hard and technical infrastructure for Asia are estimated to be 8 trillion USD approximately. Following the Sustainable Development Goals (SDGs) and updates on social and economic environment of the region, the ADB has extended the estimate for the period from 2016 to 2030. An updated figure on the demand for hard and technical infrastructure needs in a report *"Bridging the Gap: Infrastructure Needs in Asia"* in February 2017, has pointed large gap of infrastructure needs. It has provided strong policy recommendations as basis for financial needs for investment.

The purpose of our research is to estimate the investment demand of social infrastructure in Thailand up to 2030. This is to find appropriate research methodology on social infrastructure demand estimation and forecasting to be learned by other Asian countries.

The scope of research thus covers mainly the social infrastructure for education, and health system in Thailand. In addition, we would also estimate the demand for low income housing needs and affordability to serve for the long-term urbanization in Thailand. In our research, we have intension to add estimation on the demand for government facilities along side with the urbanization and decentralization in Thailand as well.

We have followed the guideline of JICA and ADB for the "micro" and "macro" approaches and adapting for Thailand's economic and social context. For macro approach, we have learned from ADB, applying multiple regression models by Fay and Yepes[2] (2003). We have link the equation with human development's hypothetical target noted by the UNDP (2016) for our macro approach

[1] ADB (2009), Seamless Asia, cited the methodology by Fay and Yepes "Investing in infrastructure: what is needed from 2000 to 2010?" World Bank Policy Research Working Paper 3102, July 2003 http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-3102

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2. The Findings and Consolidation of Social Infrastructure Demand

2.1 Micro Approach on Social Investment Needs

2.1.1 Social Investment Needs in a schooling system

We have followed the guideline in micro approach as well as schooling space needed in basic education and vocational education in Thailand. We have found that the space requirement is projected to be 197.56 million square meters in 2020. The declining population and school intake in Thailand are foreseeable to have less demand for space. It would decline to 81.05 million square meters in 2040 respectively. This is very clear for a general stream of education except for the vocational education. The spacious laboratory, workshops, as well real-world situation of training on modern industrial machinery, mechanical cum electronic, applied electronics, powers, motors vehicles and etc. are very important to raise the labor productivity for the industry. More importantly, the pneumatics and robotics etc would be new to Thailand to make a serious investment. The rail system engineer and technicians are badly needed in Thailand for her drive to be center of communications and transportation of the CLMV and Thailand.

Table 1: Hypothetical Cost and Saving of Investment in Physical Investment (Million Baht)

Year	Primary Education (Million Baht)	Lower Secondary (Million Baht)	Upper Secondary Vocational Stream (Million Baht)	Upper Secondary General Stream (Million Baht)
2016-2040	-99,726	-65,724	16,501	-34,989

In such situation, we can conclude that the cost of construction investment in physical periphery i.e., buildings and facilities can be *reduced*. Instead, the construction investment for new building and facilities should be replaced by the modern building which serves for the grooming of skills for the 21st Century. The targets of educational achievement are not just credential but also to prepare proper human resource. The institutional arrangement, inequality of schools facilities and equipments, teacher's skills and abilities to deliver quality classrooms are needed. It can be financed from this cost

saving.

The consolidating source of funds is in consultation with the Treasury Department, Ministry of Finance. The Ministry of Finance would issue the long-term bond for an investment fund to cover the cost. Table 1 is the *cost saving* estimate, if the consolidation of the public asset is assumed i.e., a negative investment while vocational education would still need the new investment of 16,501 million baht in modernizing school systems.

2.1.2 Social Investment Needs in Public Services

We have tested the hypothesis of the human capital mode of the declining civil servants workforce under the trend of aging population. We foresee the declining need of space for working and conducting services for the people at large. Table 2, depicts the scenario of declining needs for space in the face of declining employment in the public administration in general. We further project the office space requirement for service tasking. It is found that the magnitude of space needed is 22.078 in 2020; 23.203 and 24.388 million square meters by end of 2025 and 2030.

This implies that we would have a cost saving of 58.00 billion baht owing to declining civil servants and public personnel in 2020. We, however, would need to invest in office space of 9.135 billion and 1.401 billion baht that would be needed in excess of previous periods as shown below.

For example, the excess of physical need can be assimilated into other type of social infrastructure such as modern office IT and improving the consolidated system of 'Big Data' on human resources and assets of the government bureaus and the comptroller auditing system in disbursement.

Table 2: The Scenario of Public Employment Reduction and Cost Saving of Public Need of Social Infrastructure

Scenario	**At end of 2020**	**At end of 2025**	**At end of 2030**
employment in Public Admin 1,000 persons	1,577 reduced from a baseline of 2,087	1,657	1,742
(Year % change.)	-3.1	1.0	1.0

Office space requirement, (1,000) sq. Meter.	22,078	23,204 or + 1,126 from 2020	24,388 or + 1,184 from 2025
Construction investment needed in million baht	-58,001.69 (negative sign is *cost saving)owing to reduction in*	valuation at 8,113 baht per sq. meter = + 9,135 million baht of investment cost	valuation at 8,113 baht per sq. meter = +1,401 million baht of investment cost

Note: construction *cost saving* = base line office space need (1) minus the scenarios (2)

2.1.3 Social Investment Needs in Urban Low Income Housing

The excess demand for a house in the urban area (95 percent of total excess demand) during 2020-2037 amounts to 2,157.07 thousand units. With the assumption of poor households shares 30 percent of the demand (based on our model forecast), the low-income housing need would be 647.121thousand units over the mentioned period. In other words, excess demand for low-income housing is 38,065.94 units per year on average. It is an extension of the NHA's long-term plan for low-income housing during 2019 which is 44,000 units. Assuming low-income townhouse price of 600,000 baht a unit we would require an investment cost of 22,839.56 million baht per year.

Table 3: Total Households, Housing Inventory and Housing Start 2009-2037

	2020	**2025**	**2030**	**2035**	**2037**
Total household (1,000 units)	**22,535**	**23,599**	**23,603**	**23,882**	**23,991**
1. Intact household share	100.03%	103.90%	90.28%	74.96%	70.10%
2. one person household share	23.60%	25.56%	34.09%	42.25%	45.04%
3. single head household share	39.06%	40.90%	46.02%	55.19%	58.04%
4. others household share	0.06%	0.06%	0.06%	0.06%	0.06%
Urban household (1,000 units)	**8,648**	**9,839**	**10,671**	**11,649**	**12,045**
Rural household (1,000 units)	**13,887**	**13,761**	**12,932**	**12,233**	**11,945**
Housing start (HS) :Total = 1+2+3+4 (1,000 units)	**463.94**	**(253.79)**	**1,149.23**	**569.51**	**323.91**
Housing start (HS) :<u>*urban*</u> = 1+2+3+4 (urban) (1,000 units)	**415.53**	**264.20**	**503.57**	**547.64**	**426.13**

Note: (...) indicates negative numbers. Housing inventory is stock adjustment annually,
While housing start is regarded as the changing of inventory each period after taking into account
The housing withdrawal owing to dismantle or causing fire etc. and has to be cleared from the inventory.

In order to estimate the cost of social investment from our micro-analysis low income housing needs in urban area during 2020-2037, we estimate the unit value of house price by extrapolating from Table 7.8, it assumes government's unit cost of house on average is 0.99 million baht in 2020. It increases to 1.86 and 2.23 million baht per unit in 2035 and 2037 respectively. Total cost of investment during 2020-2037 is in sum 3.487.7e billion baht for all urban households. Now, if we assume proportion of poor urban households to be 30 percent, we arrive at the cost of investment for low income housing in urban area of 1,046.32 billion baht. If the proportion of low income households is 16 percent, the social cost of investment is 558.04 billion baht.

Table 4: Estimated Cost of Social Investment on Urban Low Cost Housing

Cost of Social Investment (1,000 Million Baht)									
Year	Urban Housing Start (Units)	Unit Cost (Million Baht)	Value of Urban House (thousand Million Baht)	Assumptions on Poor Household Proportion					
				poor 40%	poor 30%	poor 25%	poor 20%	poor 15%	poor 16%
2020	415.53	0.99	409.85	163.94	122.96	102.46	81.97	61.48	65.58
2025	264.2	1.24	327.61	131.04	98.28	81.90	65.52	49.14	52.42
2030	503.57	1.55	780.53	312.21	234.16	195.13	156.11	117.08	124.89
2035	547.64	1.86	1,018.61	407.44	305.58	254.65	203.72	152.79	162.98
2037	426.13	2.23	951.12	380.45	285.34	237.78	190.22	142.67	152.18
All	2,157.07	1.57	3,487.73	1,395.09	1,046.32	871.93	697.55	523.16	558.04

Note: 1) unit cost is extrapolated from Table 6.9; 2) Urban housing start is from our model; 3) value of urban house is (3)=(1)x(2); 4) value of urban house by proportion of poor (4)= proportion x (3) respectively.

2.1.4 Social Investment Needs in Health Services

In this study, we propose the projection model of healthcare services in Thailand. The budget request has been shifted from supply side where ministerial request yearly budget based on the size of hospital in terms of beds numbers of in-patients to a demand-side. The public health service philosophy has been substantially changed in 2002. The health system is called the 'Universal Coverage Scheme' (UCS) is

implemented nationwide for major of population who are not covered by other system. The service was managed by the *National Health Security Office*.

The philosophy of management is to separate supervision of supply and demand for healthcare. The healthcare *demand* by all clients will be consolidated under the supervision of NHSO as a clearinghouse of all health care purchasers.

Clearly, the UCS system has empowered any Thai's accessibility to fundamental healthcare service. Conceptually, the *total cost* of supply provision has been equated with demand-side projection, assuming an equilibrium between demand and supply of health service, where 'average cost of provision= average buying price of health service per capita'. The demand-side was calculated from the given population cohort weighted by probability of illness of in-out patients, less success rate in precautionary effort. The total buying budget, conceptually, cover the new capital investment and maintenance cost.

Recently, the stochastic influence of 'non-communicable disease, NCD' has distorted the demand price and cost of supply unexpectedly. As a result, the *ex-post* demand price is lower than the average cost has created wide *margin of gap*. The marginal cost of service delivery has been rising. Some public hospitals are overload with patients. This has reduced the welfare of personnel, especially the medical doctors. It is a hot debate in Thailand among practitioners, NPO and general public of the UCS.

A consolidated demand under the UCS has been claimed to improve social welfare of the Thais households on health accessibility. Problems still remain on the supply side and personnel's welfare i.e., medical doctors and others, as well as capital investment of hospitals owing to the rising marginal cost of supply provision, uneven congestion of demand and spatial inequality of service supply.

The size of social infrastructure need in this scheme in the coming decade in terms of health budget is 233.096 billion baht in 2020 and 366.559 billion baht in 2030 respectively.

Here, the capital investment is projected to be 36.52 and 54.07 billion baht in two mentioned periods. In fact, the UCS budget of 147.233 billion baht is in fact the

demand side investment in human health.

Table 5: Projected Total Budgets for Healthcare (unit: million baht)

	Universal Healthcare	Salary and Compensation	Capital Investment	Total
2020	147,233.61	49,333.43	36,529.52	233,096.56
2025	185,017.60	63,731.83	44,443.74	293,193.18
2030	230,154.16	82,332.53	54,072.61	366,559.30

Note: 1) The projected budget covers new capital investment and maintenance as well. 2) This is a minimum demand for health services under UCS. It can be inflated further with international wage of medical doctor to represent its shadow rate of return to human capital investment in part with international price. Services of the medical doctor and nurse are 'tradable services' in part with developed countries. It can be adjusted by a 'PPP' weight to arrive at the 'true cost' of medical personnel's wage. This is left for further analysis.

Source: Authors 'calculation

2.2 Macro-Economic Approach

The macro approach shown in Table 6 below has concentrated in the construction of residential investment. The amount of social infrastructure of this category will cost 333.8 billion baht in 2020 and tend to increase substantially to 386.9 billion baht in 2025 and 444.7 billion baht in 2030 respectively. Schools and hospital are lower in their investment cost as far as construction is concerned. However, we have found that the non-construction social investments are still needed to be fulfilled in the schooling and hospital system services. The modern classrooms, laboratory, and modern medical types of equipment are needed in our simulation for schools and hospital. This will be allocated from the public source of non-construction investment in capital formation. The magnitude of non-construction for schooling system would be 10.25 billion baht in 2525 and 20.98 billion baht in 2030 respectively. This is what we have termed it as social infrastructure investment in knowledge for human capital built up towards 21st Century Skills.

Table 6: Macro Approach to Social Infrastructure Investment Need 2020-2-30, measured in current price (Billion baht)

Description	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gross fixed capital formation: Construction (scenario1)	**1,318.15**	**1,358.48**	**1,399.70**	**1,441.63**	**1,484.30**	**1,527.79**	**1,572.05**	**1,617.04**	**1,662.74**	**1,709.10**	**1,756.07**
Social Infrastructure RESIDENTIAL	333.8	344.0	354.4	365.1	375.9	386.9	398.1	409.5	421.0	432.8	444.7
Social Infrastructure SCHOOL	36.3	37.4	38.5	39.7	40.9	42.1	43.3	44.5	45.8	47.1	48.4
Social Infrastructure HOSPITAL	20.1	20.7	21.3	21.9	22.6	23.3	23.9	24.6	25.3	26.0	26.7
OTHER building	32.0	32.9	33.9	35.0	36.0	37.1	38.1	39.2	40.3	41.5	42.6
Other Non-Building	896.0	923.5	951.5	980.0	1,009.0	1,038.5	1,068.6	1,099.2	1,130.3	1,161.8	1,193.7
Change in Gross fixed capital formation: Construction Changed from baseline	18.84	39.00	61.70	86.18	110.77	135.81	162.11	189.69	218.24	247.62	277.84
Social Infrastructure RESIDENTIAL	4.77	9.88	15.62	21.82	28.05	34.39	41.05	48.03	55.26	62.70	70.36
Social Infrastructure SCHOOL	0.52	1.07	1.70	2.37	3.05	3.74	4.46	5.22	6.01	6.82	7.65
Social Infrastructure HOSPITAL	0.29	0.59	0.94	1.31	1.69	2.07	2.47	2.89	3.32	3.77	4.23
OTHER building	0.46	0.95	1.50	2.09	2.69	3.29	3.93	4.60	5.29	6.01	6.74
Other Non-Building	12.81	26.51	41.94	58.58	75.30	92.32	110.20	128.95	148.35	168.33	188.87
Social Infrastructure Investment Need, (scenario 1)	**1,244.07**	**1,282.14**	**1,321.05**	**1,360.62**	**1,400.89**	**1,441.94**	**1,483.71**	**1,526.18**	**1,569.30**	**1,613.05**	**1,657.39**
Non-construction											
Public	**248.81**	**256.43**	**264.21**	**272.12**	**280.18**	**288.39**	**296.74**	**305.24**	**313.86**	**322.61**	**331.48**
Education	99.53	102.57	105.68	108.85	112.07	115.35	118.70	122.09	125.54	129.04	132.59
Health	119.43	123.09	126.82	130.62	134.49	138.43	142.44	146.51	150.65	154.85	159.11
Residential	4.98	5.13	5.28	5.44	5.60	5.77	5.93	6.10	6.28	6.45	6.63
Social Infrastructure Investment Need, Additional	**17.78**	**36.81**	**58.23**	**81.34**	**104.54**	**128.17**	**153.00**	**179.03**	**205.97**	**233.71**	**262.23**
Non-construction,											
Public	**3.56**	**7.36**	**11.65**	**16.27**	**20.91**	**25.63**	**30.60**	**35.81**	**41.19**	**46.74**	**52.45**
Education	1.42	2.94	4.66	6.51	8.36	10.25	12.24	14.32	16.48	18.70	20.98
Health	1.71	3.53	5.59	7.81	10.04	12.30	14.69	17.19	19.77	22.44	25.17
Residential	0.07	0.15	0.23	0.33	0.42	0.51	0.61	0.72	0.82	0.93	1.05

Source: Model simulation in this study; see system model and applying national accounts of Thailand

3. Consolidation of Social Investment Needs in Thailand

The consolidation of social infrastructure investment's cost is shown below to be at the 5-6 percent of GDP in the case of construction. We have estimated the non construction elements like modern technology facilities for schooling system at all level, the high technology of health equipments and machinery, the modern housing facilities for aged citizen and modern office machinery and human facilitations etc. Besides, as we have noted in the study, the human capital built-up in Thailand would desperately need the non-physical capital but rather to raise the skills of our human resource towards the 21st Century Skills. Thus, the total investment would be amounted to 1-2 percent in additional to the physical building and facilities. This is amounted to social cost of infrastructure of 6-7 percent of GDP on average 2020-2030.

Table 7: Consolidation of Social Infrastructure Investment, Thailand 2020-2030

(measured in current prices, billion baht)						
Description	2020	2021	2022	2023	2024	2025
(1)Gross domestic product	18,933.31	19,953.09	21,037.56	22,169.57	23,346.01	24,600.05
(2) Social Investment (construction)	**1,318.15**	**1,358.48**	**1,399.70**	**1,441.63**	**1,484.30**	**1,527.79**
as % of GDP	6.96	6.81	6.65	6.50	6.36	6.21
(3) Social investment (non construction)	**248.81**	**256.43**	**264.21**	**272.12**	**280.18**	**288.39**
as % of GDP	1.31	1.29	1.26	1.23	1.20	1.17
(4) Total social investment	1,566.96	1,614.91	1,663.91	1,713.75	1,764.48	1,816.18
as % of GDP	8.28	8.09	7.91	7.73	7.56	7.38
	2026	2027	2028	2029	2030	
(1)Gross domestic product	25,897.94	27,256.47	28,676.89	30,139.08	31,643.02	
(2) Social Investment (construction)	**1,572.05**	**1,617.04**	**1,662.74**	**1,709.10**	**1,756.07**	
as % of GDP	6.07	5.93	5.80	5.67	5.55	
(3) Social investment (non construction)	**296.74**	**305.24**	**313.86**	**322.61**	**331.48**	
as % of GDP	1.15	1.12	1.09	1.07	1.05	
(4) Total social investment	1,868.79	1,922.28	1,976.60	2,031.71	2,087.55	
as % of GDP	7.22	7.05	6.89	6.74	6.60	

The macro approach has concentrated in the construction of residential investment. The amount of social infrastructure of this category will cost 333.8 billion baht in 2020 and tend to increase substantially to 386.9 billion baht in 2025 and 444.7 billion baht in 2030 respectively. Schools and hospital are lower in their investment cost as far as construction is concerned.

However, we have found that the non-construction social investments are still needed to be fulfilled to the schooling and hospital system services. The modern class rooms, laboratory and modern medical equipments are needed in our simulation too for schools and hospital.

This will be allocated from the public source of non-construction investment in capital formation. The magnitude of non-construction for schooling system would be 10.25 billion baht in 2525 and 20.98 billion baht in 2030 respectively. This is what we have termed it as social infrastructure investment in knowledge for human capital built up towards 21st Century Skills.

The consolidate source of funds is through initiation of consultation with the Treasury Department, Ministry of Finance. Land asset after consolidation would be returned to the kingdom for other purpose. In exchange for that consolidation willingness, the ministry of finance would issue the long-term bond for investment fund. In order to avoid a 'crowding-out' of public investment, part of the finance can be from public-private coordination and from *international long-term source of fund.*

4. Macro-economic Impacts of Investment in Social Infrastructure

We have applied the CGE model showing the macro economic impact of the hypothetical investment in social infrastructure on Thai Macro Economy 2020-2030. In model simulation, the growth of HDI's component is estimated to raise the Total Factor Productivity or a shift parameter in the production function in the model.

In addition, the labor productivity is assumed to grow as HDI component like mean years of schooling, expected year of schooling, life expectancy are assumed to grow and will drive the productivity shift in the production. The HDI target will give rise to solution to replace the unskilled labor from neighboring countries in the long-run. The physical capital investment in couple with human capital investment will hypothetically raise the labor productivity towards sustained growth in the long-run 2020-2030.

Table 8: Impact of Hypothetical Investment in Social Infrastructure on Thai Macro Economy 2020-2030

Macro Variables (measured in billion baht)					
Description	2020	2021	2022	2023	2024
Change in Real Gross Domestic Product	8.6	17.8	28.7	41.0	54.9
Change in Real Export	3.2	6.8	11.2	16.3	22.2
Change in Real Government Expenditure	1.7	3.3	5.1	7.0	9.0
Change in Gross Fixed Capital Formation	2.4	5.0	8.1	11.8	16.1
Change in Real Import	2.8	6.0	9.8	14.3	19.5
Change in Private Consumption Expenditure	3.8	8.0	12.9	18.6	25.1
	2025	2026	2027	2028	2029
Change in Real Gross Domestic Product	70.4	87.9	107.7	129.9	155.0
Change in Real Export	28.9	36.7	45.8	56.2	68.2
Change in Real Government Expenditure	11.1	13.3	15.6	18.0	20.7
Change in Gross Fixed Capital Formation	20.9	26.5	32.9	40.2	48.6
Change in Real Import	25.5	32.5	40.5	49.8	60.6
Change in Private Consumption Expenditure	32.3	40.5	49.8	60.4	72.3

	2030				
Change in Real Gross Domestic Product	183.1				
Change in Real Export	82.0				
Change in Real Government Expenditure	23.5				
Change in Gross Fixed Capital Formation	58.1				
Change in Real Import	72.9				
Change in Private Consumption Expenditure	85.7				

Note: Direct summation of right -hand real expenditure change is not matched to change in real GDP owing to the study did not add the change in investment in the table. Besides, the change has to be weighted by GDP share.

5. Methodological Notes for Further Analysis by Other Asian Countries

We have our final notes for further applications of these proposed methodologies by other Asians fellows as follows:

(1) The study should start with clearing all data at the macroeconomic level. Especially, researchers have to request the time series data on capital stock and gross fixed capital formation (GFCF) or investment by construction types. What we need is the GFCF on social investment especially the school, hospital, resident construction value in current prices. If this is not available, the researcher may try to use published data from developing countries that have a higher epoch of development and re-estimate as a proxy.

(2) It is recommended that estimation would be started from the Investment demand function as done in our study and by ADB. The simultaneous equation system can be tried to link the investment with HDI. The scenarios can be tried to estimate the social infrastructure. See Chapter 3 in this study.

(3) The micro approach can be benchmarked with an international study such as PISA for the education. The health system study researcher has to study the current supply-side oriented first. The researcher can try to estimate the demand-side approach following the experience of the Universal Health Coverage in Thailand as a case study.

(4) Data on population forecast can be obtained from the international organization like the WPF, IMF, and WB etc. Most of developing Asians have their own projections. The data on household types would be needed as well. Data on income growth can be estimated from national level using the National accounts data and translating it to the household level at a monthly frequency. The data at micro level on housing stock, inventory, schools building by types and age is not easy to find in developing countries. However, the ratio method can be a guess using projection number of students by level.

(5) This study does not require high-level econometric knowledge. On some skills to manage the readymade econometric software is sufficient to do the task. In the low-income housing need and affordability, it runs on MS Excel or any spreadsheet just to understand the notation and get ready for data inputs. In fact, all

micro approach can be managed on spreadsheets without difficulty. Only some impact analysis using the counterfactual as 'what if we need HDI to reach this target level, then what will be the macroeconomic impact?' this can be done easily with any macroeconomic model where the current state of the art is easily done and explained by and 'tube' lesson in the standard media or even hand telephone.

(6) Only some researchers who are really serious to get through with full strength, they can consult with us to decide whether to go on with such modeling to get a result from the large-scale macro-econometric model and/or the Dynamic General Equilibrium Model (CGE). It has been used in part of this study. But not knowing techniques and complications will not depress the willingness to do simple estimate and projection of the social infrastructure by any Asian's countries.

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