MACROECONOMIC ASPECTS OF DEMOGRAPHIC CHANGE AND INTERGENERATIONAL TRANSFERS IN THAILAND

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAI'I IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

ECONOMICS

MAY 2008

By
Amonthep Chawla

Dissertation Committee:

Andrew Mason, Chairperson
Sang-Hyop Lee
Gerard Russo
Timothy Halliday
Yean-Ju Lee

We certify that we have read this dissertation and that, in our opinion, it is satisfactory in scope and quality as a dissertation for the degree of Doctor of Philosophy in Economics.

DISSERTATION COMMITTEE

Chairperson

ACKNOWLEDGEMENTS

I would like to thank Professor Andrew Mason, Professor Sang-Hyop Lee, Professor Gerard Russo, Professor Timothy Halliday and Professor Yean-Ju Lee for valuable comments. I also thank Chanyaporn Parinyavottichai, Turro and Diana Wongkaren, Maliki and Nicole Lai for their friendship during my study in Hawaii. I would like to thank the East-West Center for generous financial support and working opportunity. My special thanks are due to my chairperson and advisor, Professor Andrew Mason, who stimulated my interest in this research and provided advice in numerous areas throughout my time at the University of Hawaii.

ABSTRACT

This dissertation is empirical research on how age structure affects economic flows across ages. Economic flows consist of transfers and reallocations through assets, which can be used to finance consumption. Intergenerational transfers are estimated using the National Transfer Flow Account methodology. The NT Flow Account is an accounting system for measuring transfers and reallocations through assets at the aggregate level in a manner consistent with National Income and Product Accounts. The main contribution of this dissertation is on the development of the methodology used to construct the NT Flow Account. The NT Flow Account for Thailand is constructed, which could be used as an example for other countries.

In addition to economic flows across ages, reallocations through assets are major forms of consumption support. People save in order to accumulate assets in different forms, such as capital, credit and property. This dissertation contributes to developing the methodology used to measure how individuals rely on different forms of assets to support consumption throughout their lifecycle.

Saving rates are simulated in order to measure how change in age structure influences saving in the economy. There is controversial and important empirical issue on how much change in age structure can account for a significant change in saving rates. Several empirical studies find that saving rates change substantially as population age structure changes. Some studies find that change in population age structure has modest effects on aggregate saving rates. This dissertation replicates the methodology used by Deaton and

Paxson (2000) to simulate saving rates in Thailand. Deaton and Paxson method does not explicitly include intergenerational transfers. This dissertation contributes to taking into account intergenerational transfers, using the NT Flow Account methodology, to simulate saving rates. Simulated saving rates from Deaton and Paxson model are then compared with results using Mason and Lee (2006) model. The main finding, based on both methods, shows that change in age structure influences saving rates in Thailand before 1985. However, after 1985 change in saving rates are not due to change in age structure but some other secular trend.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

PREFACE

Intergenerational transfers are large and important. Transfers can be made through the public sector and the family. Transfers across ages greatly influence welfare of children and the elderly, such as education, health care and old-age security systems. Apart from transfers, the elderly also rely on assets that they accumulated during their working ages. Changes in transfers or asset accumulation would significantly affect consumption by children and the elderly.

Change in age structure could affect intergenerational transfers and saving rates. Declining fertility and mortality leads to smaller share of children and increasing share of working ages. An increase in the share of productive working ages leads to greater available resources to save and to provide transfers to children and the elderly. The economy could benefit from having higher saving rates and economic growth. Children may receive larger education and health transfers leading to higher productivity growth. Continual decline in fertility and mortality leads to population aging. The share of working ages declines, while the share of the elderly increases. There could be fewer resources available to save or make transfers. Population aging could lower saving rates and transfer programs. However, if a country prepares for population aging by relying on accumulating assets and less on receiving transfers to support old age consumption, population aging could lead to favorable effects, such as by increasing capital accumulation in the country.

Thailand is used as a case study in this research in order to measure how change in age structure could influence economic flows across ages, particularly saving rates. During the past few decades an increase in saving rates in Thailand is associated with an increase in the share of the working ages. However, the favorable demographic structure of high proportion of working ages is about to dissipate. Continual decline in fertility and mortality as well as increase in life expectancy leads to population aging. The proportion of the elderly, ages 65 and older, in Thailand has increased from 3 percent in 1950 to 6 percent in 2000. Even though the proportion of the elderly in Thailand is lower than many countries, the speed of population aging is high. The proportion of the elderly is expected to increase to 21 percent by 2050. Rapid change in age structure of Thailand is interesting, which could be used as an example for other countries that are experiencing demographic transitions to understand how change in age structure could affect their economy.

CHAPTER 1
INTRODUCTION

1.1 Backgrounds and Motivation

The purpose of this research is to investigate the relationship between population age structure and how individuals support their consumption in Thailand. This research measures Thailand's economic lifecycle, which is a concept of how population age structure influences saving and the economy. Economic lifecycle identifies which age groups within the population are dependents and the extent of that dependency. There is also important relationship between age structure and how individuals vary their support from different forms of assets. Younger individuals may rely on certain types of assets to achieve their lifecycle plan differently from older individuals. Thus, it is important to quantify how much individuals in different age groups rely on different forms of assets and other types of mechanisms to support their dependency period. Further, there is empirical question if a change in age structure affects national saving. According to the lifecycle hypothesis, an increase in the portion of the working ages has a favorable impact on saving because the working ages produce more than they consume, allowing them to have excess resources to save. It is important to know if change in age structure account for a significant change in saving rates. Thailand is used as a case study. Thailand experienced a rapid change in population age structure. Result found for Thailand could be used as an example for other countries that are experiencing changes in age structure in order to understand if population aging could affect saving rates.

1.2 Statement of the Problem

Children and the elderly consume more than they produce relying on resources reallocated from the working ages to support their consumption. The support provided by the working ages is large and important; however, it is rarely measured. In addition, saving is a major type of support. People save in order to accumulate assets in different forms, such as capital, credit and property. However, there are few studies that measure how people in different age groups rely on different forms of assets to support their consumption. Further, people vary their saving with age. Older workers usually save more than younger workers and the elderly. Population aging, which increases the share of older workers, may increase national saving. However, saving rates may change when the bulge of older workers retires in the future.

The main research questions are as follows. First, how are the economic lifecycle and support systems determined in Thailand? Second, how do individuals accumulate or dis-accumulate different forms of assets through out their lifecycle? Third, how change in age structure affects saving rates of Thailand?

The methodology, which is used to measure the economic lifecycle and comprehensive reallocation systems, is the National Transfer Flow Account (Mason et al. forthcoming; www.ntaccounts.org). The NT Flow Account is an accounting system for measuring transfers and reallocations through assets at the aggregate level in a manner consistent with National Income and Product Accounts. The NT Flow Account measures economic flows across age groups that occur because children and the elderly consume more than they produce, relying on reallocations from the working ages through both the public and private sectors. Further, aggregate saving rates of Thailand are simulated under changes in demographic and economic trends.

1.3 Organization of the Dissertation

This research is organized as follows. Chapter 2 summarizes how to estimate the economic lifecycle and support systems. The National Transfer Flow Account for Thailand is presented. In Chapter 3, details of reallocations through assets are presented. In Chapter 4, national saving rates of Thailand are simulated in order to measure how change in age structure affects saving rates. Chapter 5 summarizes the findings of the research and states it limitations.

CHAPTER 2
THE ECONOMIC LIFECYCLE AND SUPPORT SYSTEMS FOR THAILAND IN 1996

2.1 Introduction

The human lifecycle begins and ends with periods of dependency when consumption exceeds labor earnings. This shortage of labor income, or lifecycle deficit, makes the young and the elderly depend on resources reallocated from the working or lifecycle surplus ages. How age structure that shapes the human lifecycle affects consumption, production and reallocations of economic resources is the fundamental concept of the economic lifecycle. The economic lifecycles and the reallocation systems are important; however, they are rarely measured.

This paper has two major objectives. The first is to estimate the economic lifecycles of individuals – the age profiles of consumption and production (labor income). The economic lifecycles identify which age groups within the population are dependents and the extent of that dependency. The second is to quantify the individuals' economic forms of age reallocations, which describe how dependents support their periods of dependency. The support provided from the working ages consists of transfers and reallocations through assets.

The methodology, which is used to measure the economic lifecycle and comprehensive support systems, is the National Transfer Flow Account (Mason et al. forthcoming; www.ntaccounts.org). The NT Flow Account is an accounting system for measuring transfers and reallocations through assets at the aggregate level in a manner consistent with National Income and Product Accounts. The NT Flow Account measures economic flows across age groups that occur because children and the elderly consume more than they produce, relying on reallocations from the working ages through both the public and private sectors. Reallocations through the public sector are, for example, public school construction, student loans and public health care provision. Reallocations through the private sector are, for example, factory construction, consumer loans and familial support of children and elderly parents. These reallocations can be either cross-sectional (transfers from parents to children) or longitudinal (accumulation of wealth during working ages and dis-accumulation during retirement). The major contribution of this paper is on the development of the methodology to estimate public transfers of the NT Flow Account.

This paper is organized as follows. The next section reviews the literature on the economic lifecycle and reallocation systems. This is followed with a presentation of the methodology that summarizes the estimation of the National Transfer Flow Account for Thailand. Then, the results are presented and discussed. The final section concludes this study.

2.2 Literature Review

There are two major areas of literature on the lifecycle and individual elements of the support system. One is based on the lifecycle hypothesis of saving and the other is based on the overlapping generations model. Both literatures emphasize the economic lifecycle, but each discusses different mechanisms that individuals rely on to support consumption during deficit periods.

The lifecycle hypothesis of saving, developed by Modigliani and Brumberg (1954), shows a well-defined linkage between the consumption plans of individuals and their income and income expectations as individuals pass though different stages of the lifecycle. Individuals save some fraction of their income when they earn more than they consume during their working ages in order to dis-save when they earn no income during retirement.

The overlapping generations model, introduced by Samuelson (1958), presents the relationship between the population growth rate and the amount of transfers that individuals receive from successive generations to support their old age. At any time period the young population, who has excess income, makes transfers to the elderly, who do not earn income. In the next period when the young population becomes old and can no longer work, they receive support provided by the next young generation. Based on some simple demographic assumptions, the overlapping generations model shows the amount the elderly receive from the younger generation depends on the population growth rate, which determines the size of the younger generation.

Both the lifecycle hypothesis of saving and the overlapping generations model look at reallocation systems in isolation. The lifecycle hypothesis of saving emphasizes an individual's responsibility in supporting consumption, while the overlapping generations model relies on the existence of successive generations in providing support. In addition, both literatures are based on highly stylized models with very simple lifecycle assumptions. For example, the lifecycle consists of two or three broad age groups, workers and retirees, with perfect survival until the end of the second period. Childhood is not included in the lifecycle, and the lifecycle starts only when individuals enter the labor market. There is only one dependency period rather than two; therefore, it is not possible to fully explain the economic lifecycle and the reallocation systems of individuals at all age groups. There are more realistic models, such as those of Auerbach et al. (1999), Lee (1994a; 1994b; 2000), Stecklov (1999), Mason and Lee (forthcoming) and Lee et al. (2006). Despite some drawbacks of these two literatures, both the lifecycle hypothesis of saving and the overlapping generations model are polar cases that explain how individuals support their consumption over the lifecycle. These two important literatures successfully combine demography and macroeconomics and lay down the fundamental framework for this field of study.

Both the lifecycle hypothesis of saving and the overlapping generations model discuss the importance of the economic lifecycle. The economic lifecycle can be summarized by the amount consumed at each age and by the amount produced through labor at each age. The human lifecycle begins and ends with stages of dependency, when consumption exceeds labor earnings, which leads to the shortage of income or lifecycle deficit. Based on this perspective, old people are considered economically dependent even if they receive other sources of income, such as asset income and transfer income, which are large enough to finance their consumption. Lifecycle deficit ages receive resources reallocated from those who receive higher labor earnings than their consumption, or lifecycle surplus ages, to bridge the gaps between consumption and labor income. Examples of the economic lifecycle of selected countries are presented in Lee et al. (2006).

Combining the importance of saving and transfers, Lee (1994a; 1994b) developed a comprehensive conceptual and empirical framework of the reallocation systems. In Lee's model, people at each age group solve the discrepancy between consumption and labor income by holding wealth in three forms: capital, credit and transfer. Summing the demand for wealth over all ages in a population yields an aggregate demand for wealth. Capital wealth or real wealth is a form of physical capital. Credit wealth, including government debt, is the present value of the flows of borrowing and lending. Such loans take place through the family, the market and the public sector. Under the assumption that the economy is closed to foreign participation in credit markets, and by treating the lending and borrowing of the private non-household sector as adhering to the individuals holding equity in these firms, it must be the case that the flows of borrowing and lending add to zero across the population at all times. Transfer wealth is the present value of expected future transfers to be received minus transfers to be made. For example, familial transfer wealth is net support that the elderly expect from their family members, while public sector transfer wealth is healthcare or public pension the elderly expect to receive net of taxes to be paid. When one person makes transfers to another, the amount of transfer made by one person is equal to the amount of transfer received by another person. Thus, in a closed economy the sums of current transfers made and received at every instant must be zero. However, the aggregate transfer wealth may not be zero. Transfer systems can obligate the unborn to make future transfers to the living population who themselves have made corresponding net transfers, such as social security benefits, to the previous generation. The aggregate transfer wealth can be either positive or negative. From the point of view of the individual, real wealth and transfer wealth may be a close substitute. From the point of view of macroeconomy, however, real and transfer wealth have very different properties. Real wealth yields valuable services that increase productivity of labor and per capita income. Transfer wealth, on the other hand, yields no productivity service and has no effect on per capita income. It changes the level and age pattern of lifecycle consumption from a given per capita income. Lee uses this framework to estimate intergenerational transfers in the United States, distinguishing education, health and social security programs, but often under a restrictive set of assumptions (i.e., steady-state equilibrium and golden-rule growth).

Following Lee's framework, the individual's economic lifecycle and reallocation systems of the US and Taiwan are estimated by Mason et al. (forthcoming). Mason et al. establish the framework that measures the reallocation systems at the aggregate level, which is called the National Transfer Flow Account. The methodology being employed in this paper builds on Mason et al.'s framework. Age profiles of consumption and production define the economic lifecycle. The reallocation systems are modified from Lee's to include transfers and reallocations through assets, combining capital and credit transactions. Transfers are categorized into public and private transfers.

Mason et al. also develop comprehensive measures of familial transfers, which quantify how much individuals at each age group receive and make transfers to other age groups within a household. As opposed to Mason et al., there are studies that simply rely on results reported from several surveys to measure how much the elderly rely on their family. Results from surveys do not provide comprehensive view of familial transfers. Namely, questions about how much food or clothes people in the family receive from their co-resident members are not asked, which makes it unknown how much children and the elderly rely on their family. Despite narrow measures of familial supports, several surveys show that familial transfers are large and important to support the elderly (Martin 1989; Mason 1992; Biddlecom et al. 2002; Hermalin 2002).

In summary, there is a large body of important research on the economic lifecycles and reallocation systems, but most of it describes the importance of reallocation systems in isolation. Intergenerational transfers are large and important; however, they are rarely measured. The main contribution of this paper is to empirically measure the economic lifecycles and comprehensive reallocation systems of individuals at all age groups for Thailand.

2.3 Estimation of the National Transfer Flow Account for Thailand in 1996

2.3.1 An Overview of the National Transfer Flow Account[1]

[1] Details of the National Transfer Flow Account can be viewed from Mason et al. (forthcoming) and the website www.ntaccounts.org.

The National Transfer Flow Account is an accounting system for measuring reallocations of economic resources across age and time at the aggregate level. There are two parallel elements of the NT Flow Account: the lifecycle deficits and age reallocations. The lifecycle deficits are the difference between consumption and labor income at each age. Age reallocations show how dependents solve their economic lifecycle problem, or how working ages reallocate economic flows to other age groups through different reallocation systems.

Reallocation systems vary along two important dimensions: the governing or mediating institution and the economic form of the reallocation (Mason et al. forthcoming). Both the public and the private sectors are mediating institutions that facilitate the reallocation of resources among individuals. The public sector reallocates resources relying on social mandates embodied in law and regulation, while the private sector reallocates resources relying on voluntary contracts and social conventions. The public sector of the NT Flow Account for Thailand includes the central government, local governments and social security funds, while public enterprises are excluded from the public sector and considered to be part of the private sector. The private sector consists of households, unincorporated enterprises, private corporations, public enterprises, non-government organizations (NGOs) and other private institutions.

The NT Flow Account distinguishes two economic forms of reallocations: transfers and asset-based reallocations as shown in Table 2-1. Reallocations through the public sector are, for example, public school construction, student loans and public health care.

Reallocations through the private sector are, for example, factory construction, consumer loans and familial support of children and the elderly parents. These reallocations can be either cross-sectional (transfers from parents to children) or longitudinal (accumulation of wealth during working ages and dis-accumulation during retirement).

Table 2-1: A Classification of the National Transfer Flow Account Reallocations

	Asset-based Reallocations		
	Capital and Property	**Credit**	**Transfers**
Public	Public infrastructure	Public debt Student loan programs Money	Public education Public health care Unfunded pension plans
Private	Housing Consumer durables Factories Farms Land Inventories	Consumer credit	Familial support of children and parents Bequests Charitable contributions

Source: Mason et al. (forthcoming)

Assets-based reallocations include the reallocations through capital, property and credit. Assets can be accumulated and dis-accumulated. They provide income to individuals. They are used primarily to reallocate resources from the present to the future. Even though people perceive reallocations through capital as close substitutes for reallocations through property and credit, from the perspective of the macroeconomy, there are important differences between capital, property and credit.

Capital-based reallocations are transactions that increase future consumption by foregoing current consumption. Individuals can reduce current consumption when they are young so as to increase the stock of reproducible capital in the present and the future, which subsequently increases the aggregate productive potential of the economy. Capital can be used to reallocate resources from younger to older ages only.

Reallocations through property and credit are similar to capital-based reallocations because they involve an exchange of economic resources in the current period in return for compensation in one or more future periods. However, reallocations through property and credit do not yield a higher aggregate wealth in the future because an increase in the wealth of one group is always balanced by the decline in wealth of another age group. Therefore, the net payments must cancel when summed over the whole population.

Property and credit transactions are distinct. First, credit transactions allow one group of individuals to reduce current consumption and another group of individuals to increase current consumption. The use of credit cards to finance consumption by individuals and the use of public debt, including the printing of money, to finance government programs are examples. Credit transactions can be used to reallocate resources either from younger to older ages or from older to younger ages. Second, the exchange of land and other non-reproducible assets allows one group of individuals to increase or reduce consumption by acquiring or disposing of a non-reproducible asset. Individuals can acquire non-reproducible assets when young and dispose of them when old. Thus, the exchange of land and other non-reproducible assets can be used to reallocate resources from younger to older ages only.

Transfers are the reallocations from one group to another which involve no explicit *quid pro quo*[2]. Transfers can flow in either direction; for example, transfers from older to younger in terms of childrearing and educational transfers or from younger to older in terms of providing old age support and health care for the elderly.

2.3.2 An Accounting Identity of the National Transfer Flow Account

The NT Flow Account is governed by an accounting identity that states that inflows to each age group must equal outflows from each age group. The accounting identity holds for the economy and for individuals. The flow identity for age group *a* is

$$\underbrace{Y^l(a)+Y^a(a)+\tau^+(a)}_{\text{Inflows}}=\underbrace{C(a)+S(a)+\tau^-(a)}_{\text{Outflows}} \quad . \qquad \textbf{2.1}$$

Inflows consist of labor income $Y^l(a)$, asset income $Y^a(a)$ and transfer inflows $\tau^+(a)$. Outflows consist of consumption *C(a)*, saving *S(a)* and transfer outflows $\tau^-(a)$. Asset income is the combination of the return to capital, land and credit. Saving includes investment in capital, land and credit. Transfer inflows and outflows include both private transfers and public transfers.

---

[2] There are important models of private transfers that emphasize that people make transfers in order to exchange goods and services (Cox 1987; Bernheim et al. 1985; Kotlikoff and Spivak 1981). These types of transfers can be made in different forms. For example, parents may give money to their children to purchase services (e.g. personal care) from their children. Parents may finance human capital investment in their children in order to receive old age support from their children (Lillard and Willis 1997). These are not transfers but rather some sort of non-market transaction or intertemporal exchange that involves a *quid pro quo*. Practically, it is difficult to distinguish familial transfers from familial exchange.

Rearranging equation 2.1, the difference between consumption and labor income, termed the lifecycle deficit, is matched by age reallocations, consisting of asset-based reallocations and transfers. Asset-based reallocations are asset income less saving. Net transfers are the difference between transfer inflows and transfer outflows. The accounting identity of the NT Flow Account in each age group is shown as:

$$\underbrace{C(a)-Y^{l}(a)}_{\text{Lifecycle Deficit}}=\underbrace{\underbrace{Y^{a}(a)-S(a)}_{\text{Asset-based Reallocations}}+\underbrace{\tau^{+}(a)-\tau^{-}(a)}_{\text{Net Transfers}}}_{\text{Age Reallocations}}\;. \qquad 2.2$$

2.3.3 Aggregate Control of the National Transfer Flow Account

Age profiles of variables shown in equation 2.2 are compiled to construct the National Transfer Flow Account. The aggregates are estimated using three pieces of information: the population by age, a per capita age profile for the variable being estimated and an aggregate control drawn from National Income and Product Account (NIPA) or other government statistical sources.

There is the relationship among the population by age, per capita age profile and the aggregate control. Per capita profiles *x(a)* of the NT Flow Account are estimated using a variety of techniques described in the following section. When per capita profiles *x(a)* are multiplied by population by age *N(a)*, they yield the aggregate value for each age group *x(a)N(a)*. After summing up the aggregate values from all age groups $\sum_{a} x(a)N(a)$, they yield the aggregates for the economy. However, these estimated aggregates are invariably different from the aggregate controls X as reported in NIPA for a variety of reasons. Thus, these estimated aggregates need to be adjusted as:

$$\begin{aligned} X &= \theta \sum_a x(a)N(a) \\ X(a) &= \theta x(a)N(a) \end{aligned} , \qquad 2.3$$

where θ is a proportional adjustment factor calculated from the first equation and then used to adjust the per capita profile proportionally to insure consistency with the aggregate control of NIPA. $X(a)$ is the total value of X for all persons aged a. The relationship between NIPA and the NT Flow Account is shown theoretically below, following by how to practically draw NIPA to be the aggregate control for the NT Flow Account for the case of Thailand.

A. NIPA and the NT Flow Account

There is the relationship between NIPA and the NT Flow Account. NIPA is the macroeconomic depiction of the national income cycle. NIPA measures the flows of five main institutional units that are resident in the economy, i.e. non-financial corporations, financial corporations, government units (including social security funds), non-profit institutions serving households and households. In contrast, the NT Flow Account measures the inflows and outflows only at the individuals or households. The total inflows (outflows) to (from) individuals in the economy measured in the NT Flow Account are equal to the total inflows (outflows) to (from) all five main institutional units measured by NIPA. The NT Flow Account is classified into two main sectors: private and public. However, the individual is the fundamental analytic unit in the NT Flow

Account. All transactions are treated as flowing to and from individuals. Government and families only mediate these transactions.

The accounting identity of NIPA is matched with the accounting identity of the NT Flow Account. Starting from the accounting identity of national income, the total values of national income (using an income approach) are equal to total values of national expenditure (using an expenditure approach). An income approach is the measurement of factor income of the economy after paying for indirect tax on production and receiving subsidies. National income consists of post-tax compensation of employees W^x and post-tax operating surplus O^x. Post-tax operating surplus consists of income from unincorporated enterprises, income from private corporations and property and income from government corporations and property. An expenditure approach refers to spending on post-tax public and private consumption C^x, saving S, subsidies T_g^s less indirect taxes T_g^x and less net public and private current transfers received from the rest of the world τ_{ROW}. Post-tax consumption is public and private consumption after paying for indirect tax on consumption.

$$\underbrace{W^x + O^x}_{\text{National Income}} = \underbrace{C^x + S + T_g^s - T_g^x - \tau_{ROW}}_{\text{National Expenditure}} \qquad 2.4$$

Net transfers received from the rest of the world are the difference between transfer received (inflows) from the rest of the world and transfer given (outflows) to the rest of the world. In the domestic economy transfer inflows are equal to transfer outflows, leaving net transfers received in the domestic economy equal zero. Thus, net transfers received from the rest of the world are the difference between aggregate transfer inflows and aggregate transfer outflows, i.e. $\tau_{ROW} = \tau^{+} - \tau^{-}$.

There are two steps to adjust NIPA to match with the NT Flow Account in order to measure economic flows at the individual level. The first step is to allocate indirect taxes and subsidies to individuals to measure pre-tax consumption C, pre-tax compensation of employees W and pre-tax operating surplus O. Indirect taxes are taxes that are not assessed on and collected from those who are intended to bear it. There are varieties of indirect taxes, such as sales taxes, business taxes and import taxes. Unlike direct taxes, indirect taxes cannot take individual circumstances into account. Although levied on producers, the burden of indirect taxes may be shifted to consumers. Most indirect taxes T_g^x are either indirect taxes on production T_g^{xk} or indirect taxes on consumption T_g^{xc}. There is hardly any indirect tax borne by workers. Indirect taxes on production lower producers' profits or dividends. Subsidies are treated as negative indirect taxes on production. Thus, pre-tax operating surplus is measured as post-tax operating surplus plus indirect tax on production less subsidies, i.e. $O = O^x + T_g^{xk} - T_g^s$. On the other hand, indirect taxes on consumption raise price or value of individuals' consumption. Pre-tax consumption is measured as post-tax consumption less indirect tax on consumption, i.e. $C = C^x - T_g^{xc}$.

The second step is to allocate national income to labor income and asset income. Labor income is all compensation that is a return to work effort. It includes compensation of employees and the labor share of income from unincorporated enterprises O_h^l, i.e.

$Y^l = W + O_h^l$. Compensation of employees is remuneration payable by enterprises to employees. It includes labor earnings, employer-provided benefits (bonus and housing), taxes paid to government on behalf of employees (social security contribution). The labor share of income from unincorporated enterprises is the labor income, while the remaining non-labor share is asset income. Asset income consists of returns to capital, property and credit. The aggregate control of asset income includes total pre-tax operating surplus minus the labor share of income from unincorporated enterprises, i.e. $Y^a = O - O_h^l$.

B. Constructing Aggregate Control of the NT Flow Account for Thailand

The aggregate control of the NT Flow Account for Thailand can be drawn from national income of Thailand with the adjustment steps described above. The 1996 national income of Thailand, compiled by the National Accounts Division of the Office of the National Economic and Social Development Board (NESDB), is shown in Table 2-2. The left-hand side of the account shows the income variables: compensation of employees and operating surplus. The right-hand side of the account shows the expenditure variables: public consumption, private consumption, net saving, indirect taxes, subsidies and net transfers received from the rest of the world.

Table 2-2: National Income Account of Thailand in 1996 (Billion Baht)

Income Approach		Expenditure Approach	
Compensation of Employees	1,353	**Public Consumption Expenditure**	470
Operating Surplus	2,041	Education	144
Income from Unincorporated Enterprises	1,065	Health	44
Income from Private Corporations and Property	846	Other	281
Property Income	476	**Private Consumption Expenditure**	2,480
Less: Interest Payment on Consumer Debt	62	Education	22
Less: Interest Payment on Public Debt	9	Health	164
Saving of Private Corporations	252	Housing	147
Corporate Income Tax	176	Other	2,147
Corporate Transfer Payment	13	**Net Saving**	1,026
Income from Public Enterprises and Property	130	Households	278
Government Income from Property and Entrepreneurship	66	Corporations	252
		General Government	431
Saving of Government Enterprises	65	Government Enterprises	65
		Less: Indirect Taxes	573
		Subsidies	12
		Less: Net Public Current Transfers from ROW	2
		Less: Net Private Current Transfers from ROW	18
National Income	3,394	**National Expenditure**	3,394

Source: National Income of Thailand (NESDB 2001, pages 3-5)
Note: The average exchange rate of Thailand in 1996 was about 25 baht per 1 USD

Aggregate control of public consumption, saving, public transfers and private transfers can be drawn directly from national income of Thailand in order to construct the NT Flow Account. However, private consumption, labor income and asset income need to be adjusted from national income account. As mentioned in the previous section, there are two steps to adjust national income account: indirect taxes and operating surplus. First, indirect taxes can be allocated to producers and consumers depending on types of indirect taxes. Table 2-3 shows that mainly indirect taxes of Thailand are borne by consumers, which is 520.4 billion baht. Examples of indirect taxes on consumption are business tax, value-added tax, excise tax and import duties. Indirect taxes on consumption are mainly levied on private consumption of other goods and services, apart from education, health and housing. Indirect taxes borne by producers are relatively small, about 53 billion baht. Examples of indirect taxes on production are specific business tax, stamp duty, natural resource tax, fees and permits. Subsidies are treated as negative indirect taxes on production.

Table 2-3: Allocation of Indirect Taxes of Thailand in 1996 (Billion Baht)

	Billion Baht		Notes
Indirect Taxes Borne by Consumers			
Business Tax	0.5	520.4	Sales tax levied on goods and services of small entreprises
Value Added Tax (VAT)	175.3		Sales tax levied to any consumption goods, including imported goods
Consumption Goods Tax (Excise Tax)	195.2		Taxes levied on the sale of a group of commodities collected from the domestic producers and importers. The commodities that are subjected to taxes are spirits, beer, non-alcoholic beverage, tobacco, petroleum and petroleum products, vehicles, appliance, etc.
Import Duties	149.6		Taxes levied on imported goods
Indirect Taxes Borne by Producers			
Specific Business Tax	38.6	53.0	Specific business tax is levied on the gross receipts of certain businesses, such as the interest and foreign exchange gains of banks and other financial institutions, life insurance premiums, and dealing in real estate
Stamp Duty	6.0		Stamp duty is taxed on instruments defined as any chargeable document, such as transfer of land, stock transfers, debentures, mortgages, and life insurance policies
Natural Resource Tax	5.4		Taxes levied on producers used natural resources, such as petroleum royalty
Fees and Permits	2.9		Fees and permits for some business such as alien registration fees and gambling fees
Total Indirect Taxes	**573.4**		

Note: Aggregate indirect taxes of National Income of Thailand (NESDB 2001) are allocated into details using the percentages of components of indirect taxes reported in the National Statistical Yearbook (NSO 1999).

Second, operating surplus can be separated into returns to labor and returns to non-labor. Following Mason et al. (forthcoming), two-thirds of income from unincorporated enterprises are returns to labor, while one-third is returns to non-labor. Compensation of employees plus the share of labor income from unincorporated enterprises measure labor income. The share of non-labor income from unincorporated enterprises plus income from public and private enterprises and property plus indirect taxes borne by produces less subsidies measure asset income. Consequently, labor income and asset income can be shown in Table 2-4.

Table 2-4: Labor Income and Asset Income of Thailand in 1996 (Billion Baht)

Compensation of Employees	1,353
Plus: 2/3 of Income from Unincorporated Enterprises	710
Labor Income	**2,063**
1/3 of Income from Unincorporated Enterprises	355
Plus: Income from Enterprises and Property	976
Plus: Indirect Taxes Borne by Producers	53
Less: Subsidies	12
Asset Income	**1,372**

All data, except for indirect taxes borne by producers (shown in Table 2-3), are drawn directly from national income account of Thailand (shown in Table 2-2)

Further, net transfers received from the rest of the world are net transfers from abroad because transfer inflows are equal to transfer outflows in the domestic economy. Table 2-5 shows the accounting identity of the NT Flow Account: lifecycle deficit is equal to age reallocations. Finally, Table 2-5 is used as the aggregate control to estimate the per capita age profiles of the NT Flow Account in the following section.

Table 2-5: The National Transfer Flow Account for Thailand in 1996 (Billion Baht)

Lifecycle Deficit	**366**	
Consumption	**2,429**	
Public Consumption Expenditure	**470**	
Education	144	
Health	44	
Other	281	Drawn directly
Private Consumption Expenditure	**1,959**	from NIPA
Education	22	(Table 2-2)
Health	164	
Housing	147	
Other	2,147	
Less: Indirect Taxes Borne by Consumers	520	← Table 2-3
Less: Labor Income	**2,063**	←
Age Reallocations	**366**	Table 2-4
Asset-based Reallocations	**346**	
Asset Income	1,372	←
Less: Saving	1,026	Drawn directly
Transfers	**20**	from NIPA
Public Transfers	2	(Table 2-2)
Private Transfers	18	

2.3.4 Age Profiles of the National Transfer Flow Account

The age profiles are estimated, relying on information from the household socio-economic survey (SES) and the population by single-year of age. The SES is conducted every two years under the direction of the National Statistical Office Field Division. The survey provides information at the household level, such as household expenditures and income, and at the individual level, such as education level and age of household members. The population data of Thailand are from population estimates by the United Nations (UN 2003). Details of the estimation of age profiles of the NT Flow Account are described as follows.

A. Lifecycle Deficit

i. Public Consumption

Public consumption is the value of consumption of goods and services individuals receive through the public sector. Public consumption is allocated to individuals, distinguishing public education, public health care and public other consumption.

a. Public Education Consumption

Public education consumption consists of two parts: formal and informal education consumption. Formal education consumption is government spending on primary, secondary and higher education levels. The informal education consumption refers to expenditure on culture, religious studies and other types of education. Table 2-6 shows public education consumption, the number of students and unit cost per student for each level of education. Primary education receives the largest share of public education consumption, whereas per student costs are greatest for higher education.

Public formal education consumption by age $E_g^f(a)$ is estimated by summing unit cost per student per level c_l weighted by the number of students by age in each level $e_l(a)$, i.e. $E_g^f(a) = \sum_l e_l(a)c_l$, where l is a school level. Unit cost per student at each level of education c_l, shown in Table 2-6, is estimated by dividing education consumption of that level by its number of students. Unit cost of education within each level is assumed not to vary by age. The number of students by age in each level $e_l(a)$ is tabulated from the SES.

Table 2-6: Public Education Consumption of Thailand in 1996

	Formal Education			Informal
	Primary	Secondary	Higher	Education
Education Consumption[1] (Million Baht)	71,832	41,798	27,172	3,583
Number of Students[2] (Thousands)	7,935	3,927	1,333	58,465[3]
Unit Cost (Baht)	9,052	10,644	20,388	61

Sources:

[1] Percentages of education consumption in different levels reported in the Statistical Yearbook Thailand (NSO 2003, Table 3.8) are used to allocate the aggregate control of public education consumption reported in the National Income Account (NESDB 2001, Table 6) to different education levels.

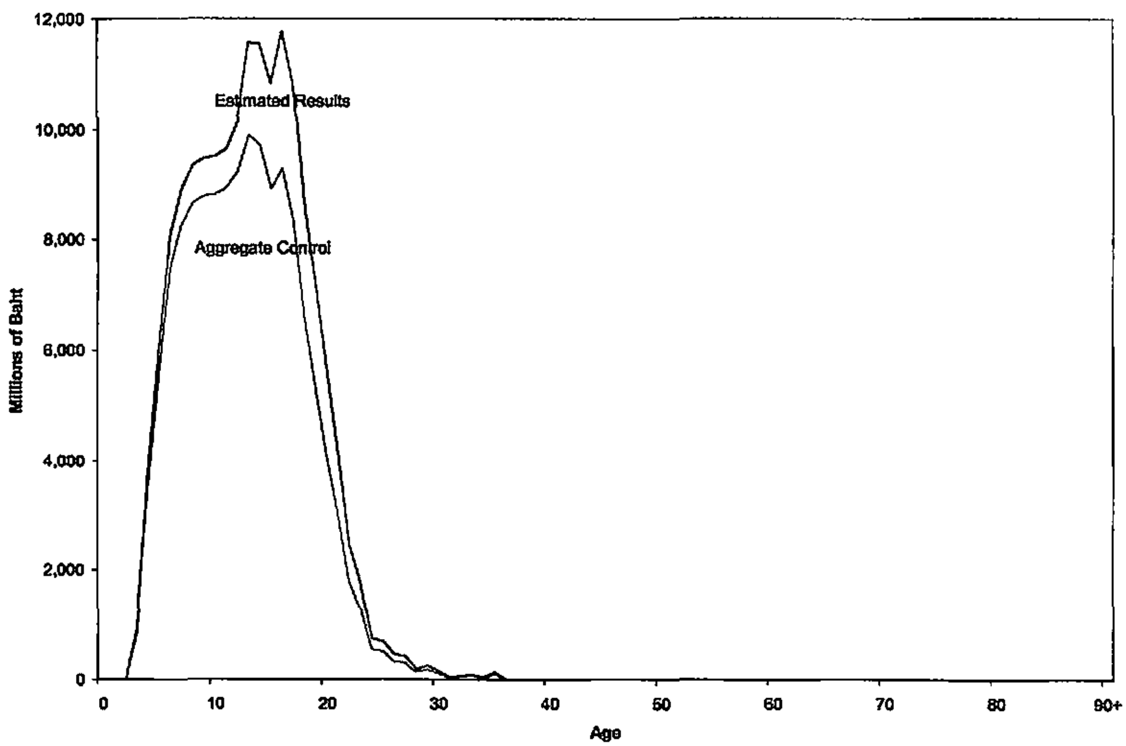
[2] The number of students in different education level is from the Statistical Yearbook Thailand (NSO 1999, Table 6.1).

[3] Informal education is allocated equally to everyone using population estimates from UN (2004).

There is an empirical problem that the total number of students by level tabulated from the SES is different from the number of students reported in the Statistical Yearbook Thailand. The difference between data of the SES and other government documents is primarily due to the difference in their estimation methods, which will not be discussed in this paper. The difference in the number of students by level leads to the difference between total education consumption per level estimated by the survey and the reported data. When public formal education consumption is summed by age $\sum_a E_g^f(a)$, the estimated aggregate public formal education consumption is not equal to the aggregate control of public formal education consumption of the NT Flow Account. Thus, the aggregate public formal education consumption by level estimated from the SES is adjusted proportionally to match with the aggregate control of public formal education consumption of the NT Flow Account.

Figure 2-1 compares aggregate public formal education consumption between "Estimated Results" from the SES and results after adjusting for "Aggregate Control" of the NT Flow Account. Estimated results from the SES overestimate aggregate control due to the problem described above. The adjustment method that makes estimated aggregate data consistent with the aggregate control of NT Flow Account is used throughout this paper.

Figure 2-1: Aggregate Public Education Consumption for Thailand in 1996 (Millions of Baht)



In addition to public formal education, public informal education consumption by age $E_g^{nf}(a)$ is estimated by dividing total public informal education consumption by total population by age. Public informal education consumption is non-age-targeted consumption, so it is allocated equally to everyone. Public education consumption by age is computed by adding public formal education consumption by age with public informal education consumption by age.

b. Public Health Care Consumption

The aggregate control of the NT Flow Account does not provide detail of public health care consumption for different uses. The National Health Accounts (NHA) of Thailand (Pongpanitch et al. 2005, Table 3.1) is instead used to allocate aggregate control of public health care consumption to different uses. The NHA reports that aggregate public health care consumption of 44 billion baht is allocated to inpatient care of 15 billion baht (34 percent), outpatient care of 9 billion baht (20 percent) and other public health care consumption of 20 billion baht (46 percent). Other public health care consumption is mainly public health programs, such as vaccination and other preventive health consumption.

Age profiles of inpatient and outpatient health consumption on the public sector are estimated separately. The SES 1996 has no information of the age profiles of inpatients and outpatients of public hospitals. The out-of-pocket health consumption expenditures reported in the SES are used as proxies for the public inpatient and outpatient health consumption expenditures. People usually share partial cost of public hospital. Thus, the age profiles of public inpatient and outpatient health consumption expenditure are assumed to be the same as the age profiles of out-of-pocket inpatient and outpatient health consumption expenditure. However, there is no information on the per capita out-of-pocket health consumption expenditures for the SES 1996. Per capita out-of-pocket health expenditures of inpatients and outpatients are tabulated from the special module on private individual health expenditure survey included in the SES 2002, assuming that age profiles of these health consumption expenditures in 2002 are the same as in 1996.

Other public health care consumption is allocated equally to everyone because most public health programs are for preventive care, which allows everyone to receive benefits from public health care consumption.

c. Public Other Consumption

Public other consumption is consumption of goods and services, such as defense, justice and police. Since public other consumption does not target specific age group, it is allocated equally to everyone.

ii. Private Consumption

The SES does not report consumption at the individual level. The SES reports consumption only at the household level. There are extensive studies of consumption allocation from the household level to the individual level, such as Deaton (1997), Maliki (2005), Lai (2006) and Lee et al. (2006). The method used to allocate household consumption to the individual level follows Mason et al. (forthcoming), distinguishing education, health and other consumption.

a. Private Education Consumption

Private education consumption includes consumption expenditures on tuition fees, uniforms, books and other education expenses paid by households. Individual education consumption is estimated using a regression model to allocate education consumption from the household level to the individual level.

Household education consumption CFE_j is regressed on the number of household members who are enrolled in school in each age group, starting from at age 3 to age group 17 and older $E_j(a)$. The SES reports whether any household members are enrolled in school. There are a number of children between ages 3-5 enrolled in kindergartens and between age 6-7 starting to enter primary schools. The education equation is estimated in homogeneous form, which guarantees that the household private education consumption is entirely allocated to enrolled persons. There is no distinction between boys and girls in this regression.

$$CFE_j = \sum_a \gamma(a) E_j(a) + \varepsilon_j \qquad 2.5$$

The coefficient $\gamma(a)$ from the regression equation is an estimate of the average education consumption of enrolled members at age group a, and it is assigned to individuals based on age and enrollment status. Those who are not represented in the equation are assigned a value of zero. Then, the total for coefficients in the household is calculated, and each household member is assigned a share of household expenditures. This share is then multiplied by reported household education consumption in the SES to measure the individual education expenditure. The individual education consumption of each member i in household j at age group a is estimated by

$$CFE_{ij} = CFE_j \frac{\hat{\gamma}(a)M_{ij}(a)}{\sum_i \hat{\gamma}(a)M_{ij}(a)}, \qquad 2.6$$

where $M_{ij}(a)$ is a dummy variable equal to 1 if member *i* in household *j* in age group *(a)* is enrolled, zero if not enrolled, and $\hat{\gamma}(a)$ are estimates from the regression equation 2.5.

b. Private Health Consumption

Household health consumption in 1996 is estimated as the sum of the product of per capita health consumption by age and the number of household members by age. Health consumption for household *j* is given by

$$H_j = \sum_a h_i(a)N_j(a) + \varepsilon_j \qquad 2.7$$

where *a* is individual age, $h_i(a)$ is health consumption for individual *i* at age *a* in 1996 and $N_j(a)$ is the number of members at age *a* in household *j* in 1996.

The SES 1996 does not report health consumption at the individual level but at the household level. The SES also has no information regarding the individual's health condition. The shortage of information in the survey makes it difficult to allocate household health consumption to the individual level. This paper uses information on per capita health consumption age profile reported in the special module of individual's health consumption of the SES 2002 to measure individual health consumption by age in 1996. Per capita private health consumption 1996 is modeled such that there is the cubic relationship between age in 1996 and health consumption by age in 2002. In addition, a dummy for individuals at age 0 is added to the health consumption equation in order to capture the characteristic of a high level of health consumption by newborns and cost of delivery. The newborns are usually subject to high mortality than nearby age groups, which could lead to higher health consumption. Thus, individual health consumption of member *i* at age group *a* in 1996 can be calculated as:

$$h_i(a) = (\beta_0 + \beta_1 a + \beta_2 a^2 + \beta_3 a^3 + \beta_4 x_0) m_i(a) \qquad \textbf{2.8}$$

where $m_i(a)$ is health consumption for an average individual at age *a* in 2002, x_0 is a dummy equal to 1 if individual's age is 0, equal to 0 if age greater than 0, and age variables in polynomial forms a, a^2 and a^3 are included to measure the relationship between individual health spending in 1996 and in 2002. Substituting individual health consumption by age in 2002 into the household health consumption equation, household health consumption in 1996 can be calculated as:

$$H_j = \sum_a (\beta_0 + \beta_1 a + \beta_2 a^2 + \beta_3 a^3 + \beta_4 x_0) m_i(a) N_j(a) + \varepsilon_j \qquad \textbf{2.9}$$

Household health consumption is regressed on all variables on the right-hand-side of the above equation. Then, coefficients are used to estimate individual health consumption. Predicted value of individual health consumption of member *i* at age group *a* in 1996 can be calculated as:

$$\hat{h}_i^*(a) = \hat{\beta}_0 m_i(a) + \hat{\beta}_1 a m_i(a) + \hat{\beta}_2 a^2 m_i(a) + \hat{\beta}_3 a^3 m_i(a) + \hat{\beta}_4 x_0 m_i(a) \qquad \textbf{2.10}$$

Similar to education consumption, this predicted individual health consumption is used to estimate the share of household health consumption on each individual. Consequently, household health consumption is allocated to each member by:

$$h_{ij}(a) = H_j \frac{\hat{h}_i^*(a) N_{ij}(a)}{\sum_i \hat{h}_i^*(a) N_{ij}(a)}, \qquad 2.11$$

where $N_{ij}(a)$ is a dummy variable equal to 1 if member i in household j is age a.

c. Private Consumption Housing and Other Consumption

Housing consumption is the imputed value of owner-occupied housing. Private consumption of other goods is total consumption less education, health and housing. Household consumption of housing and other is allocated to each member using *ad hoc* allocation rule based on an extensive review of the literature and other estimation methods[3]. The allocation rule is based on the assumption that individual consumption is proportional to an equivalence scale that varies by age; children consume less than adults, and consumption by children increases with age.

d. Indirect Taxes on Consumption

Indirect taxes on consumption, as shown in Table 2-3, are mainly taxes on private consumption of other goods. Indirect tax on consumption is deducted from private consumption of other to measure pre-tax consumption of individuals. These indirect taxes on consumption are mainly levied on three types of goods: tobacco, alcohol and other. These types of indirect taxes are allocated to individuals proportional to individual consumption on these different types of goods, assuming the tax rates of this indirect tax on consumption do not vary by age.

---

[3] Examples are Deaton (1997), Lai (2006) and Maliki (2005). For more details please refer to http://www.schemearts.com/proj/nta/web/nta/show/Documents/Flow%20Account%20Methods#H-84r1w3

There is distinction between consumption of tobacco and alcohol and consumption of other. Tobacco and alcohol are mainly consumed by adults. In contrast, other goods are consumed by individuals of all age groups. Thus, the estimation of indirect tax on consumption of these goods is separated. First, individual consumption of tobacco and alcohol is estimated using a regression method. The household consumption of tobacco and alcohol are regressed on the number of household members, by five-year age groups. Only adult members who are in the age group 15 and older (with an upper open age of 75 and older) for tobacco and age group 15-74 for alcohol[4] are included in the regression. Coefficients from the regressions are assigned to individuals according to their age group. Following the method used in the allocation of private education and health consumption, these coefficients are treated as shares of individual consumption relative to total household consumption. Second, individual consumption of other goods, such as vehicles and petroleum, is estimated using an equivalence scale method, similar to the allocation of private consumption of other.

iii. Labor Income

Labor income consists of two sources of incomes: compensation of employees (earnings) and the share of labor income from unincorporated enterprises. Aggregate control of these two sources of labor income is reported in Table 2-4. Following Mason et al. (forthcoming), the share of labor income from unincorporated enterprises is two-thirds, while the other one-third is the share of capital. In Thailand, both earnings and income

[4] When the oldest age group (75 and older) is included in the alcohol regression, its coefficient turns negative.

from unincorporated enterprises are reported in the SES at the individual level. Thus, earnings and two-thirds of income from unincorporated enterprises can be tabulated directly from the SES.

B. Age Reallocations: Public Transfers

i. Overview of Public Transfers

Public transfers are transfers from one age group to another through the public sector, combining the local and central governments. There are two counterparts of public transfers: public transfer inflows and public transfer outflows. From the point of view of individuals, inflows are benefits that people receive through the public sector, while outflows are taxes that people pay to finance public inflows. Total public outflows and inflows within the economy must sum to zero.

Public transfer inflows consist of in-kind transfers and cash transfers. In-kind transfer inflows consist of all goods and services produced by the government and consumed by individuals. Examples of public in-kind transfer inflows, shown in Table 2-7, include public education, public sector health care, defense, and other goods and services provided by the public sector. The total value of in-kind public transfer inflows is equal to public consumption. Cash transfer inflows consist of social security benefits and other cash transfers, which are monetary transfers directly to households or individuals, such as grants and social welfare. In addition to public transfers, Table 2-7 shows public saving, which is part of asset-based reallocations.

Table 2-7: Government Expenditures of Thailand in 1996

	Billion Baht
Public Transfers	**501**
In-kind Transfers	470
Education	144
Health	44
General Administration	100
Defence	110
Justice and Police	44
Special Welfare Services	4
Transport and Communication Facilitie	9
Other Services	14
Cash Transfers	31
Social Security Benefits	10
Other Cash Transfers	21
Public Saving	**431**
Disposal of Current Revenue	**932**

Source: National Income of Thailand (NESDB 2001, Account 5 and Table 6).

Public transfer outflows measure the transfers from individuals or households to the government that finance both in-kind and cash transfer inflows. For a government with a balanced budget or a budget surplus, outflows consist entirely of government revenues. For a government with a budget deficit, outflows consist of government revenues plus implicit taxes. Implicit taxes are the amount of money that the government, on behalf of taxpayers, borrows from investors, for example by issuing bonds, in order to pay the taxes necessary to finance public inflows.

Table 2-8: Government Revenues of Thailand in 1996

	Billion Baht
Tax Revenue	**863**
Personal Income Tax	112
Corporate Income Tax	176
Indirect Taxes	573
Less: Subsidies	12
Social Security Contributions	13
Non-tax Revenue	**69**
Income from Government Enterprises	66
Less: Interest Payment on Debt	9
Cash Transfers from the Private Sector	11
Net Transfers from Abroad	2
Current Revenue	**932**

Source: National Income of Thailand (NESDB 2001, Account 5)

For the government of Thailand in 1996, total revenues (932 billion baht), as shown in Table 2-8, are greater than expenditures of public transfers (501 billion baht). Thus, the government uses total revenue to finance public transfer inflows without creating implicit taxes. Total revenues consist of tax revenue and non-tax revenue. Examples of tax revenue are personal income tax, corporate income tax, indirect taxes less subsidies and social security contributions. Examples of non-tax revenue are income from government enterprises less interest payment on general government debt and plus net transfers from the private sector. Net transfer from abroad is public transfers received from abroad minus public transfers given to abroad. Tax incidence is discussed below.

According to the Revenue Department of Thailand, different types of taxes are levied on different sources of income. Personal income tax is levied on a person's chargeable income, which includes both cash income and in-kind income. Corporate income tax is levied on the company's net profit. Indirect taxes include various types of taxes, which are levied on production and consumption such as excise tax, value-added tax and specific business tax. Subsidies are contributions from the government to lower the production cost. Social security contributions are imposed on the wages of employees. Non-tax revenue does not have age-specific tax incidence. Income from property and enterprises of the general government is the revenue contributed from the state enterprises and the government monopolies. Current transfers from the private sector are, for example, fee, fines and penalties.

ii. Age Profiles of Public Transfers

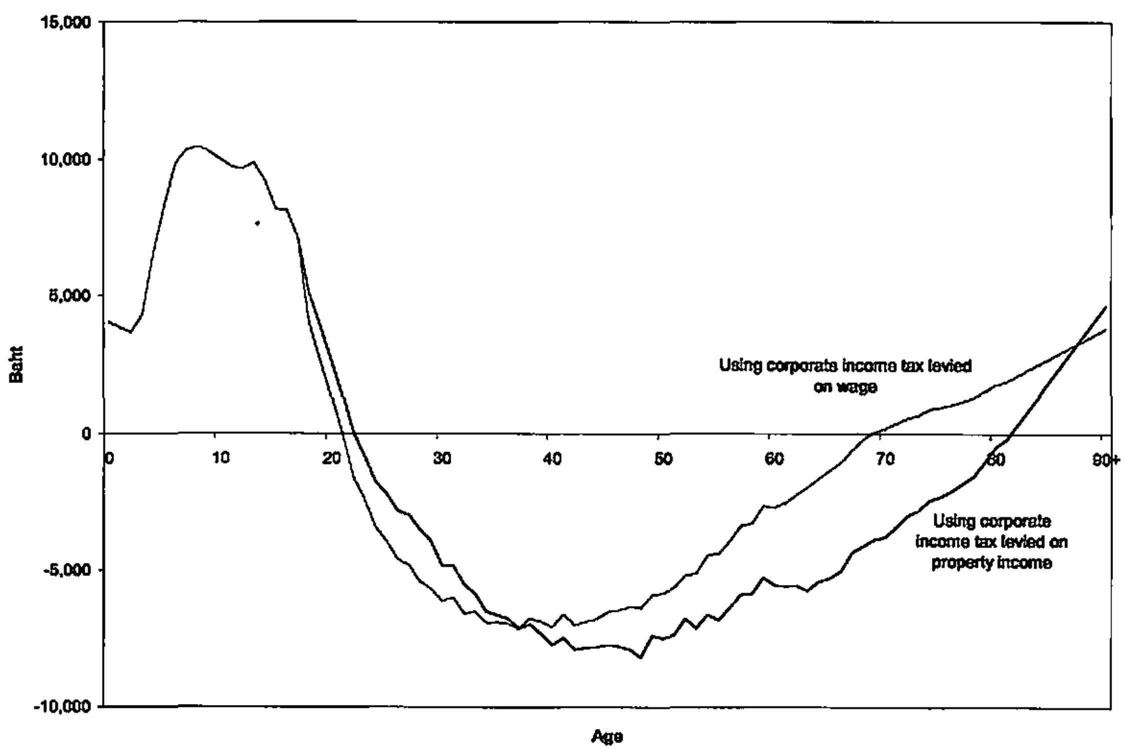
Public transfer inflows consist of public in-kind transfer inflows and public cash transfer inflows. Public in-kind transfer inflows are equal to government consumption expenditure. Estimation method of the age profile of government consumption is described in the lifecycle deficit section above. Public cash transfer inflows are social security benefits and other public cash transfers. The social security system in Thailand primarily provides health insurance for workers, with little or no benefits targeted to children and the elderly. Per capita social security benefit is estimated using the per capita private health consumption profile of workers. There is limited information regarding other public cash transfer inflow; thus, it is allocated equally to everyone. In addition to public transfers within the economy, there are flows provided by the foreign sector, such as foreign grants. Net public current transfers from the rest of the world are assumed to benefit everyone equally.

Public transfer outflows are tax payments and other government income. Following the approaches used to construct the NT Flow Account of the US and Taiwan by Mason et al. (forthcoming) and Generational Accounts (Auerbach et al. 1999), the age profiles of tax payments are estimated based on the assumption that the incidence of the tax falls on the entity that pays the tax. The age profile of personal income tax is estimated using household tax expenditures reported in the SES. Assuming the tax rate does not vary by age, taxes at the household level are allocated to individuals proportionally to individuals' income from wage, income from unincorporated enterprises and property income. Corporate income tax is allocated to individuals using property income age profile. Examples of indirect taxes are shown in Table 2-3, distinguishing indirect taxes borne by consumers and indirect taxes borne by producers. Indirect taxes borne by consumers follow the age profiles of different consumption goods, described in the private consumption section above. Indirect taxes borne by producers follow the age profile of income from property. Social security contributions are taxes on wages of employees. Consequently, the age profiles of personal income tax, corporate income tax, indirect tax and social security contribution constitute the age profile of general tax. Non-tax revenue is allocated to individuals proportionally to the age profile of general tax. Please note that individual's tax payment is estimated assuming that tax rate for each type of tax is independent of age.

There is a complicating issue in estimating corporate income tax. The age profile of corporate income tax can be estimated based on two different source of income: wage income or property income. The first method employed by the Generational Account of

Thailand uses wage income, claiming that the capital tax is borne by labor in a small open economy (Kakwani and Krongkaew 1999). The second method uses property income age profile to estimate corporate income tax, claiming that capital tax is borne by those who receive capital income, the approach mostly followed in Generational Accounts. The age profiles of net public transfers based on two different corporate income tax profiles are shown in Figure 2-2. The method using property income profile to estimate corporate income tax is used in this paper. This method is more commonly used to estimate corporate income tax by several studies to estimate the Generational Accounts and the NT Flow Accounts.

Figure 2-2: Per Capita Net Public Transfers for Thailand in 1996



C. Age Reallocations: Private Transfers

There are two kinds of private transfers: inter-household transfers (transfers between households) and intra-household transfers (transfers between individuals who live in the same household). In all cases net transfers are computed as the difference between two profiles, which are transfers received (transfer inflows) and transfers given (transfer outflows). Bequests are not estimated in this paper.

i. Inter-household Transfers

The survey reports transfers received from and given to other households. Examples of transfers given to other households are weddings, charity, funerals and other gifts to individuals outside a household. There is no detail of transfers received by people from different households. Further, there is no distinction between domestic transfers and foreign transfers. The SES reports transfers given at the household levels and transfers received at both the household and the individual levels. Transfers received and transfers given are assumed to flow between household heads.

Age profiles of inter-household transfers received and transfers given are estimated directly from the SES. However, these transfers require some adjustment since there is no information on the aggregate control of domestic transfers. National income account of Thailand reports only aggregate control of private transfers received from and private transfers given to abroad. Theoretically within the economy, inter-household transfers received have to equal inter-household transfers given. Thus, the difference between aggregate inter-household transfers received and inter-household transfers given have to equal aggregate net private transfers received from abroad.

The problem arises when the aggregate net private transfers received estimated from the SES are lower than the aggregate net transfers received from abroad reported in national income account. The problem is solved by inflating the aggregate net transfers received estimated from the SES to match with the net transfers received from abroad reported in national income account.

ii. Intra-household Transfers

Intra-household transfers measure transfers within a household unit. Aggregate net intra-household transfers are zero because transfers received by one household member are given by another member. However, net intra-household transfers in each age group are not zero. Some age groups have positive net intra-household transfers, while some have negative net intra-household transfers. There is no report on the intra-household transfers in the survey data. These values are computed based on the method described as follows.

Household members who consume more than their "disposable income" receive intra-household transfers from those who consume less than their "disposable income." Disposable income is defined as labor income plus net public cash transfers (cash inflows less taxes) plus net inter-household transfers. If a household has total disposable income of all members combined more than total consumption of all members combined, the surplus is transferred to the household head and saved. On the other hand, if a household has total disposable income less than total consumption, the household head makes additional intra-household transfers to finance this deficit by using asset income or by dis-saving.

Intra-household transfers to support current consumption, or non-durable goods such as education, health and other, are financed by imposing a household specific flat-rate tax on each member's surplus income. Within the household, each member is taxed at the same rate. The tax rate does not vary by age. In contrast, consumption for housing, or services for owner-occupied housing, by any non-head household member is financed by intra-household transfers from the head to the member. The amount of transfers is equal to the value of member's housing consumption. Consumption of housing is different from current consumption because, by assumption, the household head owns all household assets and all income generated by those assets flows to the head[5].

There is an empirical problem for measuring the aggregate intra-household transfers. Net intra-household transfers measured within a household are invariably zero. However, when the age profile of per capita intra-household transfers is multiplied by population by age, the aggregate intra-household transfers does not sum up to zero. This is due to the difference between the age structure of population reported in the survey and the age structure of population estimates by the UN.

---

[5] For more details, please refer to the website http://www.schemearts.com/proj/nta/web/nta/show/Documents/Private%20Transfers

In Thailand, the aggregate intra-household transfer inflows are greater than the outflows. This problem is solved by inflating the aggregate intra-household transfer outflows proportionally to match the aggregate intra-household transfer inflows.

D. Age Reallocations: Asset-based Reallocations

Asset income equals one-thirds of income from unincorporated enterprises and income from enterprises and property (aggregate control shown in Table 2-4). Age profiles of income from farm and non-farms enterprises, tabulated from the SES, are used to allocate the aggregate income of unincorporated enterprises to individuals across age groups. The property income profile, which consists of income from rent, interest, and dividends, is used to allocate income from enterprises and property. Following Mason et al. (forthcoming), only the household head[6] receives asset income.

Saving by age is estimated as a residual. Based on equation 2.2, saving is computed from income from asset $Y^a(a)$ plus transfer received $\tau^+(a)$ less transfer payments $\tau^-(a)$ plus labor income $Y^l(a)$ less consumption $C(a)$. Similar to private asset income, only the household head saves.

[6] Household head is defined as self-reported head, who is the person reported in the survey that he or she is the head of the household.

2.4 Results and Discussions

The National Transfer Flow Account for Thailand in 1996 estimated in this paper is shown in Table 2-9. The age-specific values are presented in broad age groups to facilitate discussion, but the underlying values are estimated by single-year of age. The results are consistent with the accounting identity shown in equation 2.2 that the lifecycle deficit is equal to age reallocations in total and every age group. Different age groups have different lifecycle deficits and they use different mechanisms to support their consumption. The components of the NT Flow Account estimated in the described methods are divided by population by age to present per capita values. All age profiles presented here are smoothed using "the super smooth method" or the *supsmu* command in "The R Project for Statistical Computing" (http://www.r-project.org; Friedman 1984).

Table 2-9: The National Transfer Flow Account, Thailand, 1996, Aggregate, Billion Baht

	Total	Domestic by age				
		0-19	20-29	30-49	50-64	65+
Lifecycle Deficit	**366**	**687**	**39**	**-425**	**-23**	**88**
Consumption	**2,429**	**751**	**544**	**759**	**260**	**116**
Public	470	246	74	93	37	19
Private	1,959	505	469	666	223	97
Less: Labor Income	**2,063**	**64**	**504**	**1,184**	**283**	**28**
Age Reallocations	**366**	**687**	**39**	**-425**	**-23**	**88**
Asset-based Reallocations	**346**	**5**	**35**	**146**	**88**	**72**
Income on Assets	1,372	0	85	789	358	140
Less: Saving	1,026	-5	50	643	270	68
Transfers	**20**	**682**	**4**	**-570**	**-112**	**17**
Public	2	177	-16	-113	-37	-8
Private	18	505	20	-457	-75	25
Inter-household Transfers	18	1	2	-7	11	11
Intra-household Transfers	0	504	19	-450	-85	13

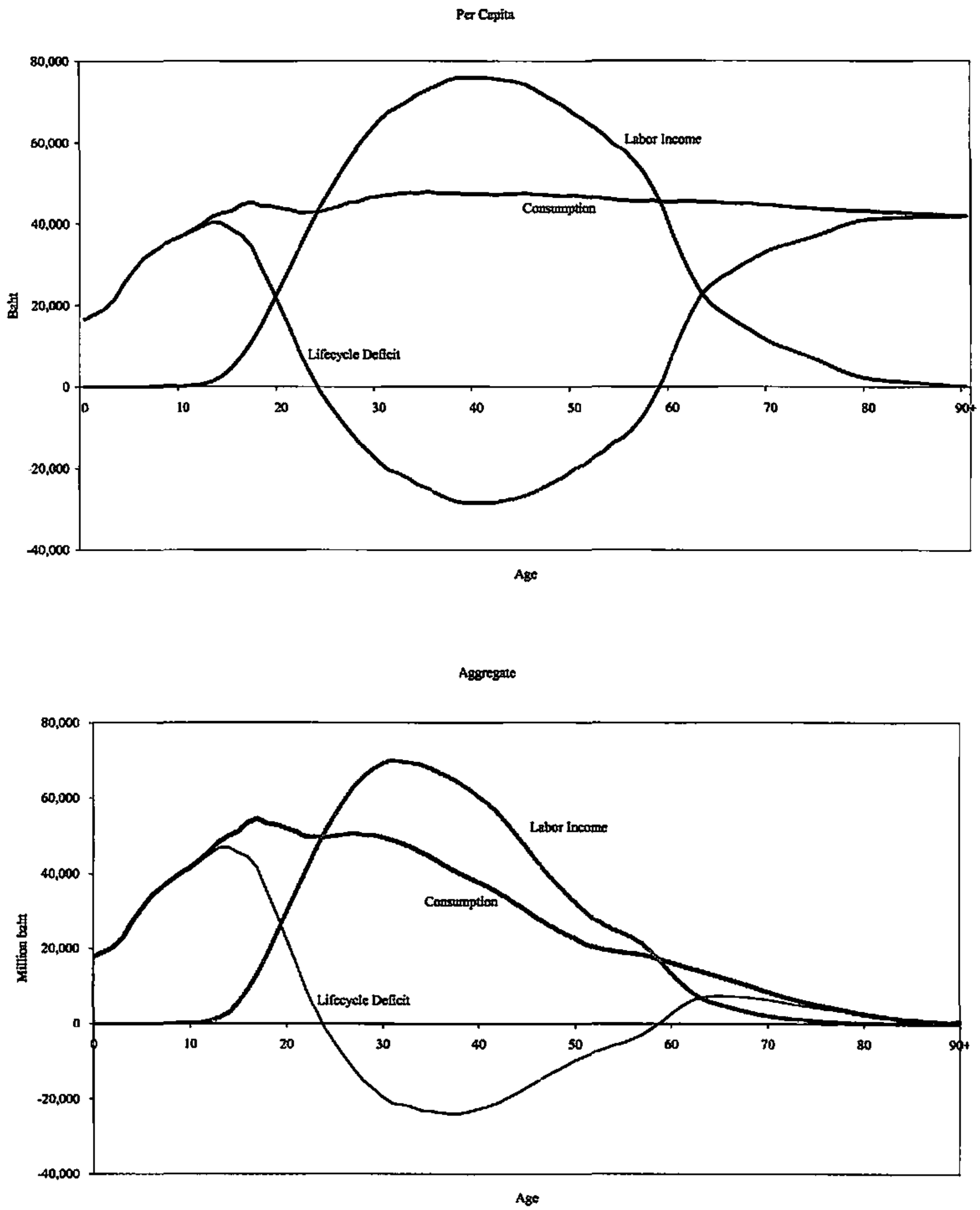
2.4.1 Lifecycle Deficit

Production, consumption and lifecycle deficit age profiles are shown in Figure 2-3 for both per capita and aggregate levels. Aggregate age profiles are useful to show the relationship between population age structure and the economic lifecycle. Please remind that the results are from cross-sectional data rather than cohort data.

Per capita labor income age profile of Thailand has an inverse U-shape. Per capita labor income profile of young workers increases with age, and it reaches a peak at around the ages of late thirties to early forties. Then, per capita labor income profile of old workers declines.

Despite concentrating among working ages like the labor income profile, per capita consumption profile is relatively flat across age groups. Per capita consumption profile is low among children, and then it increases steeply with age. Per capita consumption age profile slightly declines in the early twenties before rising to reach the peak in the early thirties. After reaching a peak, per capita consumption profile is relatively stable at older age groups.

Figure 2-3: Labor Income, Consumption and Lifecycle Deficit for Thailand in 1996



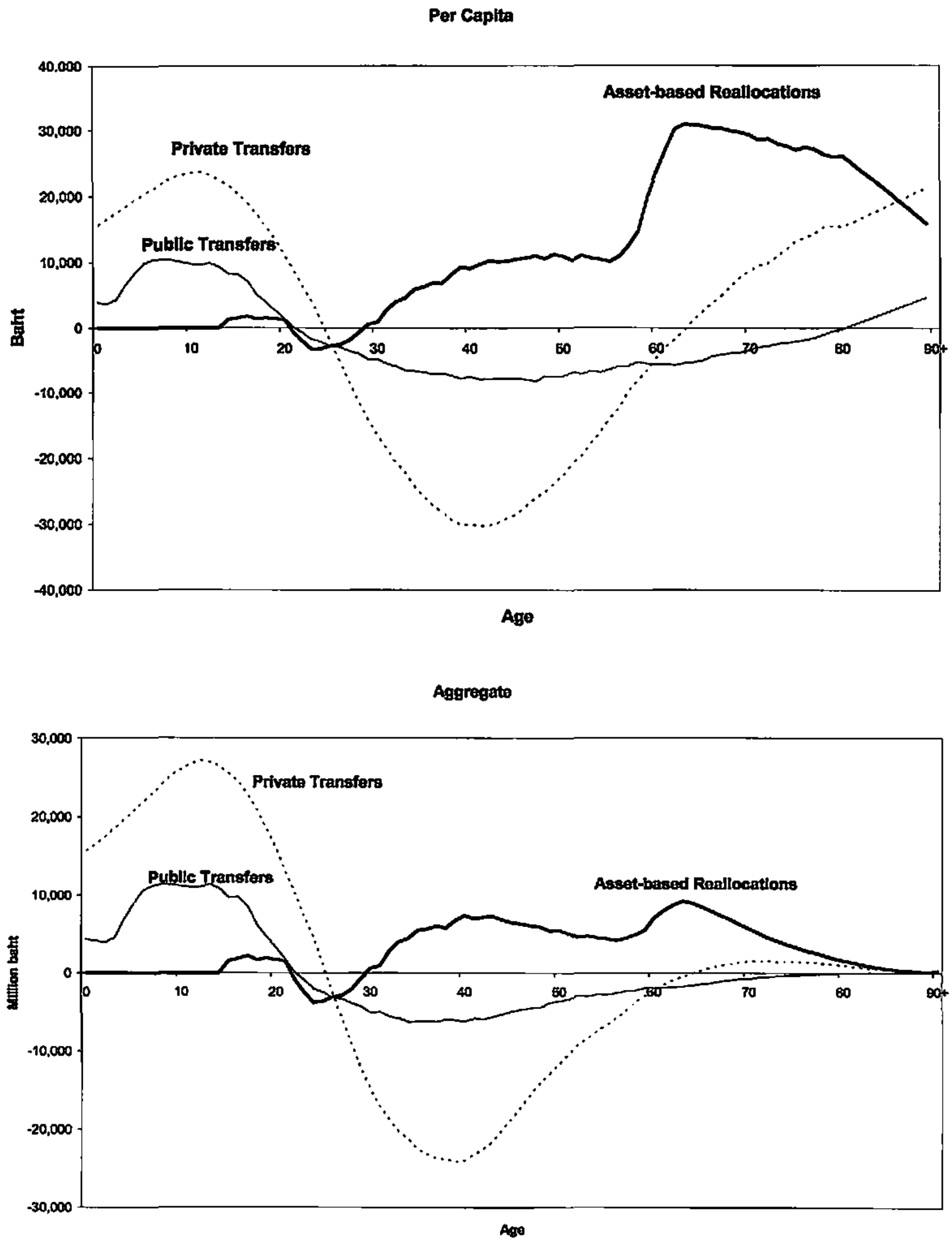
The lifecycle deficits of Thailand, both per capita and aggregate levels, show that children and the elderly consume more than they produce, resulting in large lifecycle deficits. The working age groups produce more than they consume, generating a lifecycle surplus. Per capita lifecycle deficits of young children increase with age and reach a peak at around ages 13-14. Per capita lifecycle deficits start to decline when young adults begin to earn labor income and partially support their consumption. The peak of per capita lifecycle deficit in Thailand is quite young compared to at around ages 15-17 in Taiwan and the US (Mason et al. forthcoming). The lifecycle deficit of Thailand turns negative to be lifecycle surplus at around age 24 when individuals produce more than they consume or become net producers. Per capita lifecycle surplus ages reach a peak in the mid-forties. After reaching a peak, a lifecycle surplus continually declines, which follows the fall in labor income for older workers. The lifecycle surplus turns positive back to be lifecycle deficit at around age 59 when individuals are no longer net producers. Then, per capita lifecycle deficits for the elderly continually increase. The span of years during which there is a lifecycle surplus for Thailand in 1996 is about 35 years. The span of lifecycle surplus years in Thailand is longer than what Mason et al. (forthcoming) found in Taiwan and the US, which is about 33 years in both countries.

Results for the lifecycle deficit are important to show the relationship between age structure and how much resources are produced and consumed by individuals across age groups. Age groups of dependents can be measured. Further, the findings show that aggregate lifecycle deficit in Thailand is concentrated among children more than the elderly. However, with population aging, aggregate consumption as well as lifecycle deficit may be higher for the elderly and lower for children. The results also imply that if population age structure is concentrated among lifecycle surplus ages, the economy will benefit from having higher production, leading to higher saving rates and economic growth rates. In addition, there could be more transfers from working ages to provide education and health care for children, which could increase productivity in the future. Despite having large portion of population among working ages, combined aggregate lifecycle deficits by children and the elderly in Thailand is greater than aggregate lifecycle surplus by about 366 billion baht in 1996.

2.4.2 Age Reallocations

There are three economic forms used to reallocate resources: asset-based reallocations (asset income minus saving), public transfers and private transfers. These age profiles are shown in Figure 2-4 for both per capita and aggregate levels. Children and the elderly rely on different support systems.

Figure 2-4: Per Capita Age Reallocations Profiles for Thailand in 1996



For children, familial transfers dominate their reallocations. Familial transfers to children in Thailand account for about 75 percent of child reallocations, whereas public transfers account for about 24 percent. It is not surprising that young children (younger than 15) do not rely on assets. Young children do not earn asset income. They also have limited access to the credit market; hence they cannot finance their consumption by acquiring debt. The reallocation system for young children is not addressed by the lifecycle hypothesis of saving. On the contrary, transfers are more important, which confirms Lee's model (Lee 1994a; Lee 1994b) that includes children in the economic lifecycle. In contrast to younger children, older children (ages 15-19) rely more on assets. Older children are able to access financial markets. Some of them may form a household and become household head around these ages, which allow them to accumulate assets and earn asset income[7].

The support systems for prime-age adults are mainly asset-based reallocations. Asset-based reallocations turn positive at around ages 29 and increase gradually with age. Asset-based reallocations increase rapidly around ages 59-64. These age groups may prepare for retirement period by increasing their saving. This finding is consistent with the lifecycle hypothesis that individuals rely on saving during their working ages to support their old age consumption. In addition to asset-based reallocations, prime-age adults provide large transfers through both the public and private sectors to other age

[7]Apart from receiving asset income and incurring debt, older children may receive private capital transfers or bequests from their parents. However, bequests are not estimated in this paper. Examples for private bequests for Taiwan and the US are shown in Mason et al. (forthcoming).

groups. The peak of net private transfers (negative) is at around the early forties. The peak of net public transfers (negative) is around the late forties.

For the elderly, asset-based reallocations dominate, but they continually decline with age. Asset-based reallocations account for about 81 percent of all old age reallocations, private transfers account for 28 percent, and public transfers account for -9 percent. Asset-based reallocations increase with age and reach a peak at the early-sixties. Consumption by people in this age group is almost entirely financed by asset-based reallocations, which is consistent with the lifecycle hypothesis of saving. However, after reaching the mid-eighties, the elderly receive lower asset-based reallocations than private transfers. Lifecycle hypothesis of saving is important, but it does not fully explain the consumption finance mechanisms for the elderly over the age mid-eighties. Private transfers turn to be the major source of support for the elderly in this age group. Public transfers to the elderly in Thailand are negligible. The results found in this paper that the elderly in Thailand receive small public transfers are consistent with the Generational Accounts for Thailand (Kakwani and Krongkaew 1999). However, there are some differences on the tax incidences used in this paper and in the generational accounts for Thailand. This paper uses private asset income age profile to estimate corporate income taxes, whereas the generational account for Thailand uses earnings age profile. If earnings age profile is used to estimate tax incidence, the elderly would pay less taxes and would receive slightly higher net public transfers.

The results show that intergenerational transfers significantly affect consumption by the elderly. Apart from income generated from assets, the elderly in Thailand have limited source of income. For example, social security system in Thailand is not so developed, which could allow the elderly to receive a constant flow of income until death. A decline in asset income could affect how the elderly finance their consumption. Despite a steep decline in asset-based reallocations of the elderly, consumption by the elderly does not decline so much. This finding is contrast to Hansen and Imrohoroglu (2006), claiming that in an absence of annuity market that allows individuals to receive a constant flow of income until death, consumption by the elderly will decline steeply as the elderly get older. Hansen and Imrohoroglu (2006) claim that consumption by the elderly declines because the elderly have lower asset income to finance their consumption. However, this paper shows that consumption by the elderly in Thailand does not decline much with a decline in asset-based reallocations because the elderly in Thailand receive larger support from their family and the public sector when they are older.

The support systems for individuals across ages are important to show how lifecycle deficits are financed and how economic flows are generated by lifecycle surplus ages. How consumption is financed during old ages has an important economic implication on economic growth and capital accumulation, described by Mason and Lee (2006) as the second demographic dividend. For example, if lifecycle deficits for the elderly are mainly financed by transfers, there is little incentive for the elderly to accumulate assets during their working ages, leaving no favorable effect to the economy. On the other hand, if old age support is mainly in the form of asset-based reallocations, working ages would plan to accumulate assets in order to support their old age consumption, leading to higher capital accumulation, saving rates and economic growth rates in the economy. The findings for Thailand that old age support is mainly in the form of asset-based reallocations imply that, with population aging, the economy would benefit from having higher capital accumulation.

2.5 Conclusions

This paper shows that economic lifecycle and support systems for individual across ages can be measured. The results also provide better understanding on the relationship between age structure and how resources are produced, consumed and reallocated within the economy.

For example, in Thailand in 1996, the age at which people begin to produce more than they consume or become net producers is 24, whereas the age at which people no longer produce more than they consume is 59. If there is a large population between 24 and 59, the economy would benefit from having larger production than consumption, leading to greater lifecycle surplus.

The results also show how lifecycle deficits for children and the elderly can be financed. Children and the elderly have different mechanisms to support their economic lifecycle. Children mainly rely on transfers from their family members more than the public sector. Familial transfers account for 75 percent of child reallocations, while familial transfers account for about 24 percent. For the elderly, the most important source of support for the elderly is asset-based reallocations. The elderly also rely largely on familial support but not as much as asset-based reallocations. Further, the elderly do not receive much net public transfers. This finding shows that old age support in Thailand is consistent with the lifecycle hypothesis of saving. People rely heavily on their accumulated assets to support their old age consumption. Asset-based reallocations account for about 81 percent of all old age reallocations, private transfers account for 28 percent, and public transfers account for -9 percent.

CHAPTER 3
ASSET-BASED REALLOCATION SYSTEMS

3.1 Background and Significance

Asset-based reallocations are major forms of the reallocation system. Individuals may accumulate and dis-accumulate assets throughout their lifecycle in order to smooth consumption in the current and future periods. Individuals also may receive income generated by holding these assets. There are different forms of assets that individuals in different age groups hold. Examples are capital, property and credit. Some forms of assets are used more by individuals in one age group than another. It is important to understand how much individuals rely on different forms of assets; however, there are few studies on this topic. The main contribution of this paper is to develop a methodology to estimate the relationship between age structure and different forms of assets individuals in different age groups hold to achieve their lifecycle plan.

There are important studies on how people in different age groups may have different motives to accumulate assets. Assets can be used to smooth consumption during old ages (Modigliani and Brumberg 1954; Modigliani 1988). People may accumulate assets in a form of precautionary wealth to buffer against income risk (Kennickell and Lusardi 2004; Carroll 1994; Deaton 1991). In addition, assets can be used to provide inter-vivo transfers (Kotlikoff and Summers 1981; Kotlikoff 1988) or bequests (Tomes 1981; Bernheim et al. 1985; Bernheim 1991) to younger ages.

These previous studies are important because they describe the relationship between age structure and asset holdings; however, assets, explained by most studies, are restricted to a form of saving. It is important to note that people in different age groups can save in different forms. For example, individuals may save by investing in capital or credit.

Based on Lee (1994a; 1994b), assets can be held in two forms: capital and credit. People in different age groups use capital and credit to smooth their consumption plan. There are important differences between capital and credit. People accumulate capital when they are young, and they can dis-accumulate it when old. Capital can be accumulated as a form of lifecycle wealth to provide old age support. On the other hand, people may accumulate or dis-accumulate credit when they are either young or old. Thus, credit transactions can be made either from old to young (i.e., student loans) or from young to old (i.e., credit card loans).

Following Lee's framework, Mason et al. (forthcoming) include asset income together with accumulation or dis-accumulation of asset to describe how individuals in different age groups rely on assets to achieve their lifecycle plan. Asset income is, for example, dividend, interest, rent and other non-labor income. This income is the returns to assets that individuals have accumulated, such as corporate stocks and government bonds. Changes in assets within a year through accumulation or dis-accumulation are called saving or dis-saving. Mason et al. (forthcoming) is an important literature that extends the literature on saving to present a broader perspective of how individuals in different age groups rely on assets. It is necessary to follow this framework and extend it to measure age profiles of different forms of assets. The results show that individuals at younger age groups rely on different forms of assets than individuals at older age groups to achieve their lifecycle plan.

This paper has two objectives. The first is to present the concept and principles of asset-based reallocations. The second is to estimate age profiles of asset-based reallocations, using Thailand in 1996 as a case study. Even though assets can be reallocated through the public and the private sectors, the primary focus of this paper is on the age reallocations of the private assets. The concept and estimation methods used in this paper rely on the National Transfer Flow Account (Mason et al. forthcoming; www.ntaccounts.org). The main contribution of this paper is on the development of the methodology used to estimate age profiles of public and private saving.

This paper is organized as follows. In section 3.2, concepts and principles of asset-based reallocations are presented. Section 3.3 presents how age profiles of asset-based reallocations are estimated in details. Results and discussion are shown in Section 3.4. Section 3.5 concludes this study.

3.2 Concept and Principles

Overview

Asset-based reallocations involve inter-temporal "exchange". Individuals acquire assets in one period, and they can earn income or dispose of assets in the future periods, allowing individuals to shift resources from one age to a different age. There are three forms of assets: capital, property and credit (or debt). Different forms of assets are used to support consumption by people in different age groups. This section presents similarities and differences among these forms of assets and how they are used by people in different age groups. The general concept used to explain asset-based reallocations relies on the concept of the National Transfer Flow Account[8] and the United Nations Systems of National Account or UN SNA (UN 1993).

From the point of view of the macroeconomy, there are major distinctions between capital, property and credit, but from the point of the view of the individual, they may be close substitutes as stores of wealth. For the macroeconomy, an increase in capital assets, by forgoing current consumption in order to increase the stock of reproducible capital in the present and the future, increases capital stock. Capital is productive, and it is generally a complement to labor, raising its marginal productivity. On the other hand, an increase in property and credit by people in one age group is always balanced by a decline in property and credit of another age group. Saving in these asset forms must be zero; no net increase is possible, in principle. There is an exception for credit or property owned by foreigners. For the individuals, capital, property and credit may differ, according to their risk and rate of return. In addition, there is a difference in how people in different age groups reallocate capital, property and credit. People acquire capital and property when they are young, and dispose of them when old. Capital and property can be used only to postpone consumption of resources to a later date. On the other hand, credit can be positive or negative (debt). People can reallocate credit either from younger

[8] Details are on the website http://www.schemearts.com/proj/nta/web/nta/show/Documents/Asset-based%20Reallocations

ages to older ages by lending, or from older ages to younger ages by incurring debt. In a sense, credit can be used to reallocate resources backward in time - from the future to the present - and from older ages to younger ages.

Despite the differences among capital, property and credit, reallocations through these three forms of assets similarly consist of two flows: outflows and inflows. Age groups achieve asset-based reallocation outflows in two ways: by saving, i.e., acquiring an asset, and by paying interest on accumulated debt. Age groups generate asset-based reallocation inflows by dis-saving, i.e., disposing of an asset, and by earning returns on their accumulated assets in the form of profits, property income, and interest income. Formally, asset-based reallocations can be measured as $rA(x) - S(x)$, where r is a rate of return to assets, A denotes stock of assets, S denotes saving, and x refers to age group.

The NT Flow Account methodology does not distinguish between capital and other non-financial assets, such as land. Thus, the accumulation of any non-financial asset is included in investment and all non-financial asset income is included in capital income. There are two forms of asset-based reallocations: capital and property-based reallocations (investment) and credit-based reallocations (intertemporal exchange). These two forms of asset-based reallocations differ in their macroeconomic effects and inter-generational features. Following the national accounts, saving and investment used in the NT Flow Account are net of depreciation.

Capital and property-based reallocations are achieved through investment, i.e., the accumulation of reproducible material wealth. Examples are the accumulation of equipment, vehicles, buildings, highways, ports, homes, land, and consumer durables. Net reallocations are equal to the difference between returns to capital and property and investment. Capital and property-based reallocations can be presented as $rK(x)-I(x)$, where K is stocks of capital and property and I is investment.

Credit-based reallocations involve transactions in which one age group lends economic resources to another age group, which in turn is obligated to repay the loan and agreed upon interest. Examples are student loans, credit card debt, interest income earned from credit accumulation, and dis-accumulation of the amount of credit outstanding. Net reallocations are equal to the difference between returns to credit and net lending. Net lending is the difference between saving and investment. Credit-based reallocations can be presented as $rM(x)-S^M(x)$, where S^M is net lending and M is stock of credit.

There is another important distinction between credit transactions and investment particularly when assets are owned indirectly through financial intermediaries. Credit transactions can be used to finance investment when savings by one age group in financial intermediaries are borrowed by another age group to accumulate capital stock. This adds complexity to defining and to estimating which age groups are investing, which are accumulating credit and debt, and which are accumulating and dis-accumulating land. Based on the principle of the NT Flow Account, net saving by individuals is classified by the ultimate use of the funds. Thus, when debt is used to finance consumption this is classified as a credit transaction. Credit transactions refer exclusively to loans that are used to finance consumption, not to finance the acquisition of new or existing capital or the acquisition of existing land. When debt is used to finance investment this is classified as a capital transaction, i.e., the lender is accumulating capital. The interest income subsequently received is counted as a return to capital, i.e., as capital income.

Similar to domestic credit transactions, net borrowing from abroad, used to invest in the domestic, economy is considered as net investment rather than a credit transaction. For example, if an economy invests more than it saves, it needs to borrow from abroad to finance excess investment. This part of investment is owned by foreigners from the point of view of the NT Flow Account. On the other hand, if individuals borrow from abroad to finance consumer debt, this loan is part of a credit transaction and foreigners own consumer credit.

Further, asset-based reallocations can be measured as public and private asset-based reallocations. A fundamental distinction between public and private assets is that private assets are accumulated as a matter of individual choice, whereas public assets are accumulated as a matter of collective choice.

Public Asset-based Reallocations

Income on public assets consists of income from public capital and public credit. Based on the System of National Accounts (SNA), public capital does not produce income. Thus, public capital income is zero at all ages. Public credit income includes the flows to creditors and from debtors. The aggregate public credit income is zero because credit income received by one party is always matched by credit expense (negative credit income) for another party. However, net public credit income (credit income less credit expense) in each age group is not necessarily equal to zero. Age reallocations can occur only to the extent that the parties on either side of the transaction belong to different age groups. Based on the NT Flow Account, these parties are taxpayers and investors. If the government is a net debtor (creditor) then public credit income for taxpayers is negative (positive) and public credit income for investors is positive (negative). Even though total public credit income must always be zero, domestic public credit income can be positive (negative) if the government is a net creditor (debtor) to the rest of the world.

Public saving consists of three components: public investment, public lending, and net public bequests. Public investment is a change in public capital. Public lending is a change in public credit. Public bequests are intergenerational transfers of public assets, consisting of public capital bequests and public credit bequests.

First, public investment is net investment defined as gross investment plus capital transfers less depreciation. Public investment includes the accumulation of publicly-owned capital, the acquisition of land and other non-financial assets. The relationship between public capital stock and public investment is

$$K(t) = K(t-1) + I(t) + X(t) \qquad 3.1$$

where $K(t)$ is the capital stock at the end of the period, $I(t)$ is net investment during the period, and $X(t)$ is *other economic flows* during the period. Other economic flows consist of *holding gains*, which arise because of changes in prices, and *other volume changes* due to exceptional events, e.g., natural disasters and wars; normal events such as the discovery of a subsoil asset or changes in the liability of a defined benefit pension plan resulting from a change in the benefits covered; and reclassifications of units to exclude or include them as part of general government (Government Finance Statistics Manual 2001 Chapter 4, Section G).

Estimates of other economic flows may or may not be available. Based on the NT Flow Account methodology, other economic flows are calculated as a residual. It should be compared with the value reported in national accounts if available. If not, it should be evaluated based on information that is available. For example, other economic flows will be substantial in a country in which general prices (including assets prices) are rising rapidly.

Second, public lending is measured as the changes in the amount of public credit (or debt) held by taxpayers. For example, if the public sector invests more than it saves, it needs to borrow from investors[9] on behalf of taxpayers, i.e., by issuing government bonds. Then, public lending is negative and the amount of public debt held by taxpayers increases. There are two transactions that occur when taxpayers borrow from investors, which are an inflow to taxpayers and an outflow from investors (domestic investors or investors from the rest of the world). Only the transaction for taxpayers is a part of public saving. The one for investors is a part of private saving, which will be explained below. Total inflows are always equal to total outflows because an increase in credit by one age group is matched by an increase in debt by another age group.

The relationship between public lending and public credit is conceptually the same as described above for public capital. Public credit at the end of the year is equal to the sum

[9] Note that some credit transactions are between the governments and parties that are not investors, e.g., students. The term "investors" as it is used here is intended broadly to include all parties except taxpayers who acquire public credit and debt.

of (a) public credit at the beginning of the year; (b) public lending; and (c) other economic flows. Other economic flows consist of holding gains, which arise because of changes in prices and foreign exchange rates, for example; and other volume changes that arise because of debt forgiveness and changes in liabilities associated with defined benefit pension plans, for example. Other economic flows are calculated as a residual and the result should be compared with the value reported in National Income Accounts, if available, and carefully evaluated.

Third, net public bequests occur because current generation of taxpayers acquires existing public capital and public credit (debt) created by previous generations of taxpayers. Public capital and credit held by age groups changes over time because existing capital and credit is transmitted from one generation to the next. Aggregate net public bequests are zero because bequests received by one age group are matched by bequests given by another age group. However, net public bequest at each age group is not necessarily equal to zero. In order to estimate net public bequest at each age group, the flow account is based on the assumption that each age group holds public capital and credit in proportion to its share of general taxes, i.e., public capital own by age group *a* in year *t*, *K(a,t)*, is computed from a share of general taxes from age group *a*. As the share of taxes paid by a cohort increases, its holding of public assets and liabilities increase. The increase comes in the form of a bequest from cohorts experiencing a decrease in their share of public assets and liabilities. Given the capital stock and investment by age, public capital bequests for each age group, *B(a,t)*, are measured as the change in public capital stock a cohort owns between two periods less public net investment less other economic flows, i.e.,

$$B(a,t) = K(a,t) - K(a\text{-}1,t\text{-}1) - I(a,t) - X(a,t) \qquad 3.2$$

Other economic flows by age are based on the assumption that the proportion between other economic flows by age and capital stock for the same age group in the previous year is fixed for all age groups, i.e., $x(a,t) = X(a,t)/K(a\text{-}1,t\text{-}1)$. Thus, bequests by age can be shown as:

$$B(a,t) = K(a,t) - [1+x(t)]K(a\text{-}1,t\text{-}1) - I(a,t) \qquad 3.3$$

The same concepts are used to construct an estimate of bequests of public credit.

Private Asset-based Reallocations

Private asset income consists of capital income and credit income. Capital income is generally a large portion of asset income. Distinguishing components of capital income is useful because they have distinctive age profiles that can be estimated using income data that are often available. There are two major components of capital income. First, mixed income is return to capital invested in individual proprietorships and other unincorporated businesses including farms. Second, operating surplus is return to capital invested in corporations, including imputed rent of owner-occupied housing. In addition to mixed income and corporate income, rent, the return to land and sub-soil assets, is also included to capital income. The second component of private asset income is credit income, which is return to consumer credit, i.e., loans that finance consumption only. There are two components of net consumer credit income: interest payment on consumer debt and interest income from consumer credit. Aggregates interest income and interest expenses are equal; however, domestic interest income can be less than domestic interest expenses if foreigners are net creditors and earn income flows from the domestic economy.

Private saving consists of three components: private investment, private lending to the public sector and net private lending to consumers. First, private investment is net investment defined as gross private investment plus capital transfers less depreciation. Net private investment is the accumulation of private capital, land and other non-financial assets. Similar to how to measure public capital stock, private capital stock at the end of the period equals private capital stock at the beginning of the period plus net investment during the period. Second, private lending to the public sector is an increase in public credit (debt) held by investors. This part is the counterpart of public lending by taxpayers (public saving). As mentioned above, when investors lend to taxpayers, i.e., by purchasing government securities, there is an outflow from investors. Investors save by investing through the public credit. Third, net private lending to consumers is the change in the amount of consumer credit. This part is a credit transaction for consumer credit, which does not involve capital accumulation. There are two parties involved in consumer credit transactions: the ones who lend money to consumers and consumers who receive money. Net private lending is measured as private lending to consumers minus private borrowing by consumers. Aggregate net private lending is zero because private lending equals private borrowing. The rest of the world may have positive net private lending if money flows from abroad to domestic consumers is greater than money flows from domestic to foreign consumers.

3.3 Estimation of Asset-based Reallocations

There are three sources of data used to estimate details of the age profiles of asset-based reallocations for Thailand. First, the aggregate controls of asset income, saving and their components are from National Income Account of Thailand (NESDB 2001) and the Flows-of-Funds Account of Thailand (NESDB 2003). Second, the 1996 Socio-economic Survey (SES) is used to estimate age profiles. Third, population by age is from the estimates of the UN (2003).

The age profiles of different types of asset-based reallocations are estimated, distinguishing the public and private sectors. In each sector, the discussion starts with the aggregate controls, which are derived from the government documents and adjusted to maintain consistency with the national accounts. Then, the estimates of age profiles of asset income and saving are explained.

3.3.1 Estimation of Public Asset-based Reallocations

Aggregate Control

Public asset income consists only of public net interest income. Aggregate public net interest income is zero as interest income received from one age group is matched by interest expenses from another. Domestic net interest income is not zero because some part of interest income or expense can be from abroad. Foreigners who pay taxes are assumed by the NT Flow Account methodology to own part of public assets proportionally to their share of general taxes. The foreign share of general tax revenues may be positive if indirect taxes are paid by rest of the world (ROW). An example would be value-added tax (VAT) paid by foreign tourists although some portion of VAT is often refunded to foreign visitors. In addition, foreign investors may purchase government securities and earn interest income. It is important to measure how much foreigners are affected by public credit transactions, i.e., how much foreigners hold government securities to receive interest income and how much they pay taxes that finance interest expense. However, this information is not available. Relying on the speculation based on government documents (BOT 2000), the share of government securities held by foreigners and the share of general taxes paid by foreigners are assumed to be about 10 percent and 3 percent, respectively. Public interest income shown in Table 3-1 is about 9 billion baht in 1996, which is negative for taxpayers and positive for investors since the government is a net debtor. In addition, foreigners receive interest income more than they pay taxes to finance interest expenses, resulting in positive net interest income for the foreign sector of about 660 million baht[10].

[10] The results can differ depending on the share of foreigners who own government securities and their share on general taxes.

Table 3-1: Aggregate Public Asset-based Reallocations, Thailand 1996, Million Baht

	Total	Domestic	Foreign
Public asset-based reallocations	**-431,404**	**-419,122**	**-12,282**
Public asset income	**0**	**-660**	**660**
Public capital income	0	0	0
Public credit income	0	-660	660
Public credit income, taxpayers	-9,429	-9,146	-283
Public credit income, investors	9,429	8,486	943
Less: Public saving	**431,404**	**418,462**	**12,942**
Public investment	254,031	246,410	7,621
Public lending, taxpayers	177,373	172,052	5,321
Public bequests, net	0	0	0

Sources: National Accounts (NESDB 2001) and Flows-of-funds Account (NESDB 2003)
Note: there is no information regarding to shares of the foreign sector. Numbers presented here are speculated from general information reported in the Balance of Payments (BOT 2000) and Statistical Yearbook (NSO 2001).

Public investment is about 254 billion baht. Public investment is a major part contributing to an increase in public capital stock from 2,499 billion baht at the beginning of the year 1996 to 2,925 billion baht at the end of the year. Other economic flows are about 172 billion baht, which is another factor leading to an increase in public capital stock.

Public lending is about 177 billion baht. Public lending is positive because the government invests less than it saves. There are two transactions for public lending. The first transaction is a part of public saving when the government pays back loans to investors and reduces public debt. The second transaction is a part of private saving, which is included in private asset-based reallocations below, when investors dis-save because their holdings of public credit decline as the government pays back loans. In 1996, public debt declined from about 192 billion baht at the beginning of the year to about 175 billion baht at the end of the year. The rest of the change in public debt is due to other economic flows, similar to what is described for public capital.

The other part of public saving is public bequests, which aggregate to zero. Bequests received by one age group are given by another age group. There is no net increase in the economy.

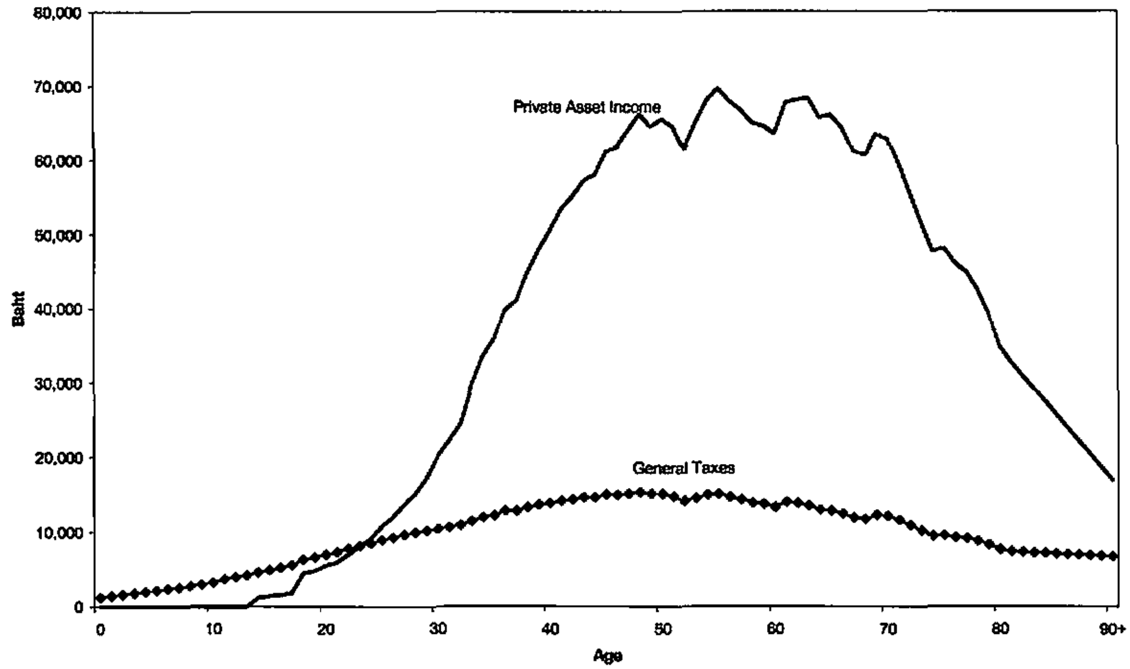
In addition to public investment and public lending by residents, foreigners who pay taxes also invest, lend and own some part of public capital and public credit proportionally to their share of general taxes. For simplicity, foreigners do not involve in public bequests.

Estimation of Age Profiles of Public Asset-based Reallocations

The age profile of public net interest income is measured as the difference between the age profiles of public interest expense and public interest income. The age profile of public interest expense is measured as the age profile of taxpayers. Public debt is owned by taxpayers, thus taxpayers are responsible to finance the debt. The per capita profile is based on general tax payments, i.e., taxes used to fund general government spending including the payment of interest on public debt. The age profile of public interest income is proportional to the age profile of private asset income. The age profile of private asset income is used to determine the age distribution of private investors in government securities. By assumption the private asset portfolio is independent of age. Per capita age profiles of private asset income and general taxes are shown in Figure 3-1, which determine the shape of the age profiles of public interest income and interest expense. The shapes of these two age profiles are mainly different among children and the elderly because children and the elderly pay taxes, mainly consumption taxes, but children do not earn asset income.

The age profile of public saving includes the age profiles of public investment, public lending, and public bequests. The age profiles of public investment and public lending follow the age profile of general taxes. The age profiles of public bequests include the age profiles of public capital bequests and public credit bequests. The estimation method for the age profile of public capital bequests follows Equation 3.3. There are three age profiles required to estimate the age profile of bequests: the age profiles of public capital in the current year, the age profile of public capital the previous year and the age profile of public net investment. The age profiles of public capital in the current year and public net investment follow the age profile of general taxes. The age profile of public capital in the previous year follows the age profile of general taxes in the previous year. However, there is no estimate for the age profile of general taxes for the year 1995 because the SES was not conduct in that year. The age profile of general taxes in 1996 is used to estimate public capital by age in 1995. The estimation method for the age profile of public credit bequests is similar to public capital bequests.

Figure 3-1: Per Capita Age Profiles of Private Asset Income and General Taxes, Thailand, 1996



3.3.2 Estimation of Private Asset-based Reallocations

Aggregate Control

Private asset income consists of two major parts: private net credit income and private capital income and rent. Private net credit income is the difference between private interest income and private interest expense. Aggregate interest income equals aggregate interest expense (about 62 billions baht) since income received by one age group is an expense by another age group. The main difference is on the shares of foreigners who receive interest income and pay interest expense, which are assumed to be 7 and 5 percent respectively, based on speculation from net property income earned by foreigners reported in the balance of payments (BOT 2000). Private capital income and rent is a major part of private income, which is about 1,372 billion baht. The share of foreigners who receive asset income is assumed to be 10 percent, also based on speculation from the balance of payments (BOT 2000).

Table 3-2: Aggregate Private Asset-based Reallocations, Thailand 1996, Billion Baht

	Total	Domestic	Foreign
Private asset-based reallocations	**777**	**654**	**123**
Private asset income	**1,372**	**1,234**	**138**
Private net credit income	0	-1	1
Private interest income	62	58	4
Private interest expense	-62	-59	-3
Private capital income and rent	1,372	1,235	137
Less: Private saving	**595**	**580**	**15**
Private investment	772	749	23
Private credit transactions	-177	-169	-8
Private lending to the public sector	-177	-169	-9
Private net lending to consumers	0	-1	1
Private lending to consumers	80	77	3
Private borrowing by consumers	-80	-78	-2

Sources: National Accounts (NESDB 2001), Flows-of-funds Account (NESDB 2003) and Reports for household socio-economic surveys (NSO 1994, 1996)
Note: Similar to the public sector, the shares of foreign sector for private asset-based reallocations are speculated from general information reported in the Balance of Payments (BOT 2000) and Statistical Yearbook (NSO 2001).

Private investment is about 772 billion baht, calculated as the difference between net private capital accumulation of about 1,120 billion baht and net private borrowing from abroad to finance domestic saving-investment gap of about 348 billion baht. Further, private investment increases private capital stock at the end of 1996 to the level at 9,202 billion baht. The share of foreign investment is assumed to be about 3 percent of total investment, based on speculation from balance of payments (BOT 2000).

Private net lending to consumers consists of two parts: private lending to consumers and private borrowing by consumers. Private lending to consumers is positive, whereas private borrowing by consumers is negative because consumers accumulate more debt.

Consumer debt increases to about 432 billion baht by the end of 1996. Aggregate comes from the SES, which reports consumption loans in the households. An increase in consumer loans by about 80 billion baht is computed from averaging the difference between consumer debt reported in the SES 1994 and 1996.

Estimation of Age Profiles of Private Asset-based Reallocations

Age profiles of interest income and interest expense from the SES are used directly to allocate aggregate domestic credit income and credit expenses by age. Age profile of capital income and rent is computed from age profiles of interest, rent, dividends, capital's share of mix income and other non-labor income, which is described above in Chapter 2.

Age profile of private saving consists of four age profiles: age profiles of private investment, private lending to the public sector, private lending to consumers and private borrowing by consumers. Only age profile of private borrowing by consumers can be estimated directly from the SES, using age profile of interest expense to allocate domestic private borrowing by age. The other three age profiles are estimated as the difference between different types of assets a cohort accumulates or dis-accumulates within a year. There are several steps used to estimate age profiles of different types of assets, which are explained as following.

The first step is to estimate age profile of private asset in year t. Total assets by age can be estimated using asset income age profile, i.e., $A(x,t) = \gamma(x)P(x,t)$; where $\gamma(x)$ is age profile of private asset income and $P(x,t)$ is population age group x in year t. The second step is to estimate age profiles of three different types of assets: private capital, public credit (accumulation of private lending to the public sector) and consumer credit. Based on assumption from the NT Flow Account, the portfolios of the components of private assets are independent of age. Thus, total assets are allocated proportionally to the amount of different types of assets, i.e., $A(type,x,t) = A(x,t) * A(type,t) / A(t)$. The third step is to estimate total assets by age in the previous year $(t-1)$. Assets by age in year $t-1$ are computed as assets by age in year t minus saving by age in year t, i.e., $A(x-1,t-1) = A(x,t) - S(x,t)$. Saving by age is estimated as residual in the NT Flow Account, which is explained in Chapter 2. The fourth step is to estimate age profiles of different types of assets in year $t-1$. Using the same assumption that age profiles of components of assets are independent of age, total assets in year $t-1$ can be allocated proportionally to different types of assets, i.e., $A(type,x,t-1) = A(x,t-1) * A(type,t-1) / A(t-1)$. Finally, different types of saving in year t can be computed as the difference of assets for a cohort between 2 years, i.e., $S(type,x,t) = A(type,x,t) - A(type,x-1,t-1)$.[11]

3.4 Results and Discussions

Aggregates asset-based reallocations by age are estimated using the methodology described above. When aggregates by age are divided by population by age, the results show per capita age profiles of asset-based reallocations, distinguishing public and private asset-based reallocations.

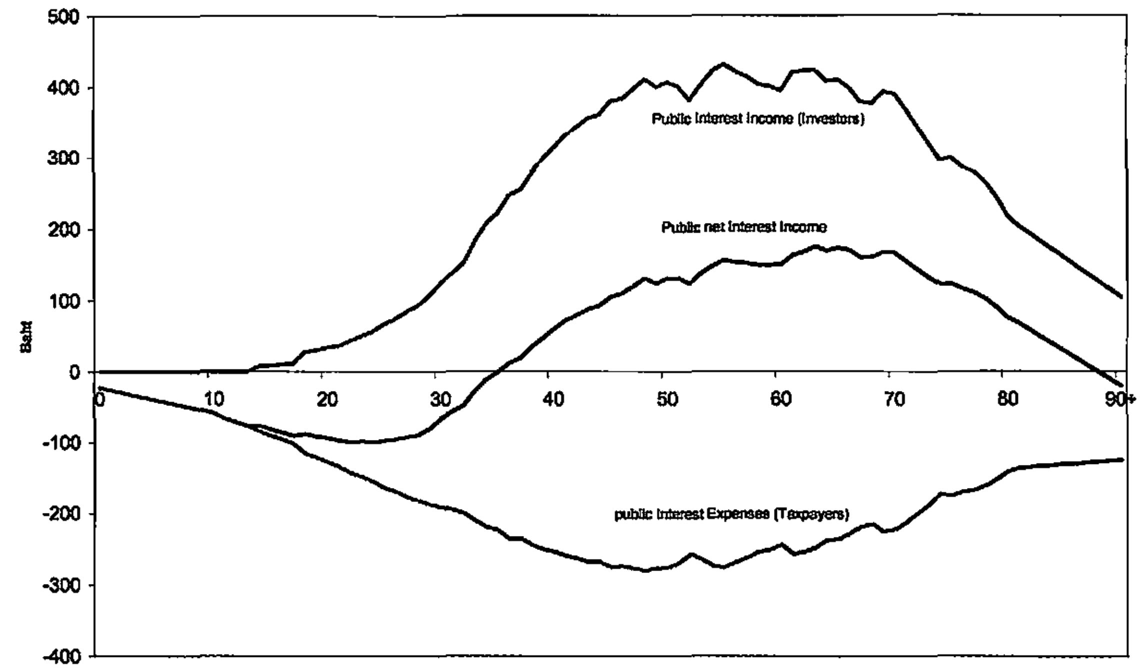
[11] Changes in asset prices are not included in this calculation.

3.4.1 Public Asset-based Reallocations

Public asset income

Public interest income received by investors increases with age and reaches the peak around ages 50-65 as shown in Figure 3-2, which its shape is the same as age profile of private asset income. Children do not earn public interest income. Public interest expense also increases with age and reaches the peak (negative) around ages 45-50, which its shape is the same as age profile of general taxes. The major difference between these two age profiles is that children pay taxes as part of their consumption taxes to finance interest expense, but they do not earn interest income. Net public interest income is negative among children and positive among adults. Thus, age reallocations for public interest income are from younger age groups to older age groups. Net interest income turns positive at around age 35 and increases with age before declining at around age 70. The elderly ages over 70 receive much lower interest income and they also pay lower taxes; however, the decline in interest income is steeper than the decline in tax payments, leading to lower net interest income.

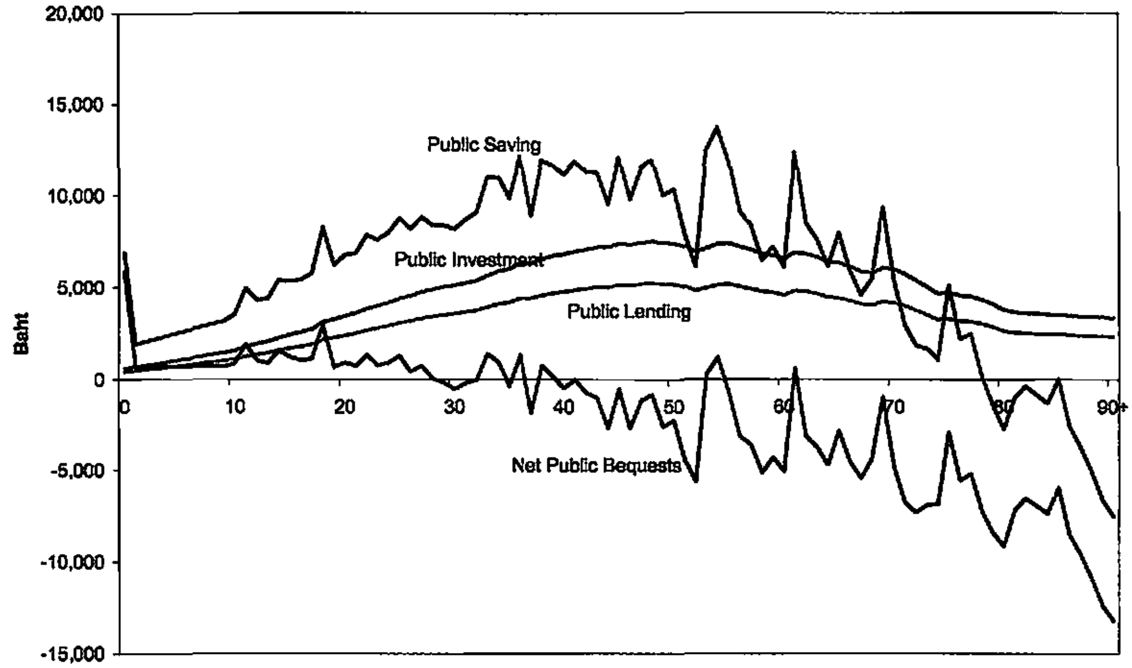
Figure 3-2: Per Capita Public Interest Income, Thailand, 1996



Public saving

Figure 3-3 shows that public investment and public lending are small for children, increase with age and fall after about age 55, which follow age profile of general taxes. The results show that individuals reallocate public assets through investing public capital and lending public credit more as they are older. However, their reliance on public investment and public lending declines as they approach retirement ages. Hence, it can be shown that individuals during working ages in Thailand saved in 1996 through public investment and public lending more than those during retirement ages.

Figure 3-3: Per Capita Public Saving, Thailand, 1996



As opposed to taxpayers, investors lend to the public sector as a part of their saving, which is included as private lending to the public sector in private saving below. Investors who lend to the public sector receive flows from taxpayers when taxpayers pay back loans. Investors dis-save, while taxpayers save. Private lending to the public sector can be combined with public lending by taxpayers in order to measure net flows. The results show that saving by taxpayers is greater than dis-saving by investors during younger ages; however, dis-saving by investors is greater than saving by taxpayers at older ages. Thus, individuals reallocate assets through lending to the public sector by saving at younger ages and dis-saving at older ages.

Public bequests are much different from public investment and public lending, and bequests influence the shape of age profile of public saving. Newborns receive large positive public capital bequest. The government accumulates more capital yearly, which can be transferred to younger cohorts. Conversely, newborns receive negative public credit bequest. The government is a net debtor, which it transfers debt (negative credit) to younger cohorts. However, public capital bequests are much larger than public credit bequest, resulting in large and positive net public bequests. Net public bequests decline with age as the size of taxpayer cohorts decline. Net public bequests turn negative at around ages 30-40. This result shows that younger taxpayers save, while older taxpayers dis-save. Public bequests are reallocated from younger ages to older ages in Thailand. The shape of per capita age profile of public bequests is not smoothed because it follows the change in the size of population cohorts between two periods. Population estimates are not smoothed for cohorts, resulting in the unsmoothed age profile for public bequests.

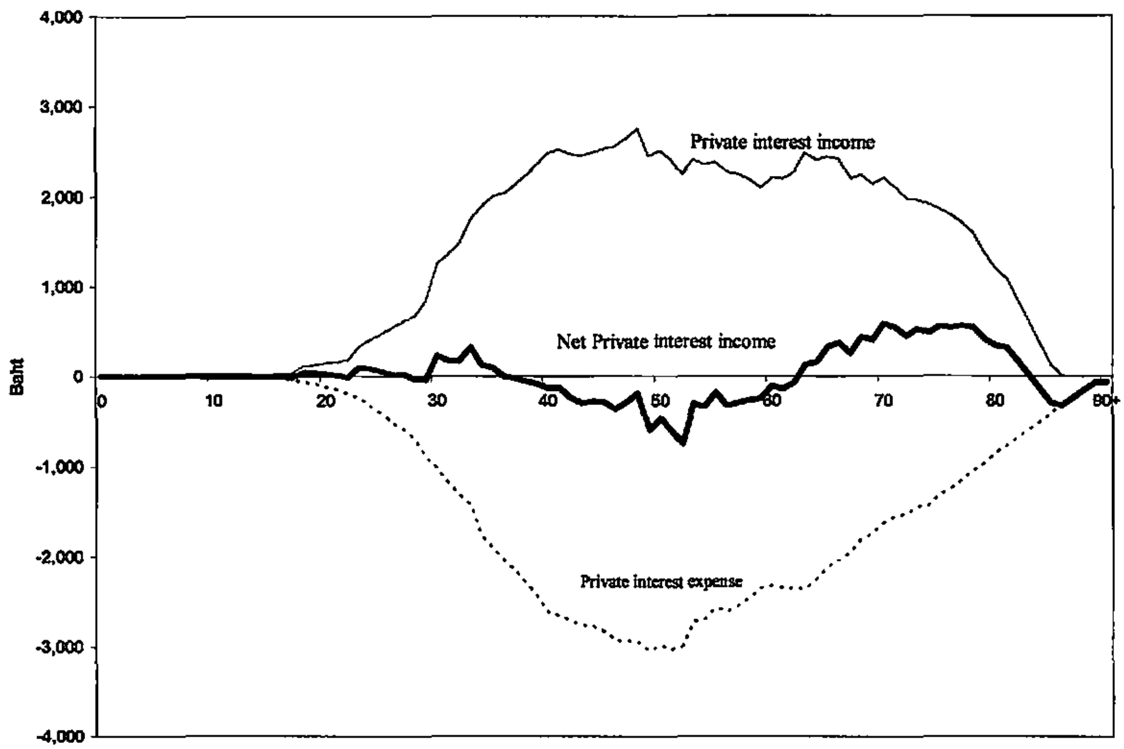
Combining three components, age profile of public saving has a hump shape, increasing with age before declining after around age 60. Saving by the elderly in Thailand through investing and lending is not large enough to offset dis-saving though giving bequests, leading to net dis-saving in the public sector. Hence, public saving turns negative (dis-saving) at around age 78 as net public bequests sharply decline.

3.4.2 Private Asset-based Reallocations

Private asset income

Age profile of private interest income has a hump shape, similar to age profile of private interest expense as shown in Figure 3-4. Thus, net interest income is small for almost all age groups. Net private interest income is positive among young working ages. Then, it turns negative around ages 36-62. Net private interest income is bigger and positive among the elderly. Reallocations through private interest income are likely to be from younger ages to older ages. Younger individuals are net borrowers to finance their consumption, whereas older individuals are net lenders and receive support through consumer credit. Private net interest income is negligibly small compared to private capital income. The age profile of private capital income has similar shape as total private asset income, shown in Figure 3-1 above.

Figure 3-4: Per Capita Private Interest Income and Expense, Thailand, 1996

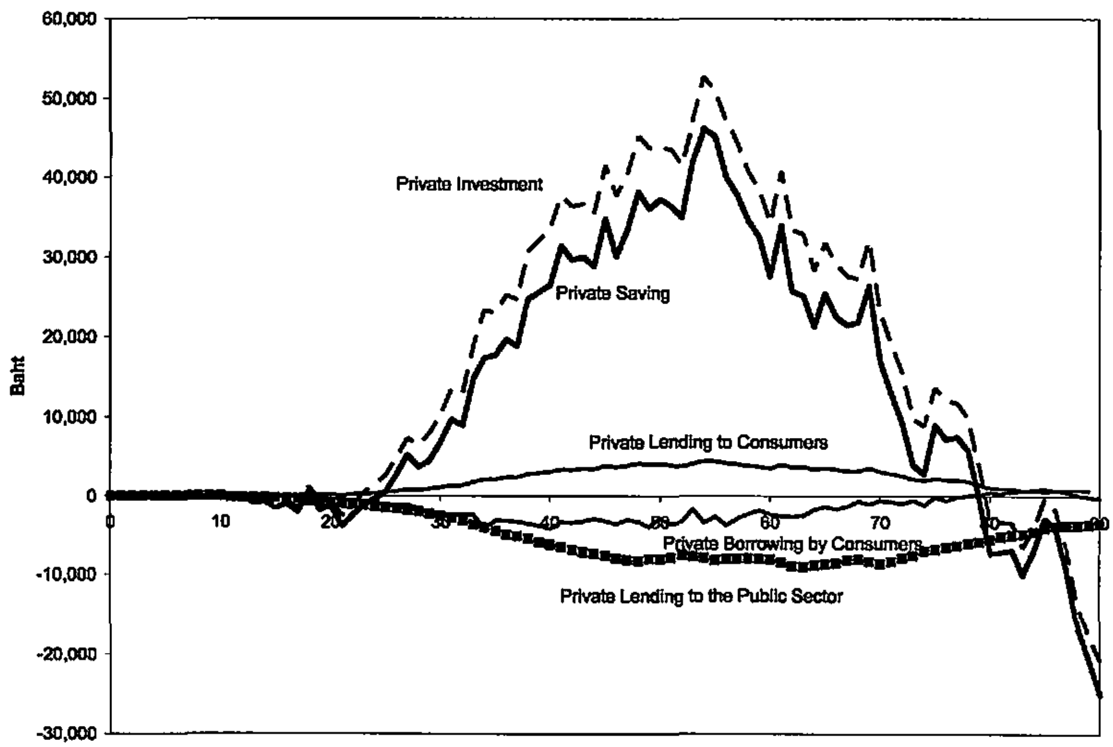


Private saving

Figure 3-5 shows that the major part of private saving is private investment. Per capita private investment has a hump shape, increase with age, reach the peak at around age 55, fall down and turn negative at around age 80. Moreover, the elderly over age 80 dis-invest, which could be bequests of private capital to younger ages. This finding of a hump-shape age profile of private investment is consistent with the lifecycle hypothesis of saving.

Private credit transactions are much smaller than private investment. Private lending to consumers is positive, whereas private borrowing by consumers is negative. Private borrowing by consumers is higher at younger ages, but private lending to consumers is higher at older ages. Therefore, net flow of private lending flows from older ages to younger ages. Younger consumers borrow from older ages to finance their consumption, resulting in negative net private lending by younger ages and positive net private lending by older ages. This finding shows that private lending in Thailand is not consistent with the lifecycle hypothesis of saving. Older age groups do not rely on assets that they accumulated during younger ages. On the other hand, older age groups reallocate assets in a form of consumer credit to younger age groups.

Figure 3-5: Per Capita Private Saving, Thailand, 1996



3.5 Conclusions

Individuals reallocate resources through accumulating and dis-accumulating different types of assets in order to achieve their lifecycle plan. Some types of assets are used by younger age groups, while other types are used by older age groups. This paper relies on the National Transfer Flow Account methodology to construct age profiles of private and public asset-based reallocations for Thailand in 1996.

There are two types of reallocations individuals rely on assets to achieve their lifecycle plan: upward reallocations and downward reallocations. Upward reallocations from younger age groups to older age groups can be achieved through public and private credit income, public capital bequest, and net lending to the public sector. Downward reallocations can be done through net lending to consumer debt and public credit bequest.

There are some important asset-based reallocations that do not have upward or downward reallocations. Age profiles of public investment, public lending and private investment show that individuals accumulate more assets with age, but they tend to accumulate fewer assets than younger age groups when they approach retirement ages.

CHAPTER 4
POPULATION AGING, INTERGENERATIONAL TRANSFERS AND SAVING IN THAILAND

4.1 Introduction

Changes in population age structure influence saving rates. The conventional lifecycle saving hypothesis implies that the elderly heavily rely on dis-saving to support their consumption during retirement periods. If this model is correct, saving rates will decline as population ages. Recent econometric studies have provided evidence for this possibility. However, there are controversial and important empirical issues concerning how much change in age structure can account for a significant change in saving rates. Several empirical studies, based on the analysis of aggregate cross-national panel data, show that saving rates change substantially (i.e. Higgins and Williamson 1997; Kelly and Schmidt 1996) as population age structure changes. Other groups of studies, based on disaggregated measures of saving rates using cross-sectional family income expenditure surveys, and historical and projected population age structure conclude that change in population age structure has modest effects on aggregate saving rates (i.e. Deaton and Paxson 2000; Lee et al. 2000).

One possible resolution for this empirical controversy is to include intergenerational transfers with lifecycle saving to measure changes in saving rates due to population aging. Recent empirical studies by Mason et al. (Mason et al. forthcoming; www.ntaccounts.org) in the "National Transfer Flow Accounts" show that intergenerational transfers are substantial and important for providing support for the elderly. This paper sheds light on measuring to what extent change in age structure can account for an important change in saving rates, using the National Transfer Flow Accounts methodology.

Two different models are used in this paper to estimate how changes in age structure affect saving rates. The major difference between these two models is how age profiles of saving are modeled. The first model follows the lifecycle hypothesis, relying on the empirical framework developed by Deaton and Paxson (2000). This model is based on the assumption that age profiles of consumption and income are fixed for all cohorts, resulting in the fixed age profiles of saving. The second model follows the simulation model, outlined by Mason and Lee (2006). The simulation model by Mason and Lee shows that intergenerational transfers could affect the levels of consumption and asset holdings, resulting in different age specific saving rates by different cohorts.

Thailand is used as a case study to assess how much a change in population age structure is associated with a change saving rates. During the past few decades the proportion of the working ages in Thailand increased substantially. However, the favorable demographic structure of high proportion of working ages is about to dissipate. Continual decline in fertility and mortality as well as an increase in life expectancy leads to population aging. The proportion of the elderly, ages 65 and older, in Thailand increased from 3 percent in 1950 to 6 percent in 2000. Even though the proportion of the elderly in

Thailand is lower than in many countries, the speed of population aging is high. The proportion of the elderly is expected to increase to 21 percent by 2050 (UN 2004)[12].

The results of my study based on the Deaton and Paxson model and the Mason and Lee model show that change in age structure affects saving rates in Thailand. However, the magnitude of the change in saving rates that is associated with the change in population age structure is different. Both models also show that population aging leads to a decline in saving rates. Further, there are possibilities that a saving rate may not decline much despite population aging. Both the Deaton and Paxson model and Mason and Lee model predict that high economic growth could prevent a saving rate from dropping severely.

This paper is organized as follows. In section 4.2, the literature on the effects of demographic changes, economic growth and transfers on saving is reviewed. Section 4.3 presents data used for the estimation. In section 4.4, saving rates are simulated based on Deaton and Paxson (2000)'s and Mason and Lee (2006)'s model. Section 4.5 concludes the study.

4.2 Literature Review

There is a large body of literature that investigates the effects of population age structure on saving rates. Most studies based on the lifecycle hypothesis of saving show that changes in age structure and economic growth influences saving rates. However, few studies include intergenerational transfers with lifecycle saving to measure the effect of

[12] Please note that there is uncertainty about these population projections by the UN. See Lee (2003, pp.179-180) for a discussion.

change in age structure on saving rates. This study includes comprehensive measures of transfers from both the family and the public sector to measure the effect of change in population age structure on saving rates.

Most studies that discuss the effects of demographic changes on saving are based on the lifecycle hypothesis of saving, developed by Modigliani and Brumberg (1954). Assuming a perfect annuity market and no bequests, individuals choose an optimal consumption path subject to the constraint that the present value of lifetime consumption cannot exceed the present value of lifetime earning and current assets. The major assumption for this model is that the shape of the lifetime path of consumption is independent of the shape of the expected path of income. Based on the lifecycle hypothesis, rational forward looking individuals will not consume more in one period than another period. Individuals' income may increase with age until individuals reach the retirement age and earn no income. Individuals save some fraction of their income when they earn more than they consume during working ages in order to dis-save when they earn no income during retirement. Thus, consumption by the elderly does not necessarily decline with income because the elderly can dis-save or run down assets to support consumption during the elderly years.

The lifecycle model predicts that both demographic and productivity growth will generate savings. There will be no net saving in the economy as a whole if there is neither of these. Given population growth, there are more young people than old people. Total saving by young people offset total dis-saving by old people, leading to positive net saving in the whole economy. Similarly, productivity growth allows younger workers to be richer than an older generation at the same age, leading to a larger level of saving than that of older generation. Thus, there exists positive net saving in the whole economy. Based on this prediction, population aging is likely to lower net saving because the share of the elderly, who dis-save, increases relative to working ages, who save.

There are several studies on how the lifecycle hypothesis is used to explain the effects of the change in age structure on saving. Many models are also used to predict saving rates. There are two general ways that the lifecycle model is used to study the effects of age structure on aggregate saving.

One approach is highly aggregative, using cross-national panel data, and depends on estimating a saving model that includes one or more measures of age structure. There are many examples: Leff (1969), Mason (1987, 1988), Bloom et al. (2003), Higgins and Williamson (1997) and Kelly and Schmidt (1996). Most studies find that population aging (or slow population growth) will lead to lower saving rates. A recent study by Kinugasa and Mason (2006) raises the possibility that saving rates may not decline with aging if increases in life expectancy have a sufficiently strong effect.

The second approach, and the one that is emphasized here, is more disaggregated and relies on simulation. Kinugasa and Mason explicitly model the age profile of saving (or consumption and income). Age specific saving rates are then aggregated using a historical or projected population age structure to determine the household or national saving rates. Two different approaches are used to defining the age profile. One uses the household as the unit of analysis and constructs profiles by the age of household head (Paxson 1996; Deaton and Paxson 1997; 2000; Jappelli and Modigliani 2003; Attanasio 1998). The other approach uses the individual as the unit of analysis and constructs the age profile of the individual (Deaton and Paxson 2000; Demery and Duck 2006; Mason and Lee 2006). Further, some simulation studies have relied on consumer theory, such as the lifecycle model, to determine the age profile of saving. Cutler et al. (1990) use the Ramsey Model. Lee et al. (2003) and Attanasio (1998) use the lifecycle model.

Even though lifecycle hypothesis is important to describe the relationship between age structure and saving, it does not present a comprehensive view of the support systems. Apart from saving, intergenerational transfers are large and important mechanisms used to support consumption by children and the elderly. People make transfers when they are productive, and receive transfers when they earn lower or no income. Combining transfers with lifecycle saving is necessary to explain the effect of change in age structure on saving rates. Population aging leads to more burdens for the working ages to provide larger transfers to the elderly because the share of the elderly who receive transfers increases, whereas the share of working ages declines. The working ages have fewer resources available to save, resulting in a decline in saving rates. Overlooking the importance of transfers may mislead the measurement of saving by people in different age groups and the effect of change in age structure on saving.

The contribution of this paper is to apply the methods by Deaton and Paxson (2000) with comprehensive measures of intergenerational transfers estimated using the National Transfer Flow Accounts methodology to measure effects of change in age structure on saving rates in Thailand. Further, this paper compares saving rates based on the simulation model from Deaton and Paxson with the ones from Mason and Lee. The key distinguishing features of the simulation models are the ways in which the age profiles of saving are modeled. The first model is based on the Deaton and Paxson model, assuming individuals rely only on dis-saving without transfers to support consumption during the retirement period. Age specific saving rates, measured from age profiles of consumption and income using repeated cross-sectional surveys, are fixed for all cohorts. The unit of analysis of this model is at the household level, represented by the age of a household head. The second model is based on the simulation model by Mason and Lee, assuming individuals rely on reallocations through assets and transfers received from younger ages to support their consumption during the retirement period. Saving or asset accumulation by different cohorts allows individuals in different cohorts to vary their consumption, resulting in different age profiles of saving across periods. In addition, the unit of measurement in the Mason and Lee model is at the individual level rather than at the household level.

In summary, the lifecycle hypothesis is a fundamental framework to explain how changes in age structure and economic growth affect saving rates. Lifecycle hypothesis is important; however, it does not take into account intergenerational transfers. Change in age structure affects transfers from working ages, which could affect saving rates. Thus, overlooking the importance of transfers could mislead the measurement of how change in age structure can account for change in saving rates.

4.3 Data

The empirical methods used to construct the National Transfer Flow Accounts for Thailand are described in Chapter 2. There are three sources of data used to estimate saving rates: household income and expenditure surveys, national income accounts, population estimates and projections by age. First, the household income and expenditure surveys of Thailand called the Socio-economic Survey (SES) are used to estimate age profiles of consumption, earning, and other sources of income. There are eleven rounds of surveys used in this paper, starting from the year 1981 and every two years from 1986-2004. The SES is operated under the direction of the National Statistical Office Field Division. The survey provides information at the household level, such as household expenditures and income, and at the individual level, such as education level and age of household members. There are, on average, 75,906 individuals from 20,763 households interviewed in each survey year. Data from each survey include 91 cohorts, or all individuals aged 0 to age group 90 and older. The total includes 115 cohorts (i.e. born between 1890 and 2004) who are observed for up to 24 years each (i.e. cohorts born in 1981 are observed until aged 23 in 2004). The data for cohorts in each survey are then pooled to estimate age and cohort effects in consumption and income. A descriptive summary of the surveys is shown in Table 4-1. Second, the national income accounts of Thailand are used to control the aggregates from the surveys as well as the aggregates from other government documents. The National income account is the macroeconomic depiction of the national income cycle, which measures the flows of five main institutional units that are resident in the economy, i.e. non-financial corporations, financial corporations, government units (including social security funds), non-profit institutions serving households and households. The national income of Thailand is compiled by the National Account Division at the National Economic and Social Development Board (NESDB). The methodology used to compile the national account of Thailand follows the System of National Accounts (SNA) 1993 (UN 1993). Third, population estimates and projections by age are used from the United Nations (UN 2005). Data for population projections up to 2300 are based on the assumption that total fertility rates (TFR) are constant at 1.85 throughout the projection periods. Migration is included in the projection. Population projections also consider the epidemic of HIV/AIDS in Thailand to forecast mortality. Between 2005 and 2050, life expectancy at birth for men and women is assumed to increase from 68.5 and 75.0 years to 76.6 and 81.6 years.

Table 4-1: Summary of Mean Statistics from Surveys, Real Prices (2004 Prices)

Survey Years	Household Characteristics					
	Age of Head (years)	Consumption (Baht/Month)			No. of Households	Household Size (persons)
		Education	Health	Total		
1981	44.4	148.2	283.7	8,374.7	11,894	0.0
1986	45.0	151.2	281.0	7,974.1	10,889	0.0
1988	45.5	98.7	252.5	6,885.0	11,017	0.0
1990	46.3	130.9	302.1	8,225.9	13,162	0.0
1992	46.2	169.5	334.8	9,322.8	13,432	0.0
1994	47.2	187.8	363.0	9,417.1	25,176	0.0
1996	47.8	206.4	411.9	9,871.3	25,069	0.0
1998	48.1	263.0	254.6	9,738.2	23,515	0.0
2000	48.5	261.8	279.7	9,062.4	24,705	0.0
2002	48.6	264.1	260.8	9,933.8	34,735	0.0
2004	49.7	263.8	262.1	10,809.3	34,803	0.0
Mean	47.04	195.03	298.76	9,055.88	20,763.4	0.00

Survey Years	Individuals Characteristics					
	Age of Individual	Income (Baht/Month)				No. of Observations
		Wage	Farm	Non-farm	Property	
1981	25.8	768.8	341.3	543.9	32.9	52,004
1986	27.2	835.9	266.0	450.7	28.8	45,072
1988	27.5	624.8	395.1	261.9	25.5	42,843
1990	28.3	860.2	422.7	362.9	25.3	52,879
1992	28.9	1,157.9	399.9	474.3	54.1	50,309
1994	30.2	1,303.7	379.1	560.3	37.0	93,735
1996	30.8	1,517.9	499.6	658.5	49.7	90,133
1998	31.2	1,537.4	468.1	655.9	71.8	85,891
2000	32.5	1,573.5	387.2	637.3	49.6	87,231
2002	32.5	1,754.7	459.5	770.8	54.0	118,550
2004	33.6	1,922.4	515.1	805.0	51.7	116,317
Mean	29.87	1,259.75	412.14	561.95	43.68	75,905.8

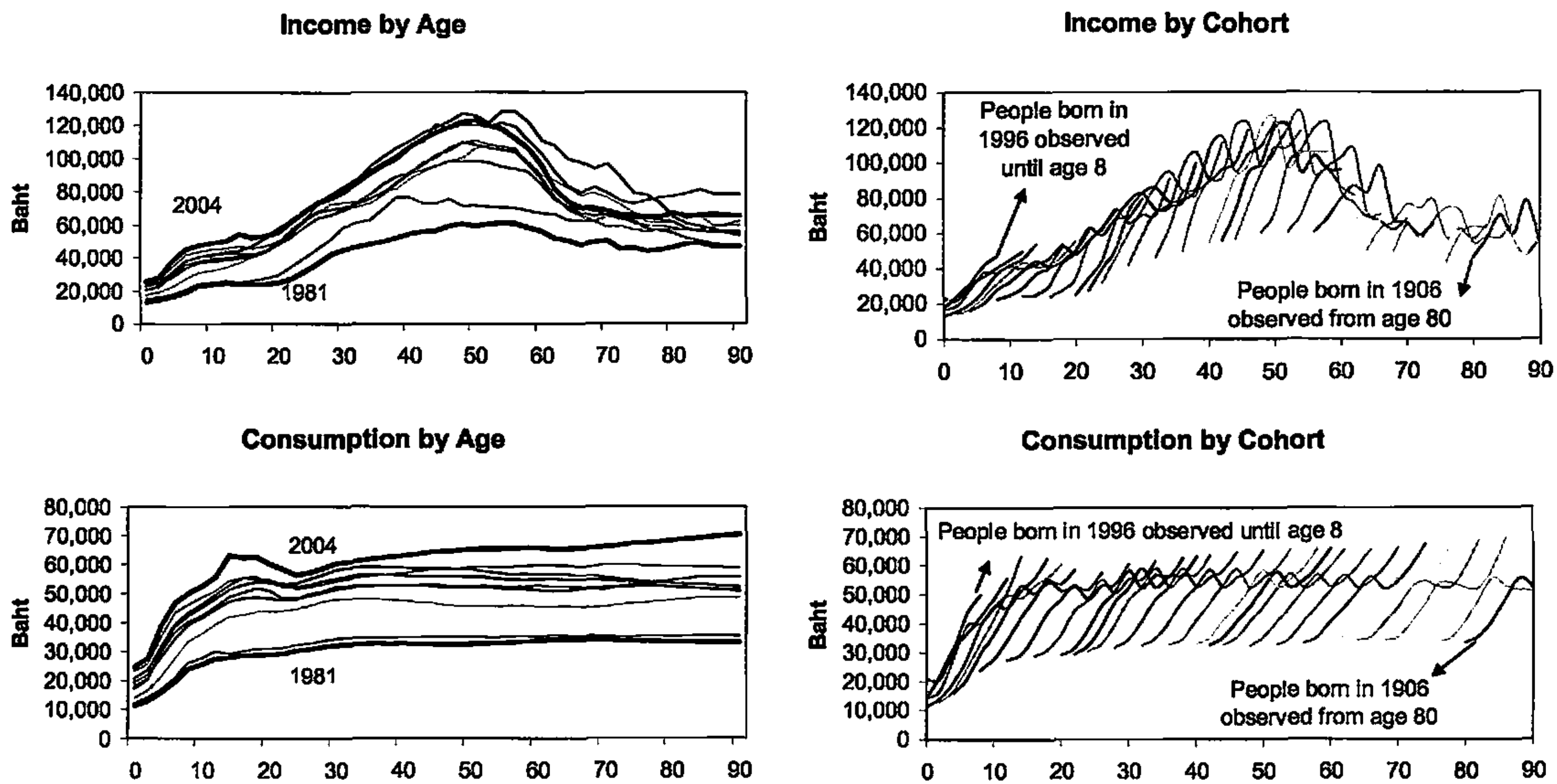
Source: Author's calculation based on the SES 1981-2004

The results shown in Figure 4-1 present per capita consumption and income by age and by cohort, for every fourth cohort. Please note that the income described here includes labor income, asset income and net transfers received from both the public and private sectors.

The left panel shows cross-sectional income and consumption by age from 1981 to 2004. The shape of the cross-sectional age profiles of consumption does not change much over time, whereas the shape of the cross-section age profiles of income fluctuate around working and retirement ages. The changes in income are mainly caused by the decline in asset income after the economic crisis in 1997. Children do not work or earn asset income. The major source of income for children is net private and public transfers received. Consumption by adults and the elderly is rather stable for most survey years. In contrast, cross-sectional income for most survey years show that income increases with age during the working ages before declining after around ages 60 and older. The decline in income is mainly due to the decline in labor and asset income as individuals are older.

The right panel shows income and consumption by cohort. The cohorts are shown every fourth cohort. For example, the first line in Figure 4-1 is income and consumption for a cohort born in 1996 observed until aged 8 in 2004; the last line is a cohort born in 1906 observed from aged 80 in 1986 until aged 90 and older in 1996. The results show that most cohorts observed during working ages receive higher income with age. For example, real income for those born in 1970 increased at the rate of 17 percent per year between the ages of 16 and 34. However, as cohorts grow older, the rate of growth is less, falling with age and eventually becoming negative. Consumption by cohort is not so much different from one cohort to another as observed in income by cohort. Consumption by younger cohort steeply increases with age. Consumption by older cohorts increases but less steeply than younger cohorts.

Figure 4-1: Per Capita Consumption and Income by Age and by Cohort, Thailand, Real Prices (2004 Prices)



4.4 Population Aging and Saving Rates

In this section, the effects of population aging on saving rates of Thailand are simulated using the models developed by Deaton and Paxson (2000) and Mason and Lee (2006).

4.4.1 Deaton and Paxson Model

Specification

Saving rates can be simulated using the age profile of income and consumption. However, age profiles of individual income and consumption cannot be simulated directly using cross-sectional surveys if age effects are confounded with cohort effects. For example, older people come from an earlier cohort, which may have different experiences and resources. Given continual technological progress, older cohorts are lifecycle poorer than younger cohorts. Thus, it is important to distinguish age and cohort effects in consumption and income in order to measure saving rates.

Consumption over the lifecycle, for any individual i born at date b and observed at age a (i.e., at date $b+a$), follows an age profile of consumption $f_i(a)$, *age effect*, and lifetime resources W_{ib}, *cohort effect*. The shape of the age profile of consumption is fixed for all cohorts, assuming there are no changes in tastes or in incentives to postpone consumption. The level of the age profile is set by lifetime resources. Thus, consumption c_{iab} is given by

$$c_{iab} = f_i(a)W_{ib}, \qquad 4.1$$

Then, the logarithm of consumption can be expressed as the sum of an age profile and a fixed lifetime wealth component:

$$\ln(c_{iab}) = \ln f_i(a) + \ln(W_{ib}) . \quad 4.2$$

There are no panel data for Thailand that can track individual consumption trajectory overtime to measure age and cohort effects. Repeated cross-sectional surveys can be used to measure consumption by cohort. Some individuals may be observed only once in survey; however, the sample from the same birth cohort is observed in a later survey. Thus, consumption can be tracked of a representative sample of individuals of the same cohort. This can be done by taking averages of equation 4.2 across all individuals of the same cohort at the same age, then equation 4.2 can be shown as:

$$\overline{\ln c_{ab}} = \overline{\ln f(a)} + \overline{\ln W_b} , \quad 4.3$$

where the lines over the variables denote means. For example, for a birth cohort born in 1950 observed at age 40 in 1990, the average logarithm of consumption is the sum of the age effect (that of age 40) and a cohort effect (that of persons born in 1950). Equation 4.3 can be obtained by regressing the average of the logarithm of consumption for those born in b and observed in $b+a$ on a set of age and cohort dummies[13], i.e.,

$$\overline{\ln c} = D^a \beta_c + D^c \gamma_c + u_c , \quad 4.4$$

where $\overline{\ln c}$ is a stacked vector of log consumption with elements corresponding to each cohort in each year, D^a is a matrix of age dummy and D^c is a matrix of cohort dummy.

[13] The regression includes the constant term and drop one age and one cohort. Year effects are included in the regression model. However, the year effects need some adjustment to avoid the multicolinearity problem with age and cohort. The adjustment method follows Deaton (1997) by restricting the year effects to sum to zero and orthogonal to time trend.

The coefficients β_c and γ_c are the age effects and the cohort effects in consumption, and u_c is sampling error.

Similarly, income profiles retain a characteristic profile that does not change shape across cohorts and they are determined by lifetime resources. Taking averages of the logarithm of income can be decomposed into age and cohort effects, i.e.,

$$\overline{\ln y} = D^a \beta_y + D^c \gamma_y + u_y, \qquad 4.5$$

where β_y and γ_y are the age effects and the cohort effects in income, and u_y is sampling error.

If consumption is close to income, the ratio of saving to income is approximately equal to the difference between 4.5 and 4.4. Then, saving ratio can be decomposed into age and cohort effects, i.e.,

$$s / y \approx \overline{\ln y} - \overline{\ln c} = D^a(\beta_y - \beta_c) + D^c\left(\gamma_y - \gamma_c\right) + (u_y - u_c) \qquad 4.6$$

Assuming bequests are zero or an unchanging fraction of lifetime wealth, the level of the saving will be the same for all cohorts. In addition, the lifecycle hypothesis assumes the lifetime consumption exhausts lifetime resources[14], thus the cohort effects in income and consumption will be the same. Consequently, equation 4.6 will have only age effects, which can be rewritten as:

$$s / y \approx D^a(\beta_y - \beta_c) + (u_y - u_c) \qquad 4.7$$

[14] However, at any period, consumption may not equal income. Borrowing and lending make up the difference between consumption and income at any period, assuming that capital markets are sufficiently developed to allow people to borrow against future income.

Saving rates from the lifecycle hypothesis are estimated by dividing total saving, the difference between total income and total consumption, by total income. Total income is the sum of the product of population by age and the exponential of the age effects of income by age. Similarly, total consumption is the sum of the product of population by age and the exponential of the age effects of consumption by age. Consequently, the aggregate saving ratios in any given year can be calculated as:

$$\frac{s}{y} = \frac{\sum_a \eta_{at}(1+g)^{-a}[\exp(\beta_{ay}) - \exp(\beta_{ac})]}{\sum_a \eta_{at}(1+g)^{-a}\exp(\beta_{ay})}, \qquad 4.8$$

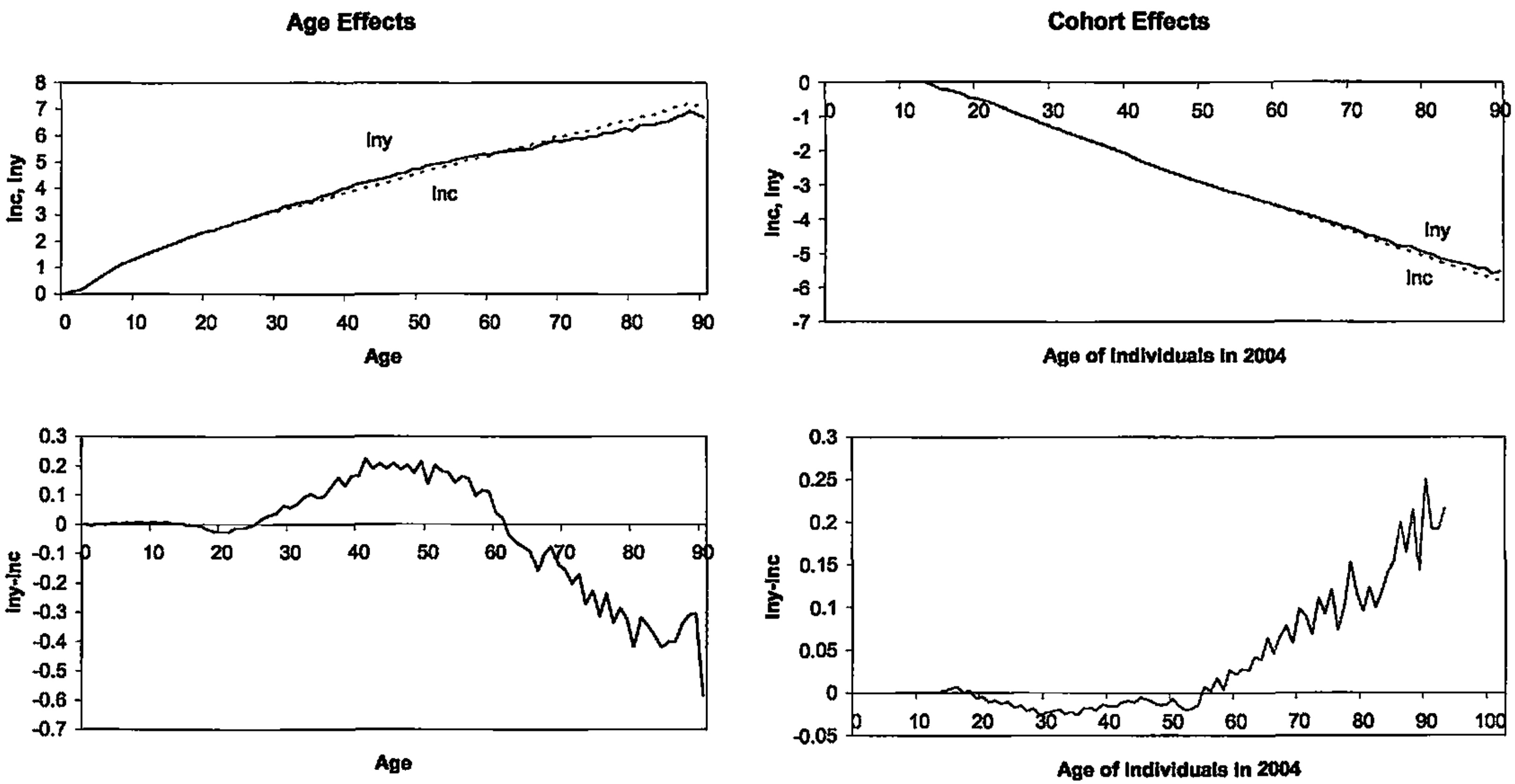
where s and y are aggregate saving and aggregate income, η_{at} is the number of people aged a at time t, β_{ay} and β_{ac} are respectively the age effects in the logarithm income and consumption profiles, g is the growth rate of per capita income.

Empirical Results

Cohort effects in log consumption, log income and the saving ratio are shown in Figure 4-2 in the two right panels, and the corresponding age effects are shown in the two left panels. Cohorts are defined by age of individuals in 2004, which show the movement from the later-born cohorts from the left to the earlier-born cohorts to the right. The earlier born cohorts are poorer over their lifetime leading to a decline in cohort effects for both income and consumption from left to right. For the age effects, income increases steeply until around ages 55-60, then consumption increases more steeply than income. The more interesting finding is on the age effects of consumption. Age effects of consumption in Thailand continually increase with age. That consumption is growing is inconsistent with the prediction by the lifecycle hypothesis. Attanasio and Weber (1995), using the household model, finds that consumption by the age of head could be hump shaped because of changes in household composition. However, in the individual model age effects of consumption are assumed to be flat in the lifecycle hypothesis. There are important studies that explain the age effects of consumption. For example, Carroll (1994) and Deaton (1992) explain that consumption tracks income because of precautionary saving incentive and liquidity constraint.

That consumption among older ages increases more steeply than income is also interesting. An increase in consumption by the elderly could be influenced by the income of others, not their own, because of intergenerational transfers, which supports the Mason and Lee model. The results of downward sloping cohort effects and upward sloping age effects of logarithm income and logarithm consumption are similar to what Paxson (1996) found for Thailand, using the ages of household heads instead of individuals.

Figure 4-2: Age and Cohort Effects, Log Income, Log Consumption and Saving Rates, Thailand

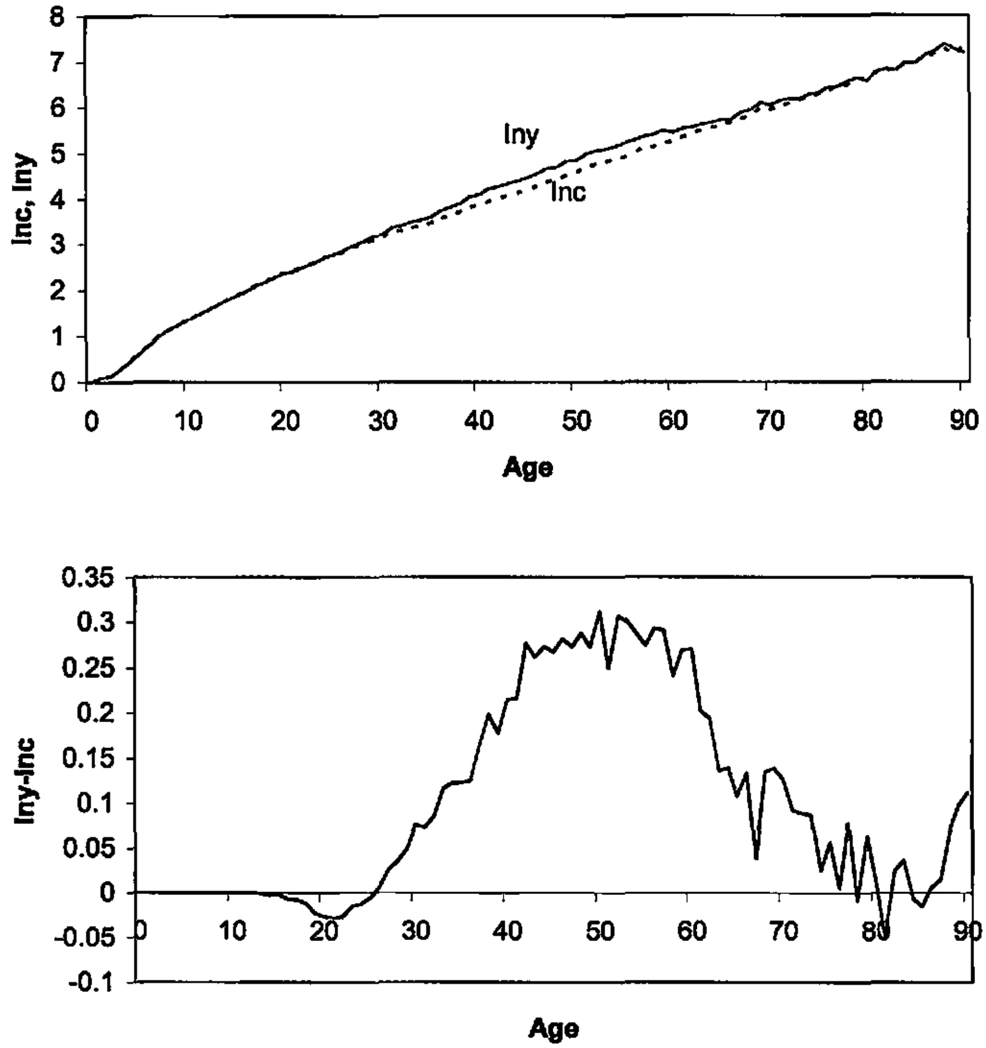


The lower left panel shows that the age profile of saving has a hump shape, suggesting the important relationship between age structure and saving rates. The results show that people save more as they are older until they reach around age 50. People start to dis-save at around age 62. The lower right panel shows that cohort effects of saving are upward sloping. Cohort effects of saving are upward sloping because more recently born people in Thailand are consuming a larger share of their lifetime resources. The finding here contradicts to the lifecycle hypothesis, which assumes that bequests are zero or a fixed fraction of lifetime resources. There are some possibilities for the upward sloping cohort effects of saving. People in Thailand at all age groups may decide that it is less important to save, so that all cohorts, at all ages, slowly decrease their saving ratios over time. The other possibility is that people in Thailand at younger cohorts may plan to bequeath less than the older cohorts. In contrast to Thailand, Deaton and Paxson (2000) find that cohort effects of saving in Taiwan are downward sloping, indicating younger cohorts save more than older cohorts.

The lifecycle hypothesis cannot explain what causes the changes in saving behavior across cohorts; however, the results can be adjusted by forcing the age effects and cohort effects in both income and consumption regression to be the same[15]. Consequently, the cohort effects of saving ratios are eliminated. The results shown in Figure 4-3 restrict cohort effects of consumption and income to be identical. Saving ratios have a hump shape and they are negative for young adults and the elderly.

[15] The method involves using the simultaneous regression for log consumption and log income on ages and cohorts, constraining cohort effect from log income regression to be equal to cohort effect from log consumption regression for each cohort.

Figure 4-3: Age Effects in Log Income, Log Consumption and Saving Rates with Restricted Cohort Effects



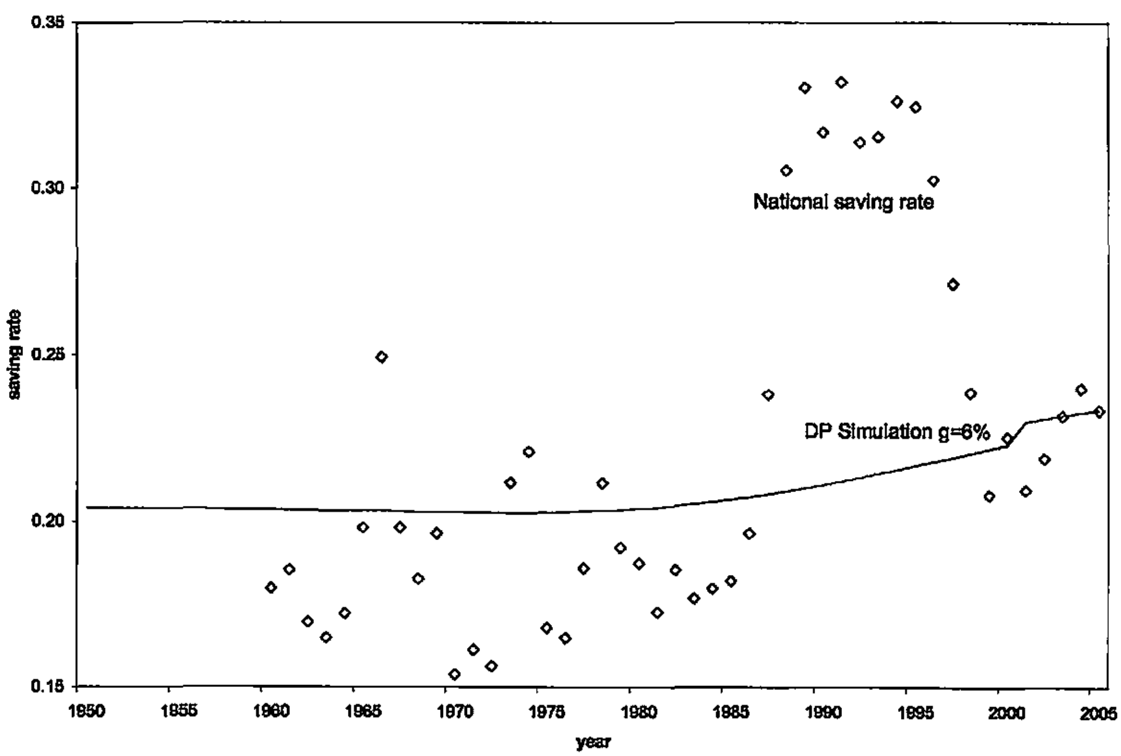
Finally, the effects of demographic changes on aggregate saving rates can be simulated using the age distribution of population in Thailand from 1950 to 2005. Consumption and income at each age for each cohort is the product of lifetime wealth of cohort members and the exponents of the age effects in Figure 4-3. The cohort-specific lifetime wealth terms are assumed to grow from year to year at a constant rate of 6.0 percent, which is close to the average economic growth rate of Thailand during 1981-2004, the period of the surveys used in the simulation. The estimation results show how age structure affects saving rates. Please note that the analysis does not explain how saving rates change due to short-term fluctuations, such as income shocks during the economic crisis in 1997-1998.

Figure 4-4 shows the predicted saving rates[16] and actual national saving rates. The simulated saving rates were stable around 20 percent of national income during 1950-1975. There was not much change in saving rates because there was large consumption by children due to high child dependency rates, leaving few resources available for saving. Then, saving rates increased after 1975, which is the period when total fertility rates started to decline, leading to a smaller share of children and a larger share of working ages. These calculations show that if lifecycle hypothesis is literally implemented, the lifecycle model could explain the increase in saving rates in Thailand before 1985. The simulated results fit actual saving rates, which show that there was no secular trend during the period. However, it may not explain the fluctuation in saving rates after 1985. There is a study showing that the decline in saving rates during the late 1990s is caused by high spending in durable goods, import luxury goods and increase in consumer debt during the period (Pootrakool et al. 2005). This paper shows that the large increase in saving observed in Thailand, or many other East Asian countries, may not be caused by change in age structure as described by Higgins and Williamson (1997) and

[16] Coefficients of income and consumption estimated from the regression are adjusted to match with the aggregate control for income and consumption in the year 2000. This is implemented by adding a constant value to the coefficients to allow the sum of the product between the exponential of the coefficients (average of the logarithm of consumption and income) and population by age to equal aggregate consumption and income reported in the national income accounts.

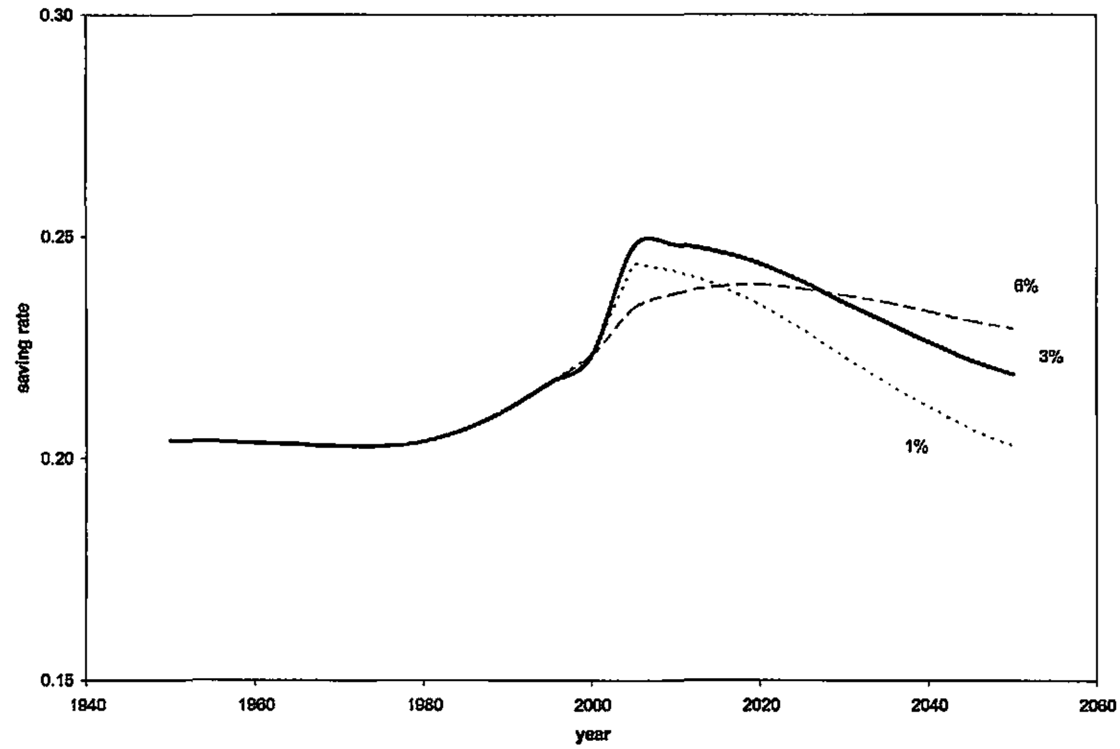
Kelly and Schmidt (1996). In contrast, the lifecycle hypothesis implemented by Deaton and Paxson show that change in saving rates was not mainly due to change in age structure or economic growth, but due to a secular trend. In addition, the results that change in saving rates is not mainly due to change in age structure as described by the lifecycle hypothesis are consistent with what Deaton and Paxson (2000) found for Taiwan.

Figure 4-4: Saving Rate Projections: Deaton and Paxson Model



Saving rates of Thailand can be forecast using the population projections from the UN and the age effects of consumption and income shown in Figure 4-3. The results of future saving rates vary owing to different assumption about per capita income growth. Each cohort is assumed to have new wealth effects due to the change in per capita income growth from 6 percent to other levels at the year 2000. It is also assumed that everyone will know immediately that the change is permanent. Figure 4-5 presents the changes in saving rates when per capita income growth rates are 1 percent, 3 percent and 6 percent. The results show that saving rates will increase for a short period of time. An increase in saving rates could be from an increase in the share of the working ages as predicted by the lifecycle hypothesis. After increasing for a short period, saving rates are predicted to decline. The decline in saving rates is predicted to be rapid with the scenario of slow economic growth. The slow economic growth provides older ages with relatively more lifetime wealth than younger ages. Thus, slow economic growth will increase the share of dis-saving by elderly relatives to saving by working ages. On the other hand, if the economy of Thailand can maintain its growth at a high level, population aging is not likely to affect saving rates much. For example, given an economic growth rate at 6 percent per year, saving rates in 2050 are predicted to decline about 4 percent from the peak in 2020.

Figure 4-5: Saving Rate Projections with Different Growth Rates, Thailand



4.4.2 Mason and Lee Model

Specification

There are a few steps used to simulate saving rates. The first step is to simulate aggregate lifecycle wealth from the consumption and labor income age profiles. Aggregate lifecycle wealth is the wealth that adults must hold, as a group, in a given period in order to achieve a given path of consumption and labor income over the remainder of their collective existence. The aggregate demand for wealth depends on the future trajectories of consumption and labor income. The shapes of cross-sectional age profiles of consumption and labor income are assumed to be fixed and shifting upwards over time. The labor income profile is assumed to shift at some exogenously specified rate of technological progress. The consumption profile shifts at endogenous rates, depending on technological progress, population age structure, the shape of consumption and labor income profile and public policy. Given the trajectory of labor income, the aggregate lifecycle wealth of all adults of age a in year t, $W(a,t)$,can be calculated for any consumption trajectory as the difference between the present value of consumption and the present value of labor income of all adults over the remainder of their lives. Let PV[] be the present value operator. Then,

$$W(a,t) = PV[C(a,t)] - PV[Y(a,t)] \qquad 4.9$$

where $C(a,t)$ and $Y(a,t)$ are vectors of current and future consumption and current and future labor income, respectively, for the cohort of age a in year t[17].

The second step is to calculate different forms of wealth. Wealth can be held in three forms: assets (A), child transfer wealth (T_k) and pension transfer wealth (T_p). Assets are, for example, funded pensions, private savings and capital stock. Child transfer wealth is the present value of the net costs of supporting children through the family or the public sector. Child transfer wealth can be estimated as the present value of the gap between consumption and labor income by children. Child transfer wealth is negative. Pension transfer wealth is the present value of the net transfers that the elderly receive from the working ages, such as familial old age transfers or pay-as-you-go pensions. Adults at a given point in time decide how much assets and transfer wealth they need to hold in order to achieve their lifecycle path that lifetime consumption does not exceed lifetime labor

[17] Averages age profiles of consumption and income from eleven survey years during 1981-2004 are used to measure aggregate lifecycle wealth. The consumption and production profiles are scaled so that when they are applied with population in 2000, they match with aggregate consumption and labor income from the National Transfer Flow Account in 2000.

income. Either assets or pension transfer wealth can be used to support future consumption when it is greater than future income. From the perspective of the individual, they are equivalent. However, from the perspective of the macroeconomy, pension transfer wealth and assets are not the same. By accumulating more assets, higher levels of aggregate consumption can be sustained in the future. Assets combined with pension transfer wealth, called pension wealth ($W_p = A + T_p$), are used to support old age consumption. A different fraction of pension transfer wealth to total pension wealth may affect asset accumulation and the aggregate consumption level. Following Mason and Lee (2006), the ratio of assets to pension wealth is assumed to be constant and assets can only be held by adults. Thus, at a given point in time how much year t adults demand for assets to support old age consumption depends on how much they expect to receive transfers from their children, or pension transfer wealth. Consequently, assets for year t adults at a given point in time can be simulated as a residual between aggregate wealth and transfer wealth, i.e., $A(t) = W(t) - T_k(t) - T_p(t)$. Further, assets accumulated by year t adults increase when current labor income exceeds current consumption and adults receive returns to assets, i.e., $A(t+1) = (1+r)A(t) + Y(t) - C(t)$, where r is rate of return to assets.

The final step is to solve for consumption. Aggregate consumption during each period is determined by several variables, such as the level of assets, interest rate and population age structure. The simulation strategy is to solve for the trajectory of assets and consumption at the steady state level, and then employ backward recursion to the present and historical periods. There are important and necessary assumptions to describe variables at the steady state level. Population is assumed to achieve stability and the model reaches steady state at some point in the distant future, which is assumed to be at the year 2300. Consumption per effective number of consumer as well as assets is assumed to grow at the same rate as productivity. Given these assumptions, aggregate consumption and assets can be solved in steady state year and years thereafter. Provided that consumption and assets in all subsequent periods are known, consumption, assets and lifecycle wealth in the year before the steady state can be solved.

There are some major differences between simulation models by Mason and Lee and Deaton and Paxson. First, saving behavior of adults and the elderly in Mason and Lee model can be changed, whereas that in Deaton and Paxson is constant. For example, the decline in the number of children allows adults to accumulate more assets, leading to a higher consumption and/or saving; an increase in life expectancy leads to lower consumption at all ages and higher saving. Second, there is a strong altruism motive included in the Mason and Lee model. The Mason and Lee model includes intergenerational transfers to simulate asset accumulation, whereas the Deaton and Paxson model does not take into account intergenerational transfers. Adult people make transfers to the elderly to ensure the elderly can maintain their living standard.

Based on Mason and Lee (2006), there are necessary assumptions for the simulation. Discount rate is assumed at 3 percent. Depreciation rate is assumed at 3 percent. The international real rate of return on assets is assumed at 6 percent, declining linearly to a a steady-state rate of interest at 4.42 percent in 2300. Productivity growth rate is 1.5

percent. In addition, there are some important assumptions, relating to how individuals accumulate lifetime wealth. The assumptions of wealth accumulation are used based on the National Transfer Flow Account for Thailand in 2004. Child transfer wealth is simulated assuming two-thirds of child costs in Thailand are financed by familial transfers and one-third by public transfers. Pension transfer wealth is simulated assuming the old age support systems in Thailand are based on assets at 64 percent and pension transfer wealth at 36 percent.

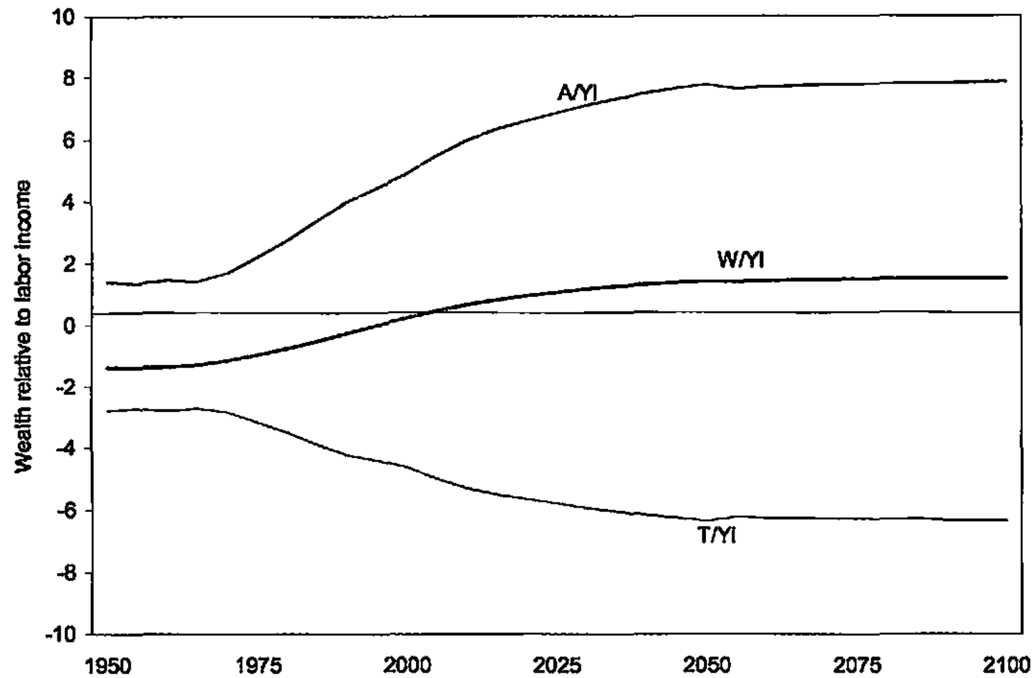
Empirical Results

Figure 4-6 shows wealth (*W*), assets (*A*) and transfer wealth (*T*) relative to labor income (*Yl*) during 1950-2100. Between 1950 and 2000, assets increased steeply from about 1.5 to about 5 times of labor income. An increase in assets during this period is associated with an increase in the support ratio[18]. People during productive ages accumulate assets to prepare for their old age consumption. Thus, an increase in people at these ages leads to an increase in assets. Wealth during this period is negative due to greater negative transfer wealth than assets. After the year 2000, assets do not increase as steeply as the previous periods. Even though assets do not increase any further, assets remain at a much higher level.

---

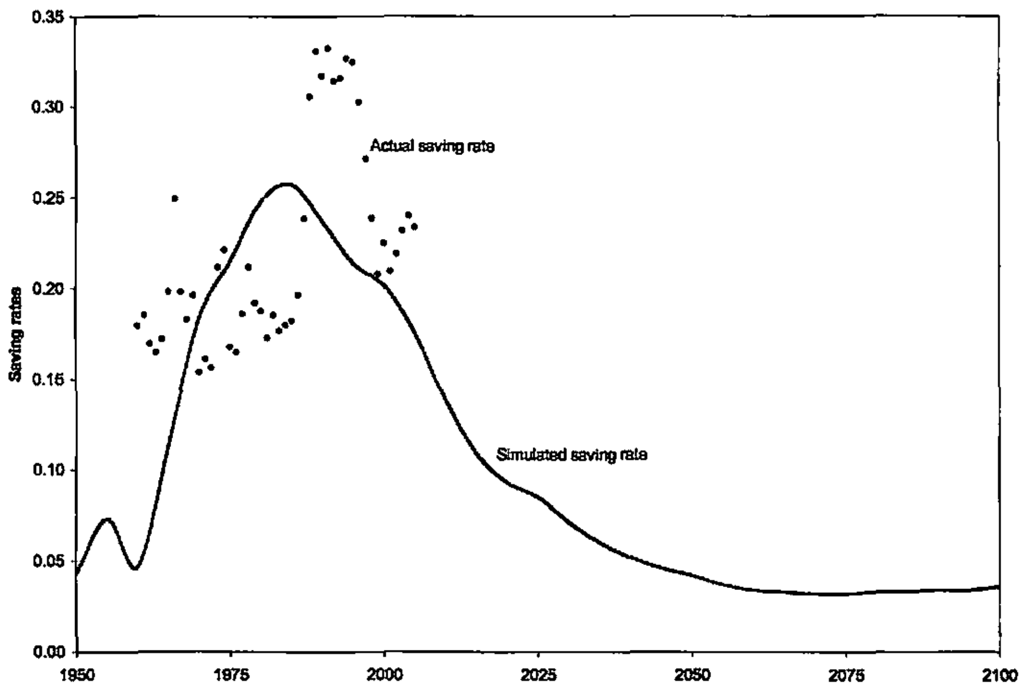
[18] Mason and Lee (2006) define support ratio as total effective number of producers divided by total effective number of consumers, which can be measure by summing the product of population by age and per capita age profile of production and consumption. This method takes into account of different productivity and consumption needs by people in different age groups, instead of using broad population age groups, such as those ages 20-64 divided by total population, to estimate support ratio.

Figure 4-6: Aggregate Demand for Wealth and Its Components, Thailand, 1950-2100



Simulated national saving rates are compared with the actual net national saving rates of Thailand as shown in Figure 4-7. The simulation results show that saving rates reach the peak at around 27 percent of national income between 1980 and 1985. High saving rates during this period contributed to a steep increase in assets as shown in Figure 4-6. The simulation results explain the relationship between age structure and saving rates well before 1985. These findings are similar to the simulated results based on the Deaton and Paxson model. Both the Mason and Lee model and the Deaton and Paxson model show that change in age structure in Thailand had major effects on change in saving rates before 1985. Then, simulated saving rates gradually decline, whereas actual saving rates remained at a high level during the 1990s and early 2000s. Similar to findings based on the Deaton and Paxson model, change in age structure in Thailand after 1985 did not affect change in saving rates much. In contrast, change in saving rates during these periods was mainly due to a secular trend. Further, based on the simulation, the saving rates decline to about 5 percent around 2050, which is about 80 percent lower than the peak during 1980-1985.

Figure 4-7: Saving Rate Projections: Mason and Lee Model



Results based on the Mason and Lee simulation model show that even though population aging leads to a decline in saving rates, assets per labor income increase and remain at a high level in the future period. These findings, using Thailand's data, are consistent with the results by Mason and Lee (2006) using Taiwan's data. An increase in assets allows individuals to earn a higher asset income, which can be used to support a higher level of consumption.

4.5 Conclusions

Population aging leads to a decline in saving rates. However, the effects of population aging on saving rates are not so severe. There are two models used to simulate saving rates under different assumptions about how age profiles of saving are modeled.

The first method, using the Deaton and Paxson (2000) simulation model, assumes the age profiles of saving are fixed for all cohorts. Saving can be decomposed into age and cohort effects. Age effects of saving in Thailand show a hump shape. People save less during young working ages than old working ages, then they dis-save when they retire. The cohort effects show that younger cohorts in Thailand save less than older cohorts. Using population estimates and projections, saving rates can be simulated. The results based on the Deaton and Paxson model show that saving rates in Thailand increased after 1975, which corresponds to the period when the fertility rates in Thailand declined and the share of the working ages increased. Simulated saving rates would increase until 2020 before declining slowly with an increase in the share of the elderly. The simulated saving rates would decline more rapidly if the economic growth is slow.

The second method, using Mason and Lee (2006)'s simulation model, assumes the saving age profiles may vary for all cohorts. The results show that simulated saving rates increased during the period when the effective number of producers relative to effective number of consumers was high. Then, simulated saving rates decline when assets increase slowly. Even though, population aging leads to a decline in saving rates, population aging leads to higher assets and asset income in the economy, allowing people to consume at higher level of consumption.

This paper finds that simulated saving rates based on both the Deaton and Paxson model and the Mason and Lee model show similar effects of change in age structure on change in saving rates in Thailand. Change in age structure in Thailand had major effects on change in saving rates before 1985. However, after 1985 changes in saving rates were mainly due to secular trends rather than change in age structure. The major difference between these two models is on the level of simulated saving rates for the future. Simulated saving rates based on the Deaton and Paxson model would not change much with population aging. In contrast, simulated saving rates based on the Mason and Lee model would decline significantly with population aging.

CHAPTER 5
CONCLUSION

This research presents the relationship between population age structure and how individuals support their consumption. Age structure can influence saving and the economy, which requires investigation. There are three main findings from the research.

First, age structure can be used to signify which age groups within the population are dependent and which are productive. Dependent ages are mainly among children and the elderly who do not produce enough to support their consumption. Productive ages are among working ages. The results for Thailand in 1996 show the age at which individuals begin to produce more than they consume or become net producers is at 24. The age at which people no longer produce more than they consume is 59. The span of years during which there is a lifecycle surplus is at 35 years. This finding shows that people have about 35 productive years to generate resources and economic flows to support other age groups. Children do not produce or earn asset income. They receive transfers mainly from the family and partly from the public sector. The elderly are not as productive as working ages. They receive large asset income and transfers from the family. However, the elderly do not receive much support from the public sector. Public programs used to support the elderly in Thailand are small.

Second, there is important relationship between age structure and different forms of assets individuals accumulate or dis-accumulate to achieve their lifecycle plan. Older age groups may rely on upward reallocations from younger age groups through public and private credit income, public capital bequest, and net lending to the public sector. Younger age groups may rely on downward reallocations through net lending to consumer debt and public credit bequest. Some forms of reallocations, such as public investment, public lending and private investment, can be increased with age until age groups approach retirement ages.

Third, this paper measures how much change in population age structure affects saving rates. The results are based on two simulation models: Deaton and Paxson (2000) and Mason and Lee (2006). Simulated saving rates based on both models show similar effects from change in age structure. Change in age structure in Thailand had major effects on change in saving rates before 1985. Declining fertility and rising share of working ages leaded to an increase in saving rates. However, after 1985 change in age structure does not have much effect on change in saving rates. Simulated saving rates decline whereas actual saving rates increase.

There are limitations for this research, which are mainly due to data limitation. This empirical research requires extensive uses of data, mainly from the Socio-economic Surveys (SES). There are several age profiles tabulated or estimated from the SES in order to construct the National Transfer Flow Accounts. Some age profiles may mis-represent the aggregates from the national accounts because the SES may under-report some income and expenses, such as income from the informal sector and tax payment. In addition, there are some data problems from the SES, such as population by age does not include institutionalized population, which could mislead the results. Apart from the SES, there are some problems with aggregate data to measure shares of the foreigners who involve with the economic activities, i.e. share of those who pay taxes or receive income from government bonds. It is important to thoroughly investigate this information in the future.

APPENDIX

Mathematical Explanation for Mason and Lee (2006) Simulation Model

This section presents how saving rates are simulated using Mason and Lee (2006) model. This part is drawn substantively from Mason and Lee (2006). First, simulation methods for lifecycle wealth and its components, which are assets, child transfer wealth and pension transfer wealth, are presented. Then, this section describes how to solve for consumption at the steady state level.

Aggregate lifecycle wealth

Aggregate lifecycle wealth of all adults of age a in year t, $W(a,t)$, is the combined lifecycle wealth of all adults of age a in year t. It is equal to the present value of the consumption less the present value of the labor income of those adults over the remainder of their lives. Let PV[] be the present value operator. Then,

$$W(a,t) = PV[C(a,t)] - PV[Y(a,t)] \tag{1}$$

where $C(a,t)$ and $Y(a,t)$ are vectors of current and future consumption and current and future labor income, respectively, for the cohort of age a in year t.

The effect of age on earnings is captured in the effective number of producers (L) where:

$$\begin{aligned} L(a,t) &= \gamma(a)P(a,t) \\ L(t) &= \sum_{a=0}^{\omega} L(a,t), \end{aligned} \tag{2}$$

and *P(a,t)* is the population aged a at time t, ω is the oldest age achieved and $\gamma(a)$ is an age-specific, time-invariant vector of coefficients measuring age variation in labor income. Similarly, the effective number of consumers (*N*) is:

$$\begin{aligned} N(a,t) &= \phi(a)P(a,t) \\ N(t) &= \sum_{a=0}^{\omega} N(a,t) \end{aligned} \tag{3}$$

where $\phi(a)$ is an age-specific, time-invariant vector of coefficients measuring relative levels by age of cross-sectional consumption.

Total labor income in year t is determined by the total number of effective producers and the level of labor productivity as measured by the labor productivity index, $\overline{y}(t)$. Likewise, total consumption in year t is determined by the total number of effective consumers and the level of consumption as measured by the consumption index, $\overline{c}(t)$:

$$\begin{aligned} Y(t) &= \overline{y}(t)L(t) \\ C(t) &= \overline{c}(t)N(t) \end{aligned} \tag{4}$$

The rate of growth of labor productivity (g_y) is exogenous and constant so that:

$$\overline{y}(t+x) = \overline{y}(t)G_y(x) \tag{5}$$

where $G_y(x) = (1+g_y)^x$. The rate of growth of the consumption index will vary over time and is endogenously determined. The consumption index can be represented as an annual series of endogenously determined growth rates:

$$\begin{aligned} \overline{c}(t+x) &= G_c(t,x)\overline{c}(t) \\ G_c(t,x) &= \prod_{z=0}^{x-1}(1+g_c(t+z)) \end{aligned} \tag{6}$$

where $g_c(t+z)$ is the rate of growth in the consumption index between year $t+z$ and $t+z+1$.

These general rules can be applied to year t adults to determine their labor income and consumption over their remaining adult years and, hence, their wealth in year t. Let $NTOT(t,x)$ denote the number of effective consumers in year $t+x$ who were adults in year t. Similarly, $LTOT(t,x)$ denotes the number of effective producers in year $t+x$ who were adults in year t, where a_0 is the age of adulthood:

$$\begin{aligned} NTOT(t,x) &= \sum_{a=a_0+x}^{\omega} N(a,t+x) \\ LTOT(t,x) &= \sum_{a=a_0+x}^{\omega} L(a,t+x). \end{aligned} \tag{7}$$

In a closed population NTOT and LTOT would depend only on survival rates, but in an open population they will include migrants who were adults in year t.

The labor income of year t adults at age $a \geq a_0 + t$ in year $t+x$ is:

$$Y(a,t+x) = \bar{y}(t+x)L(a,t+x) \tag{8}$$

and consumption by year t adults in year $t+x$ is:

$$C(a,t+x) = \bar{c}(t+x)N(a,t+x). \tag{9}$$

The present value in year t of the current and future lifetime consumption of all adults is given by:

$$PVC(t) = \bar{c}(t)\sum_{x=0}^{\omega-a_0} D(x)G_c(x,t)NTOT(t,x), \tag{10}$$

and the present value in year t of the current and future lifetime production of all adults is given by:

$$PVY(t) = \bar{y}(t) \sum_{x=0}^{\omega - a_0} D(x) G_y(x) LTOT(t,x), \tag{11}$$

where $D(x)$ is the discount factor $(1+\delta)^{-x-1}$. Substituting into equation (1), the lifecycle wealth of all adults in year t is:

$$\begin{aligned} W(t) = \bar{c}(t) &\sum_{x=0}^{\omega - a_0} D(x) G_c(x,t) NTOT(t,x) \\ -\bar{y}(t) &\sum_{x=0}^{\omega - a_0} D(x) G_y(x) LTOT(t,x). \end{aligned} \tag{12}$$

Components of Wealth

Lifecycle wealth in year t for the cohort comes in three forms: assets (A), transfer wealth associated with childrearing (T_K) and pension transfer wealth (T_P), i.e.,

$$W(a,t) = A(a,t) + T_k(a,t) + T_P(a,t). \tag{13}$$

Pension wealth is defined as $W_P(a,t) = A(a,t) + T_P(a,t)$, i.e., assets plus pension transfer wealth.

Assets can be negative, but by assumption they can only be held by adults. Aggregate assets in year t are calculated by summing over all adult cohorts:

$$A(t) = \sum_{a=a_0}^{\omega} A(a,t) \tag{14}$$

Summing transfer wealth variables over all adult ages:

$$A(t) + T_P(t) = W_p(t) = W(t) - T_k(t). \tag{15}$$

where $T_P(t)$ is pension transfer wealth, $T_k(t)$ is child transfer wealth, and $W_p(t)$ is pension lifecycle wealth equal to the sum of assets and pension transfer wealth.

The relative size of pension transfer wealth is captured by $\tau(t) = T_P(t)/W_p(t)$ and the relative size of child transfer wealth by $\tau_k(t) = T_k(t)/W(t)$. Substituting into equation (15) and rearranging terms gives the total assets of adults in year t and, because only adults hold assets, aggregate assets in year *t*:

$$A(t) = (1 - \tau(t))\left(1 - \tau_k(t)\right)W(t). \tag{16}$$

In the analysis presented here, pension transfer policy, $\tau(t)$, is assumed to be exogenous.

The following explains how to simulate child transfer wealth, pension transfer wealth and assets. Next, the solutions to estimate assets and consumption at the steady state level are described. Then, the methods to simulate assets, consumption and other variables at years before steady state using backward recursion are presented.

Child Transfer Wealth

The cost of children to year *t* adults also depends on their share of the costs of children in future periods. By assumption all of the *current* costs of children are born exclusively by year *t* adults. Year *t* adults are responsible only for a portion of the cost of children in subsequent years, because some portion of the costs of children is shifted to persons who become adults after year *t*.

The model distinguishes two ways in which child costs are financed: familial transfers and public transfers. Adult parents are assumed to bear the cost of familial transfers. Public transfers are financed through a proportional tax on labor income. The relative mix of these two mechanisms is an exogenously determined policy variable.

The cost of all children age z in year $t+x$ is:

$$\begin{aligned} COST(z,t+x) &= Y(z,t+x) - C(z,t+x) \\ &= \bar{y}(t)G_y(x)L(z,t+x) - \bar{c}(t)G_c(t,x)N(z,t+x) \qquad z < a_0 \end{aligned} \tag{17}$$

A fraction of the cost of children of age z in year $t+x$ is financed through transfers by year t adults; the remainder is financed through transfers by persons who became adults between year t and $t+x$. Let $TAX_k(z,t,x)$ be the share of child costs paid by year t adults. Then, child transfer wealth in year t for year t adults is:

$$T_k(t) = \sum_{x=0}^{\omega-a_0} D(x) \sum_{z=0}^{a_0-1} \mathrm{TAX_k}(z,\mathrm{t},\mathrm{x})\mathrm{COST}(z,\mathrm{t+x}) \tag{18}$$

Substituting for COST from equation (17) yields:

$$\begin{aligned} T_k(t) &= \bar{y}(t)\sum_{x=0}^{\omega-a_0} D(x)G_y(x)KLTOT(t,x) - \bar{c}(t)\sum_{x=0}^{\omega-a_0} D(x)G_c(t,x)KNTOT(t,x) \\ KLTOT(t,x) &= \sum_{z=0}^{a_0-1} \mathrm{TAX_k}(z,\mathrm{t},\mathrm{x})L(z,t+x) \\ KNTOT(t,x) &= \sum_{z=0}^{a_0-1} \mathrm{TAX_k}(z,\mathrm{t},\mathrm{x})N(z,t+x) \end{aligned} \tag{19}$$

where $KLTOT(t,x)$ is the total number of children in year $t+x$ dependent on year t adults measured in equivalent production units and in year $t+x$ and $KNTOT(t,x)$ is the total number of children in year $t+x$ dependent on year t adults measured in equivalent consumption units.

Tax burden of year t adults depends on whether child costs are financed through public or private (familial) transfer programs. Mason and Lee assume that the shares of public and private transfers are constant and exogenous, i.e., they are a matter of public policy. Let the familial share be τ^f and the public share be $1-\tau^f$. Then the share of cost paid by year t adults is a weighted sum of the taxes paid through a familial transfer system and the taxes paid through a public transfer system, i.e.,

$$TAX_k(z,t,x) = \tau^f TAX_k^f(z,t,x) + (1-\tau^f)TAX_k^g(z,t,x) \quad (20)$$

where $TAX_k^f(z,t,x)$ is the share of child costs paid by year t adults under a familial transfer system and $TAX_k^g(z,t,x)$ is the share of child costs paid by year t adults under a public transfer system.

All public transfers to children are assumed to be financed by a proportional tax on labor income. Thus,

$$TAX_k^g(z,t,x) = \sum_{a=a_0+x}^{\omega} Y(a,t+x)/Y_A(t+x) \quad (21)$$

where $Y_A(t+x) = \sum_{a=a_o}^{\omega} Y(a,t+x)$ is the total labor income of all in year $t+x$.

The tax share of year t adults is in year $t+x$ is their share of labor income in year $t+x$. Note that the public tax share is independent of the age of the child, z. Henceforth, the z argument can be dropped.

Mason and Lee assume that familial transfers are determined by parentage. If $F(z,t,x)$ equal the proportion of those aged z with parents (mothers) age $a_0 + x$ or older in year *t+x*, then

$$TAX_k^f(z,t,x) = F(z,t,x) \tag{22}$$

where F is calculated using the distribution of births to women:

$$F(z,t,x) = \frac{\sum_{a=a_0+x-z}^{AGEM} B(a,t+x-z)}{\sum_{a=a_0}^{AGEM} B(a,t+x-z)} \quad \text{for } x > z \tag{23}$$
$$= 1 \quad \text{for x} \leq \text{z.}$$

and $B(a,t+x-z)$ is births to women aged a in year *t+x-z*. Children who are *x* years or older are all the offspring of year *t* adults (mothers) and hence F has a value of 1. The value of F declines to zero as *x* increases. (Note that F can be represented as a function of *t* and *x-z*. It isn't really three dimensional.)

Substituting into equation (20), the share of year *t* adults is:

$$TAX_k(z,t,x) = \tau^f F(z,t,x) + (1-\tau^f) \sum_{a=a_0+x}^{\omega} Y(a,t+x)/Y_A(t+x) \tag{24}$$

Substituting into equation (19) yields child transfer wealth for year *t* adults. Note that the tax shares devoted to childrearing are determined exogenously by population age structure, fertility, the age profile of earnings – all exogenous factors. Thus, in the determination of child transfer costs, the only endogenous variable is the vector of the consumption index. Child transfer wealth is equal to:

$$T_k(t) = \bar{y}(t)\sum_{x=0}^{\omega-a_0} D(x)G_y(x)KLTOT(t,x) - \bar{c}(t)\sum_{x=0}^{\omega-a_0} D(x)G_c(t,x)KNTOT(t,x) \tag{25}$$

where $KLTOT(t,x)$ and $KNTOT(t,x)$ are the effective numbers of child producers and consumers, respectively, in year $t+x$ for which year t adults are financially responsible.

Lifecycle Pension Wealth: $W_p(t)$

Pension wealth is equal to lifecycle wealth less child transfer wealth. Combining the results from equations (12) and (25) and rearranging terms yields:

$$\begin{aligned} W_p(t) &= \bar{c}(t)\sum_{x=0}^{\omega-a_0} D(x)G_c(t,x)\big(NTOT(t,x) + KNTOT(t,x)\big) \\ &\quad -\bar{y}(t)\sum_{x=0}^{\omega-a_0} D(x)G_y(x)\big(LTOT(t,x) + KLTOT(t,x)\big). \end{aligned} \tag{26}$$

Lifecycle pension wealth is the discounted present value of current and future consumption by year t adults and their dependent children less the present value of current and future production by year t adults and their dependent children.

Assets

Total assets are governed by the lifecycle accounting just described, but also by a macroeconomic constraint: the change in assets from one period to the next must equal saving during the period. Mason and Lee assume that assets are measured at the beginning and that consumption and labor income accrue at the end of the period and, hence:

$$(1+r)A(t) + Y(t) - C(t) = A(t+1). \tag{27}$$

Steady-state Results

In steady-state, assets grow at the same rate as total labor income, g_Y. Substituting $(1+g_Y)A(t)$ for $A(t+1)$, substituting for income and consumption, and rearranging terms, assets in steady state must satisfy:

$$A(t^*) = \frac{1}{r-g_Y}\left[\bar{c}(t^*)N(t^*) - \bar{y}(t^*)L(t^*)\right]. \tag{28}$$

From the analysis of the lifecycle the relationship between assets and lifecycle pension wealth is governed by exogenously specified pension transfer policy:

$$A(t^*) = (1-\tau(t^*))W_p(t^*), \tag{29}$$

where $W_p(t)$ is given in equation (26). Combining the macro and lifecycle conditions, and noting that the growth rate of the consumption index must equal the growth rate of the production index in steady-state, the consumption index in steady-state must satisfy:

$$\frac{1}{r-g_Y}\left[\bar{c}(t^*)N(t^*) - \bar{y}(t^*)L(t^*)\right] = (1-\tau(t^*))W_p(t^*). \tag{30}$$

Rearranging terms yields:

$$\frac{\bar{c}(t^*)}{\bar{y}(t^*)} = \frac{L(t^*)}{N(t^*)}\left[1 + (r-g_Y)(1-\tau(t^*))w_p(t^*)\right], \tag{31}$$

where $w_p(t^*)$ is the ratio of lifecycle pension wealth to current labor income.

Equation (40) tells us the level of consumption that can be sustained in steady-state given any level of labor productivity. Age-structure determines the steady-state consumption ratio through two multiplicative factors – the economic support ratio and a second factor that captures the influence of age structure on lifecycle pension wealth and, hence, assets.

Backward Recursion

The backward recursion solution computes the consumption index and, hence, all other variables in period *t-1* conditional on the values in period *t*. The steady-state values are known. Hence, we can begin in period *t**, solve for period *t*-1*, and recursively solve for all periods *t*.

From lifecycle accounting, assets in period *t-1* depend on pension policy and lifecycle wealth in year *t-1*. From equations (26) and (29):

$$\begin{aligned} A(t-1) = &\bar{c}(t-1)(1-\tau)\sum_{x=0}^{\omega-a_0} D(x)G_c(t-1,x)\big(NTOT(t-1,x)+KNTOT(t-1,x)\big) \\ &-\bar{y}(t-1)(1-\tau)\sum_{x=0}^{\omega-a_0} D(x)G_y(x)\big(LTOT(t-1,x)+KLTOT(t-1,x)\big). \end{aligned} \tag{32}$$

Pension policy may vary with year, but here we drop *t* to simplify notation. The right-hand-side variables include consumption in year *t-1*, consumption in year *t* and subsequent years, and labor income terms in year *t-1* and later. Only the consumption terms in year *t-1* are unknown and must be solved for. These are distinguished in:

$$\begin{aligned} A(t-1) = &\bar{c}(t-1)(1-\tau)N(t-1)D(0) \\ &+(1-\tau)\sum_{x=1}^{\omega-a_0} D(x)\bar{c}(t-1+x)\big(NTOT(t-1,x)+KNTOT(t-1,x)\big) \\ &-\bar{y}(t-1)(1-\tau)\sum_{x=0}^{\omega-a_0} D(x)G_y(x)\big(LTOT(t-1,x)+KLTOT(t-1,x)\big). \end{aligned} \tag{33}$$

From macro-accounting, we know that:

$$A(t-1) = \frac{A(t)+\bar{c}(t-1)N(t-1)-\bar{y}(t-1)L(t-1)}{1+r}. \tag{34}$$

This gives us two equations in two unknowns, assets and the consumption index in period *t-1*. Substituting for *A(t-1)* yields:

$$\bar{c}(t-1)(1-\tau)N(t-1)D(0)+(1-\tau)\sum_{x=1}^{\omega-a_0} D(x)\bar{c}(t-1+x)\left(NTOT(t-1,x)+KNTOT(t-1,x)\right)$$

$$-\bar{y}(t-1)(1-\tau)\sum_{x=0}^{\omega-a_0} D(x)G_y(x)\left(LTOT(t-1,x)+KLTOT(t-1,x)\right) \tag{35}$$

$$=\frac{A(t)+\bar{c}(t-1)N(t-1)-\bar{y}(t-1)L(t-1)}{1+r}$$

Multiplying both sides by *1+r* and rearranging terms yields:

$$\bar{c}(t-1)N(t-1)\left((1-\tau)(1+r)D(0)-1\right)$$

$$=A(t)-(1+r)(1-\tau)\sum_{x=1}^{\omega-a_0} D(x)\bar{c}(t-1+x)\left(NTOT(t-1,x)+KNTOT(t-1,x)\right) \tag{36}$$

$$+\bar{y}(t-1)(1+r)(1-\tau)\sum_{x=0}^{\omega-a_0} D(x)G_y(x)\left(LTOT(t-1,x)+KLTOT(t-1,x)\right)-\bar{y}(t-1)L(t-1)$$

Further algebra gives the consumption index for *t-1:*

$$\bar{c}(t-1)=\frac{\left\{\begin{array}{l} A(t)-(1+r)(1-\tau)\sum_{x=1}^{\omega-a_0} D(x)\bar{c}(t-1+x)\left(NTOT(t-1,x)+KNTOT(t-1,x)\right) \\ +\bar{y}(t-1)\left\{(1+r)(1-\tau)\sum_{x=0}^{\omega-a_0} D(x)G_y(x)\left(LTOT(t-1,x)+KLTOT(t-1,x)-L(t-1)\right)\right\} \end{array}\right\}}{N(t-1)\left((1-\tau)(1+r)D(0)-1\right)}. \tag{37}$$

Assets in period *t-1* can be calculated using either equation (33) or equation (34).

REFERENCES

Attanasio, O. P. (1998). "A Cohort Analysis of Saving Behavior by US Households." Journal of Human Resources **33**(3): 575-609.

Auerbach, A. J., L. J. Kotlikoff, et al., Eds. (1999). Generational Accounting Around the World. Chicago, University of Chicago Press.

Bank of Thailand (2000). Thailand's Economic and Monetary Conditions Bangkok, Bank of Thailand.

Bernheim, B. D. (1991). "How Strong Are Bequest Motives? Based on Estimates of the Demand for Life Insurance and Annuities." The Journal of Political Economy **99**(5): 899-927.

Bernheim, B. D., A. Shleifer, et al. (1985). "The Strategic Bequest Motive. "Journal of Political Economy **93**(6): 1045-1076.

Biddlecom, A., N. Chayovan, et al. (2002). Intergenerational Support and Transfers. The Well-Being of the Elderly in Asia. A. Hermalin. Ann Arbor, The University of Michigan Press.

Bloom, D. E., D. Canning, et al. (2003). "Longevity and Life-cycle Savings." The Scandinavian Journal of Economics **105**(3): 319-338.

Carroll, C. D. (1994). "How Does Future Income Affect Current Consumption?" The Quarterly Journal of Economics **109**(1): 111-147.

Cox, D. (1987). "Motives for Private Income Transfers." Journal of Political Economy **95**: 508-46.

Cutler, D. M., J. M. Poterba, et al. (1990). "An Aging Society: Opportunity or Challenge?" Brookings Papers on Economic Activity **1990**(1): 1-73.

Deaton, A. (1991). "Saving and liquidity constraints." Econometrica **59**: 1221–48.

Deaton, A. (1997). The Analysis of Household Surveys: A Microeconometric Approach to Development Policy. Baltimore and London, World Bank.

Deaton, A. and C. Paxson (2000). "Growth, Demographic Structure, and National Saving in Taiwan." Population and Development Review **26**(Supplement: Population and Economic Change in East Asia): 141-173.

Demery, D. and N. W. Duck (2006). "Savings–age profiles in the UK." Journal of Population Economics(19): 521-541.

Friedman, J. H. (1984). "SMART User's Guide." Laboratory for Computational Statistics **Stanfort University Technical Report No.1**.

Hansen, G. D. and S. Imrohoroglu (2006). "Consumption over the life cycle: the role of annuities." NBER Working Papers **12341**.

Hermalin, A., Ed. (2002). The Well-Being of the Elderly in Asia. Ann Arbor, The University of Michigan Press.

Higgins, M. and J. G. Williamson (1997). "Age Structure Dynamics in Asia and Dependence on Foreign Capital." Population and Development Review **23**(2): 261-93

Jappelli, T. and F. Modigliani (2003). "The Age-Saving Profile and the Life-Cycle Hypothesis." Center for Studies in Economics and Finance **Working Paper Number 9**.

Kakwani, N. and M. Krongkaew (1999). Thailand's Generational Accounts. Generational Accounting Around the World. A. Auerbach, L. Kotlikoff and W. Leibfritz. Chicago, University of Chicago Press: 413-446.

Kelley, A. C. and R. M. Schmidt (1996). "Saving, Dependency and Development." Journal of Population Economics **9**(4): 365-86.

Kennickell, A. and A. Lasardi (2004). "Disentangling the importance of the precautionary saving motive." NBER Working Paper **10888**.

Kinugasa, T. and A. Mason (2006). "Why Nations Become Wealthy: The Effects of Adult Longevity on Saving." World Development.

Kotlikoff, L. (1988). "Intergenerational Transfers and Savings." Journal of Economic Perspectives **2**(2): 41-58.

Kotlikoff, L. and A. Spivak (1981). "The Family as an Incomplete Annuities Market."Journal of Political Economy **89**(2): 372-91.

Kotlikoff, L. and L. Summers (1981). "The Role of Intergenarational Transfers in Aggregate Capital Accumulation." Journal of Political Economy **89(4)**: 706-32.

Lai, M. (2006). Intergenerational Transfers: Lessons from Taiwan. Department of Economics. Honolulu, University of Hawaii.

Lee, R. D. (1994a). The Formal Demography of Population Aging, Transfers, and the Economic Life Cycle. Demography of Aging. L. G. Martin and S. H. Preston. Washington, D.C., National Academy Press: 8-49.

Lee, R. D. (1994b). "Population, Age Structure, Intergenerational Transfers, and Wealth: A New Approach, with Applications to the US." The Family and Intergenerational Relations, Journal of Human Resources **P. Gertler. XXIX**: 1027-1063.

Lee, R. D. (2000). Intergenerational Transfers and the Economic Life Cycle: A Cross-cultural Perspective. Sharing the Wealth: Demographic Change and Economic Transfers between Generations. A. Mason and G. Tapinos. Oxford, Oxford University Press: 17-56.

Lee, R. D. (2003). "The Demographic Transition: Three Centuries of Fundamental Change." Journal of Economic Perspectives **17**(4): 167-190.

Lee, R. D., S.-H. Lee, et al. (2006). "Charting the Economic Life Cycle." NBER Working Papers **12379**.

Lee, R. D., A. Mason, et al. (2003). "From Transfers to Individual Responsibility: Implications for Savings and Capital Accumulation in Taiwan and the United States." Scandinavian Journal of Economics **105**(3): 339-357.

Leff, N. H. (1969). "Dependency Rates and Savings Rates." American Economic Review **59**(5): 886-896.

Lillard, L. A. and R. J. Willis (1997). "Motives for Intergenerational Transfers: Evidence from Malaysia." Demography **34**(1): 115-34.

Maliki (2005). Essays on Education and Intergenerational Transfers in Indonesia. Department of Economics. Honolulu, University of Hawaii: 214.

Martin, L. G. (1989). "Living Arrangements of the Elderly in Fiji, Korea, Malaysia, and the Philippines." Demography **26**(4): 627-643.

Mason, A. (1987). National Saving Rates and Population Growth: A New Model and New Evidence. Population growth and economic development: Issues and evidence. D. G. Johnson and R. D. Lee. Madison, Wis., University of Wisconsin Press. **Social Demography series:** 523-60.

Mason, A. (1988). "Saving, Economic Growth, and Demographic Change." Population and Development Review **14**(1): 113-44.

Mason, A. and R. Lee (2006). "Transfers, Capital, and Consumption over the Demographic Transition." NTA Working Papers Number 06-01.

Mason, A., R. Lee, et al. (forthcoming). Population Aging and Intergenerational Transfers: Introducing Age into National Accounts. Economics of Aging Series. D. Wise. Chicago, NBER and University of Chicago Press.

Mason, K. (1992). "Family Change and Support of the Elderly in Asia: What Do We Know?" Asia-Pacific Population Journal **7**(3): 13-32.

Modigiani, F. and R. Brumberg (1954). Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data. Post Keynesian Economics. K. K. Kurihara, Rutgers University Press: 388-436.

Modigliani, F. (1988). "The role of Intergenerational Transfers and Life Cycle Saving in the Accumulation of Wealth." Journal of Economic Perspectives **2**(2): 15-40.

National Economic and Social Development Board (NESDB) (2001). National Income of Thailand. Bangkok, Office of the Prime Minister.

National Economic and Social Development Board (NESDB) (2003). Flow-of Funds Accounts of Thailand 1996-2000. Bangkok, Office of the National Economic and Social Development Board.

National Statistical Office (NSO) (1998, 1999, 2001). Statistical Yearbook of Thailand. Bangkok, Ministry of Information and Communication Technology.

Paxson, C. (1996). "Saving and growth: Evidence from micro data." European Economic Review **40**: 255-288.

Pongpanitch, A., C. Chanchareon, et al. (2005). National Health Account of Thailand. Bangkok, Ministry of Public Health.

Samuelson, P. (1958). "An Exact Consumption Loan Model of Interest with or without the Social Contrivance of Money." Journal of Political Economy **66**: 467-82.

Stecklov, G. (1999). "Evaluating the Economic Returns to Childbearing in Cote d'Ivoire." Population Studies **53**(1): 1-17.

Tomes, N. (1981). "The family, inheritance, and the intergenerational transmission of inequality." Journal of Political Economy **89**(5): 928-958.

United Nations (U.N.) (1993). Systems of National Accounts 1993. New York, United Nations publication.

United Nations (U.N.) (2004). World Population Prospects: The 2004 Revision. New York, United Nations.