



HOMES

No. 9

Using HOMES
for Population and Development
Planning

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and
Andrew Mason



HOMES Research Reports are circulated to inform planners and researchers about research findings and training materials from the Household Model for Economic and Social Studies developed at the East-West Population Institute. The primary purpose of the HOMES project is to expand the scope and improve the quality of demographic information available for development planning and the formulation of economic and social policy by providing projections of the number and demographic characteristics of households. In addition, modules have been developed to forecast economic changes in the household sector, for example in the composition of consumer expenditures, labor supply, and aggregate household saving. The HOMES project has been supported by the U.S. Agency for International Development, the Asian Development Bank, and the General Motors Research Laboratories. Their support is gratefully acknowledged. A list of other HOMES publications is included with this report. For further information about HOMES please contact: Andrew Mason, East-West Population Institute, East-West Center, Honolulu, Hawaii 96848.

HOMES Research Report

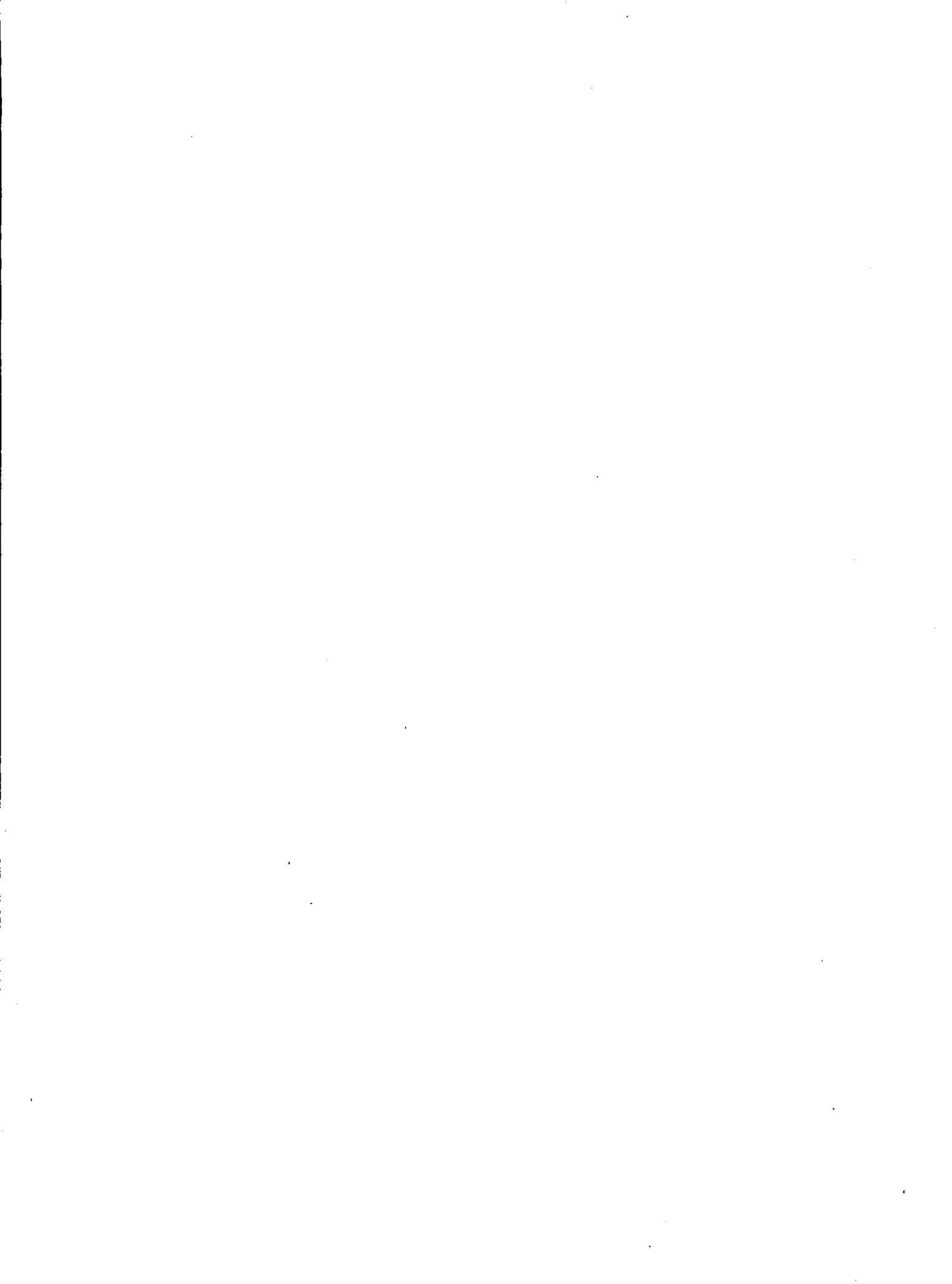
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October 1989

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This report was prepared for the United Nations' International Seminar on Population and Development Planning held at Riga, Latvian Soviet Socialist Republic from 4 to 8 December 1989.

I. INTRODUCTION

WHAT IS HOMES?

HOMES, Household Model for Economic and Social Studies, is a computer model developed at the East-West Center to forecast the number and demographic characteristics of households. By applying the model to standard population projections, the user is provided projections of the number of households; the age and sex of the household head; average household size; the number, age, and sex of household members; and, other basic demographic information about households. This demographic information is used, in turn, to forecast related social and economic trends and to examine the links between population growth and economic development.

Although one of the primary objectives of the model is to project the total number of households, four types of households are distinguished in the analysis: (1) intact households, *i.e.*, those headed by a male with the spouse present; (2) male and female single head households, *i.e.*, households in which the head's spouse is not present; (3) male and female one-person households; and, (4) primary individual households, *i.e.*, those consisting of unrelated members. These four categories encompass all members of the population except the military and institutionalized populations, which are projected separately.

WHERE HOMES HAS BEEN APPLIED

HOMES has been applied to problems of national planning and to the analysis of interactions between economic and demographic change in Japan, Thailand, and South Korea. Studies are under way utilizing HOMES in Indonesia, Singapore and the Philippines. They are planned for China and Malaysia. Backward projections to get a better understanding of experienced economic change have been carried out in some of these countries and are planned for the U.S. The Thai study, carried out under a technical assistance grant from the Asian Development Bank provides the most extensive example of the use of HOMES and will be referred to throughout this paper.

WHY HOUSEHOLD FORECASTS?

Why is it important to have this information? Changes in the number and demographic characteristics of households are known to influence saving and labor force participation rates, school enrollment, the demand for housing and consumer expenditure patterns, *e.g.*, the share of the household budget devoted to food, clothing, health etc., and the nature and extent of social welfare issues, *e.g.*, problems faced by the elderly including living arrangements and support by adult children as the number of elderly increases. HOMES provides basic demographic information necessary to analyze these issues and assess the importance of demographic change for the development of a wide range of social and economic policies.

An increasing body of research points to the importance of the household as a determinant of social and economic behavior. Women who have young children behave differently than women who do not. Children raised in homes with both parents present differ from those raised by a single parent. What the household buys and what the household owns varies with the number of members, their age, and their sex. The standard of living of most people depends as much on the earnings of other members of the household as it does on their own. Thus, improving the availability of information about households and how they will change can assist in developing more effective policy and in improving social and economic planning.

Change in the supply of labor provides one example. In many countries changes in labor force participation are dominated by the employment decisions of women, which, in turn, are closely connected to childrearing responsibilities and the presence of other wage earners in the household. Thus, accurate forecasts of labor supply cannot be prepared if the changing family circumstances of women are ignored.

Another example is economic security. In industrialized and developing countries alike, but particularly in developing countries where extended or multigenerational households prevail and government sponsored social security programs are limited, the household is the basic provider of economic security. Household members are protected from bouts of unemployment if there are many workers in the household. Old age security is also effectively handled by multi-earner, extended households. For example, in Thailand, family households with a head over 65 typically have two or more wage earners, reducing the need to rely on saving and government support.

Few would deny that the household is an important institution, but many might argue that its role need not be explicitly modelled except in a limited number of cases, *e.g.*, the demand for housing. This view would have some merit if the household were a stable and unchanging institution, but such is not the case. Many developing countries, but especially those in Asia, are experiencing major demographic changes that are having a profound impact on the household. For example, in Thailand the average size of households is dropping rapidly, the average age of the head is increasing, the number of dependent children is declining, and so on. Moreover, in some developing countries, there is evidence that the extended family may be declining in importance, whereas nuclear households are becoming increasingly important.

II. HOW HOMES FORECASTS

INTRODUCTION

HOMES can be conceptualized as consisting of two stages.¹ In the first stage, the rules governing household formation and composition are determined using base year data. In stage II, the number and composition of households are projected combining the results of stage I with population projections. Stage II is run repeatedly to assess the implications of alternative population projections. But stage I is run only when new information from a major survey or census becomes available.

The data requirements for HOMES are relatively modest and the package can be applied if the following data are available: population projections, including age-specific fertility rates; and, a recent census or large, representative survey which includes a household roster with the age, sex, and relationship to the household head of each household member.

PROJECTING HOUSEHOLDS

Forecasts of the number of intact households are made as follows, using male household heads aged 25-29 with spouses aged 20-24 as an example. The base period number of heads in this category is divided by one-half the base period sum of the male population 25-29 and the female population 20-24 to obtain the base period headship rate for males 25-29 with spouses 20-24. Given population projections, the number of intact households with male heads aged 25-29 and spouses aged 20-24 can then be forecast by multiplying one-half the sum of the projected male population aged 25-29 and female population aged 20-24 in any future period by the base period headship rate for males aged 25-29 with spouses aged 20-24. When this is done for all age groups and the results are summed the outcome is a forecast of the total number of intact households.²

Female and male headed households without a spouse are forecast as follows. The base period female heads of households aged x are divided by the total female

¹A detailed discussion of the HOMES household projection methodology is given in Andrew Mason, *HOMES: A Household Model for Economic and Social Studies*, Papers of the East-West Population Institute, Number 106, Honolulu, Hawaii, August 1987.

²This projection procedure captures the impact of the changing sex ratio on intact household headship as the following equation shows: $h_t(x) = h_0(x) \sum d_0(x, w) [(1 + s_t(x, w)) / (1 + s_0(x, w))] w$, where h is the headship rate for men aged x in the current or in the base year, d is the fraction of heads aged x married to women aged w in the base year, and s is the ratio of women aged w to men aged x in the current or in the base year. The summation term is a weighted average of a measure of the change in the sex ratio, where the weights depend on the age distribution of marriage for intact household heads and their wives.

population aged x to get the base period headship rate. The headship rate is then multiplied by the forecast female population aged x to obtain the forecast of the number of households headed by females aged x in the future period. Doing this for all age categories in both sexes yields the total number of single headed households.

Finally, one person and primary individual households are forecast similarly to single headed households with base period headship rates for these categories of households calculated for each age class in each sex group and then multiplied by the forecast population in each age-sex class.

PROJECTING HOUSEHOLD MEMBERSHIP

One of the unique features of HOMES is the projection of household membership which provided the user with the average number of members and the age and sex distributions for each household group. In addition to the household head, the number of spouses, children, grandchildren, parents, and other household members are projected. A similar procedure is followed for each relationship to head category. Using demographic procedures described in more detail below, the number of potential household members are quantified. For example, surviving male offspring are potentially children of household heads, but only if they live at home. Based on census or survey data for the base year, the numbers living at home are compared with the potential to calculate "probabilities" that describe the likelihood that relatives of a particular type will live in households headed by their father or mother or grandfather, *etc.* These "probabilities" are then applied to projections of relatives to determine future household membership. The sections that follow describe procedures for each relationship to head category.

Spouse of head

The projection of spouses is handled in a manner somewhat different from other household members because it is intrinsically tied to the projection of intact households — each intact household implies one household head and one spouse. In the absence of changes in the sex ratio (both within and across age groups), the proportion of women at each age projected to be a spouse would be held constant. Furthermore, given unchanging sex ratios the joint age-distribution of heads and spouses would be held constant. However, as sex ratios do change over time, the proportion of women who are spouses change. Declines in the relative availability of men lead to declines in the proportion of women who are the spouse of a head.³

³More specifically, the proportion of women who are the spouse of a head is calculated as: $h'(w) = h'(w) \sum d'(x, w) [(1 + s'(x, w)) / (1 + s'(x, w))] | x$, where h' is the proportion of women aged w who are spouses, d' is the proportion of spouses aged w with husbands aged x , and s' is ratio of men aged x to women aged w where the subscripts indicated either the base year (0) or the year to be calculated (t). The equations that determines headship rates, insure that the number of heads aged x with wives aged w equals the number of wives aged w with husbands aged x .

Number of children and grandchildren

To project the number of children of heads residing in households it is necessary to know the number of people who are candidates for household membership as the child of the head. Simply put, we need an answer to the following question: "If all surviving offspring decided to live with their parents, how many of each age and sex would we find in each type of household?"

The answer to this question is obtained using a technique introduced by Mason and Martin, 1982.⁴ Suppose that there are 1 million boys who are ten years old in 1980. All are candidates to be the son of a head, but how are they to be distributed among the alternative households? Ignoring some minor details, all of the boys were born in 1970 and, based on birth records, we know that, say, 5% were born to women aged 15–19, 20% to women aged 20–24, 35% to women aged 25–29, and so on. It follows that in 1980, approximately 5% of the 10 year old boys, or 50,000 of the 1 million surviving offspring, will be the sons of mothers who are currently aged 25–29 and candidates to be the son of a head in households with women aged 25–29. Likewise, 20% of the boys or 200,000 will be the sons of women who are currently 30–34 years old and candidates for membership in households containing these women. The remaining 10 year old sons, as well as sons and daughters of other ages, are distributed in similar fashion.

The principle underlying the calculations allocating the number of sons among the three household types is that children will be distributed among households in proportion to the prevalence of those households. If the number of single headed households increases relative to the number of intact households, then the number of children residing in single headed households will increase proportionately. The principle is operationalized in the following fashion. For each age group, the distribution of households by type and the distribution of sons of head by type of household are both calculated. For example, suppose intact households make up 90.3 percent of the households with a female head or spouse 25 to 29 years old but contain 93.3 percent of the children. Taking the ratio of the two values, we would obtain 1.034 — intact households have 3.4 percent more than their *pro rata* share of sons of head. This value, designated as K, is then held constant throughout the projection. Intact households generally have somewhat more than their share, which one would expect of a group with childbearing currently uninterrupted by divorce, widowhood, or the absence of the spouse for some other reason. Single male heads have well below their share of children, because when husband and wife are living apart, children are more likely to live with the mother. Conversely, single female heads typically have close to their *pro rata* share of children despite the interrupted state of their marriage.

The information employed to estimate the number of surviving offspring who are candidates to be the child of head can be readily applied to estimate the candi-

⁴Andrew Mason and Linda G. Martin, "Intergenerational Differences in Income: An Analysis of Japan", in *Income Distribution and the Family, special supplement to Population and Development Review*, Yoram Ben-Porath, ed., 1982.

dates to be the grandchild of head. From projections of the number of children of head we obtain the number of daughters at each childrearing age. To the daughters we apply surviving offspring per mother ratios to obtain estimates of the candidates for grandchild status. If childbearing by daughters of heads is identical to childbearing by women, in general, the calculated values will equal the number of surviving grandchildren of heads residing in or out of the household. The ratios of the observed number of grandchildren to the calculated "expected" number in the base year constitute the grandchild rates used to project the number of grandchildren.

Parents

Candidates for membership of households as the parent of head consist of members of cohorts who have surviving offspring old enough to be household heads or wives of household heads. The population "at risk", consisting of mothers, fathers, mothers-in-law, and fathers-in-law, is quantified as the average number of parents who would reside with their offspring if all parents lived with their children. The "at risk" population is determined by two demographic factors. First, changes in survival affect the probability that parents of a given age are living. Second, changes in fertility affect the probability that a parent will be living with any one of several offspring.⁵ The idea is illustrated by a simple example. Suppose that the household head had two surviving parents and four surviving siblings; the surviving parents per offspring for this household would be $2 \text{ parents} / 5 \text{ offspring} = 0.4$. If, in addition, the head had a spouse with 1 surviving parent and 1 surviving sibling, surviving parents-in-law would be $1 \text{ parent} / 2 \text{ siblings} = 0.5$. The sum, 0.9, would be the expected number of parents if all parents lived with their offspring. For intact households, parents per offspring includes both parents and parents-in-law; however, for households headed by single persons, the supply of potential parents includes only the parents of the head and not the absent spouse.

In the absence of behavioral changes in the rules governing coresidence, many developing countries, particularly those far along in their demographic transitions, will experience an increase in the average number of parents per household. The principle cause of the increase in parents per offspring is declining fertility. Surviving offspring will have far fewer surviving siblings with whom the responsibility of parental support can be shared. There is also some concentration of parents per offspring values within a narrower age band. Again, this reflects a concentration of fertility among women at prime childbearing ages.

Other household members

For projection purposes the number of other household members of each age and sex is calculated as a residual. The number of individuals of each age who are heads, spouses, children, parents, or grandchildren of the head are totalled and subtracted from the total number of individuals of that age. The number of others

⁵This is particularly true in East and Southeast Asia where extended families are usually of the stem type, and parents live with only one married offspring at a time.

of each age and sex are then distributed among households distinguished by type, age of head, and age of spouse in proportion to their occurrence in the base years.

Rules governing coresidence

Although the HOMES procedures described allow for many more sources of change in households and in the composition of households than do the household forecasting techniques usually employed, they do involve a key assumption. The underlying age specific head/spouse rates governing headship and coresidence are held constant over time. This assumption abstracts from the potential impact of economic growth and socioeconomic change (urbanization, changing values and opportunities with modernization, education, improved life expectancy and health) that may lead elderly to live more on their own; or, young adults to establish households before they are married with great frequency; or, married couples to divorce with greater frequency as they have in the United States. Various ways of endogenizing these relations in HOMES are being investigated. One, that models changing headship rates, is being used in the application of HOMES to Japan.⁶

⁶Andrew Mason, Naohiro Ogawa, and Takehiro Fukui, *Household Projections for Japan, 1985-2025: A Transition Model of Headship Rates*, June 1989.

III. APPLICATIONS

The following brief discussion of the application of HOMES is based on an ADB funded analysis of demographic change in Thailand between 1985 and 2015, part of the technical assistance grant noted above. The results and methodology used to derive the results of this HOMES based analysis are scheduled to be published in an edited volume by the East-West Center and ADB within the year. The goal in the following is to show the kinds of insights HOMES can provide even if all the desired data are not available and to whet the readers appetite to know more.

HOMES HOUSEHOLD FORECASTS

Using the HOMES methodology the number of households in Thailand is projected to continue to grow quite rapidly for many years to come⁷, increasing from the current 10 million to almost 22 million by 2015. Although the rules governing the formation and composition of households do not appear to be changing *i.e.*, there is no apparent movement toward the Western model of the nuclear household, the demographic character of the Thai household, its size and age composition, will change a great deal as a consequence of declining fertility and improved mortality. Detailed projections of the number and demographic characteristics of households point to the following major trends.

Table 1. Household Projections, 1970-2015.

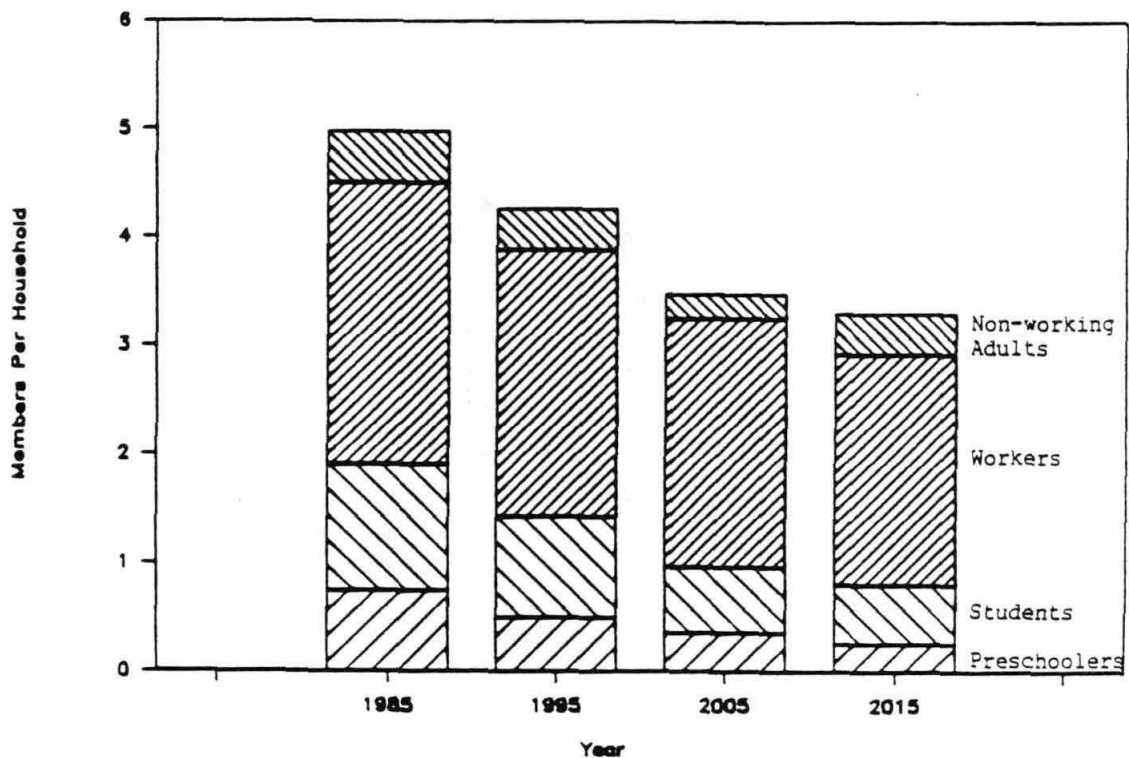
Year	Number of Household (1,000's)	Household Population (1,000's)	Average Household Size	Annual Increase (1,000's)
1970	6,200	36,370	5.82	—
1980	8,689	46,016	5.30	249
1985	10,215	50,902	4.98	305
1990	12,002	55,498	4.62	357
1995	13,977	59,638	4.27	395
2000	16,030	63,502	3.96	411
2005	18,091	67,006	3.70	412
2010	20,074	69,960	3.49	396
2015	21,870	72,307	3.31	359

⁷For an extended discussion of the material covered in this section see Andrew Mason, Mathana Phananimai and Nipon Poapongsakorn, "Households and their Characteristics: Projections from 1980 to 2015 using HOMES" in Mason, A. and Campbell, B., eds., *Demographic Change and the Thai Economy*, 1989, unpublished ADB/EWPI manuscript.

In the future, households will grow more rapidly than the population. The number of households is projected to increase from 10.2 million in 1985 to 18.1 million in 2005. This amounts to an average annual rate of growth over the period of 2.9 percent as compared with a population growth rate of 1.4 percent over the same period. The greatest increases, in absolute terms, will occur at the turn of the century when the number of households will be increasing by 400,000 per year. The result will be that, between 1985 and 2005, the average household size declines from 5 members to 3.5 members per household.

Figure 1 shows the "division of labor" for all households combined by reporting the average number of pre-schoolers, students, workers, and non-working adults. In percentage terms, the decline is shared equally by all non-working members; the number of pre-schoolers, students, and non-working adults is cut in half over two decades. However, during the same period, the number of working adults will decline by only 12%. As a result the worker dependency ratio will drop from 0.92 dependents per worker to 0.52 dependents per worker over the twenty year period.

Figure 1. The Household Division of Labor



A somewhat different pattern emerges if the projection is extended to 2015. Average household size declines at a considerably slower pace than during the preceding two decades, but there is a significant increase in the number of non-working adults. This is the beginning of a trend which reflects the underlying aging of the Thai population and projections further into the future would yield an additional increase in the number of non-working adults, particularly those who are elderly.

The decrease in average size will occur throughout the life-cycle but the decline will be proportionately much greater in the middle years, resulting in a much flatter relation between average size and age than is found at present. And, the decrease will occur in all types of households; intact households and households with single heads, households with young heads and those with old heads will all be considerably smaller within two decades. However, the average number of members varies substantially over the life cycle, rising to a peak of 5.7 members for households with a head aged 35–49, *i.e.*, those which have just completed their childrearing.

Household ‘aging’ is an emerging phenomenon. Households with a head under thirty-five years of age will grow most slowly so that by 2005 only one-quarter of all households will have a head so young. Those with heads 35 to 49 years of age will grow most rapidly, increasing their share from 36 percent to 40 percent between now and 2005.

Table 2. Distribution of Households by Age of Head, 1985–2015.

	Age of Head			
	under 35	35–49	50–64	over 64
1985	31.4	35.5	23.7	9.4
1995	29.6	37.7	23.1	9.6
2005	24.8	39.7	25.1	10.4
2015	20.3	37.7	30.1	11.9

Elderly parents will not prove burdensome. Over the next twenty years, the number of parents per household will increase only marginally and the number 65 and older hardly at all. By 2005 there should be no more than 10 parents per 100 households, but as aging sets in with more force during the twenty-first century the prevalence of elderly parents in the household should increase markedly.

The importance for the Thai economy and for key aspects of Thailand’s social and economic development of the demographic changes described is considerable. The following sections summarize some of the major lessons learned from the analysis and illustrate the application of HOMES to sectoral and macroeconomic concerns. The Thailand analysis examined six separate areas: household saving, labor supply and wages, housing, education, health and consumer expenditure patterns. Because of space and time limitations we will describe the results and approach for selected areas and briefly summarize findings in others.

HOMES MACRO FORECASTS

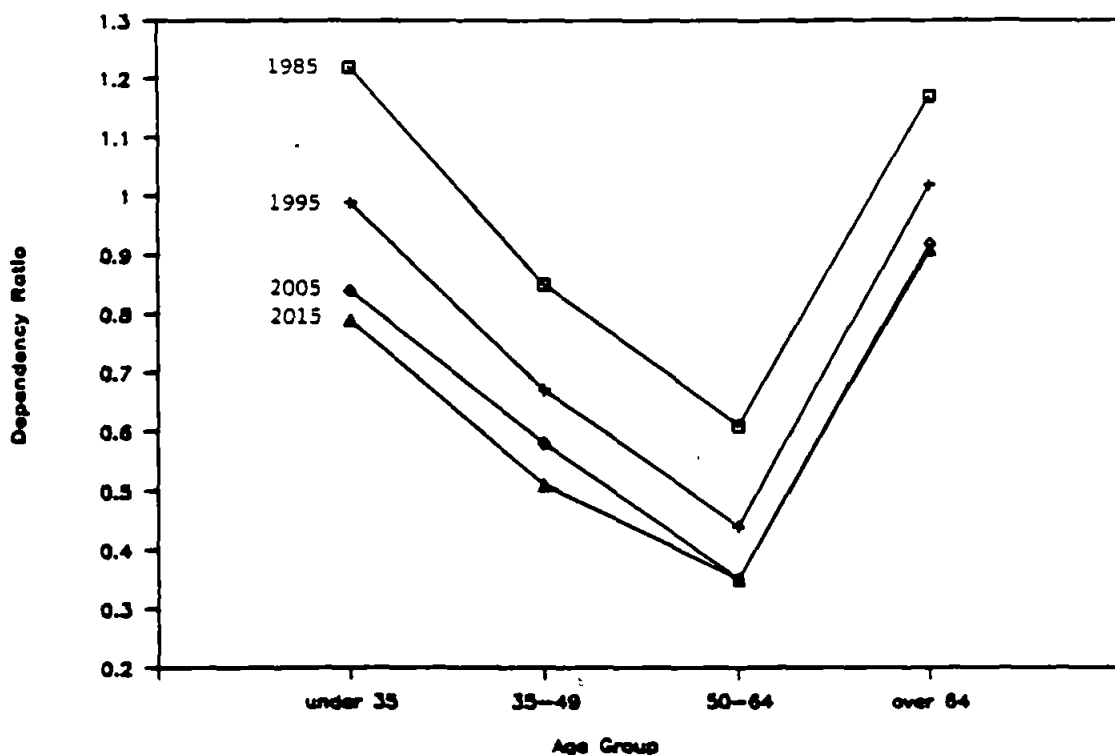
Household saving

Regression analysis of saving by Thai households, based on the 1981 socio-economic survey, was used to assess the impact of household demographic charac-

teristics, e.g., the age and sex of the head and the number of household members in various age groups. When combined with the information provided by the HOMES household projections both aggregate saving and the age profile of saving can be forecast.⁸ Although the household saving ratio, at the aggregate level, has not responded much to favorable demographic trends, the analysis at the micro level shows that reduced child dependency has a salutary effect on saving.

Over the next thirty years, the dependency burden will decline substantially irrespective of the age of the household head. Between 1985 and 2005 the dependency ratio is forecast to drop by 30% for households with a head under 35 or 35-49, by over 40% for households with a head 50-64, and by over 20% for households with an elderly head. Thus, to the extent that dependency discourages saving, households at all stages of the life cycle should enjoy higher rates of saving in the future than they do today.

Figure 2. The Age Profile of the Dependency Burden



Saving is also affected by shifts in the composition of households. Although household type and size apparently have only a minor impact on the saving ratio the age of head has a major effect. Thai households were concentrated at high dependency stages of the life cycle in 1985. Over 30% of all households were under age

⁸The discussion in this section is based on, Andrew Mason, Varai Woramontri and Robert M. Kleinbaum "Domestic Resource Mobilization: Analysis of the Thai Survey Data" in Mason, A. and Campbell, B., eds., *Demographic Change and the Thai Economy*, 1989, unpublished ADB/EWPI manuscript.

35 and fewer than one-quarter belonged to the low dependency 50–64 age category. By 2015, however, only 20% of all households will belong to the high dependency under 35 group and just over 30% will belong to the 50–64 age group. Over the next thirty years then, households will be increasingly concentrated at stages of the life cycle that, from a demographic perspective, are more conducive to saving.

Table 3. Projected Saving, 1980–2015

Year	Saving Ratio	Aggregate Monthly Saving ¹
1980	0.130	5,853
1985	0.132	8,571
1990	0.135	12,393
1995	0.137	17,531
2000	0.139	24,199
2005	0.140	32,628
2010	0.140	42,967
2015	0.140	55,498

1. Values in millions of baht.

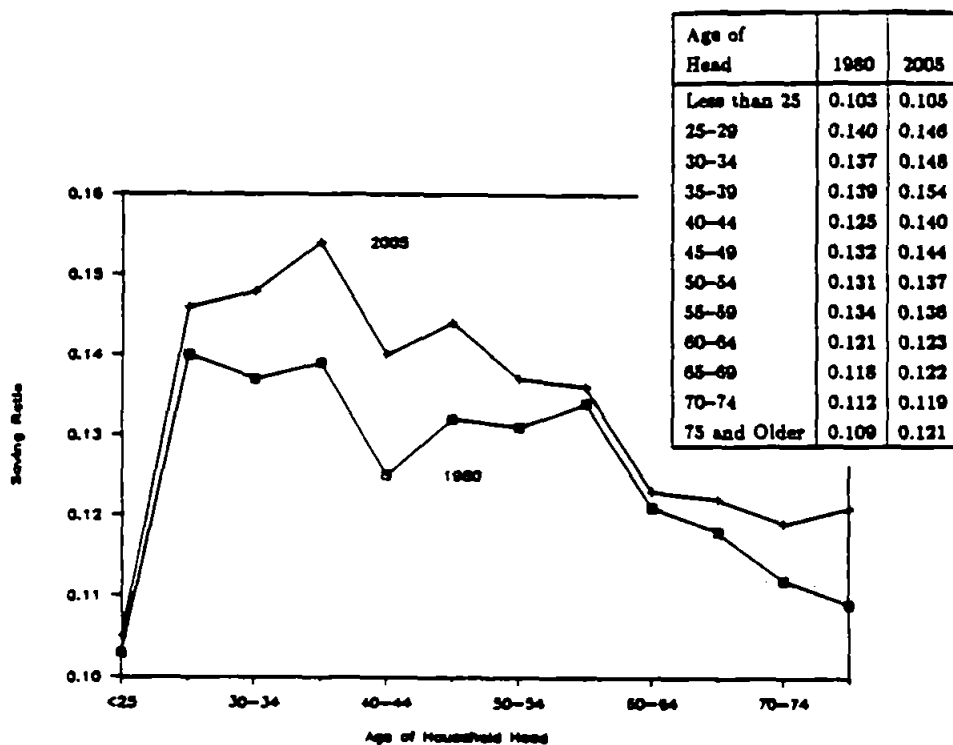
These demographic changes are expected to increase household saving to about 14% of national income over the next two decades. If the movement of young, more educated households through the life-cycle is accounted for, the Thai saving ratio is increased by an additional percentage point to 15%. At every age saving is expected to be greater, but particularly at stages of the life cycle where childrearing is an important activity. The forecast increase probably represents the minimum effect of coming demographic changes, both because households in modern sectors of the economy are more sensitive to demographic trends than those in traditional sectors and because the multi-generational family may start to decline in relative importance if per capita incomes increase at recent rates. Also taking up non-agricultural activities appears to raise measured saving as does education, which has a feedback or joint relation with saving.

In aggregate, the gradual increase in the saving ratio and income growth will combine to increase household saving ten-fold over the 35- year projection period, representing a rate of growth of 6.4 percent per annum.

Labor supply, employment, wages and quality

HOMES involves a much broader approach to forecasting the labor force than is customary. Projected educational enrollment rates and educational attainments, taken from the HOMES education sector results, are both included in the labor supply model. Future changes in household composition, *e.g.*, the number of house-

Figure 3. The Life Cycle Saving Profile



hold members of various ages and the household type, as projected by HOMES, are also included as determinants of labor force participation.⁹

The first step in the methodology involves separating future populations into students and non-students using the projected enrollment rates. The second step is the projection of future labor force participation rates of the non-student population using an estimated probit model that includes HOMES projections of educational attainment and household characteristics among the determining variables. The final step is to multiply the resulting age-, sex-, and household composition-specific participation rates by the forecasts of the nonstudent population to yield the projected labor force.

This methodology gives estimates of much more than the size and age/sex composition of the labor force. It also projects the educational attainment of the labor force by age and sex, an important input to estimates of future human capital, and the age and sex composition of the labor force participants in different types of households, *e.g.*, classified by presence or absence of spouse, by age and sex of head, by age and sex of other household members. These results provide a basis for analyzing the future welfare status of households, including forecasts of

⁹A detailed analysis and discussion of the methodology used in deriving the results reviewed in this section is given in John Bauer, Naohiro Ogawa and Nipon Poapongsakorn, "Forecasts of Labor Force and Wages for Thailand" in Mason, A. and Campbell, B., eds., *Demographic Change and the Thai Economy*, 1989, unpublished ADB/EWPI manuscript.

household income and its distribution. Knowing the number and ages of working and nonworking household members also allows for detailed and precise estimates of future trends in dependency, *e.g.*, the extent of working mothers.

Table 4. Projected Labor Force by Age Groups.

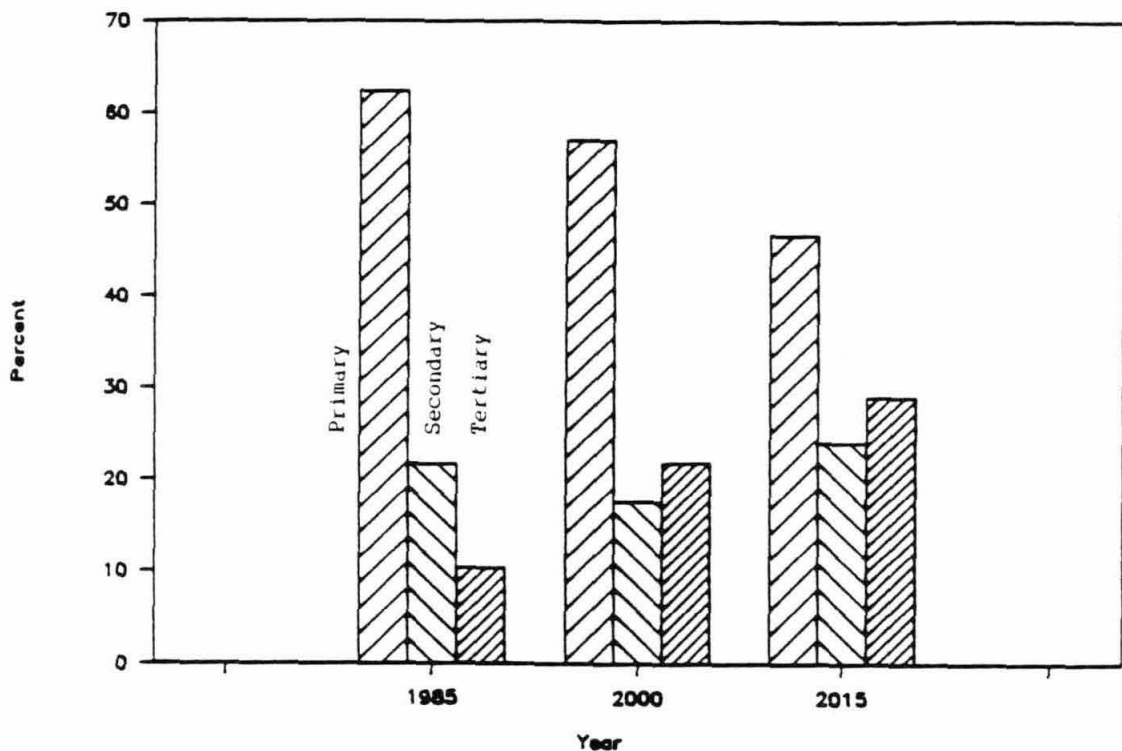
	11-24	25-34	35 and over
1980	7.36	5.98	8.18
1985	8.25	7.49	9.55
1990	8.79	8.85	11.33
1995	8.73	10.22	13.57
2000	8.62	11.08	16.17
2005	8.43	11.24	19.25
2010	7.92	11.40	21.95
2015	7.38	11.39	23.99

This general approach was used in Thailand, based on the 1984 Labor Force Survey and the mentioned HOMES forecasts of educational outcomes and households numbers and composition. Looking first at some of the supply side results, from 1985 to 2015 the Thai labor force will increase from 26.5 to 46.4 million (or by 75%). The labor force will also be aging. At present, the number of workers is growing in all age categories, but the number aged 15-24 is increasing slowly and is forecast to begin a gradual decline after 1990. A clear expression of the coming changes is given by looking at the proportion of workers over age 35. In 1985, only 40% of all workers were over 35 years of age. In 2000, the proportion will increase to 50% and by 2015 it will be 60%. At the same time, the average educational level attained will increase considerably, especially at the late life-cycle stages as more recent cohorts reach those stages. These changes have many very important implications.

For example, an aging labor force means increased productivity and decreased flexibility. Relatively speaking, fewer and fewer workers will come equipped with the latest technology and with a "have skills will travel" mentality. Not much can be done about the latter beyond providing some way of reducing the risks (by reducing information costs) in moving to new opportunities. However, older workers can be kept up to date via adult education and on-the-job training.

Another possible problem involves the fact that the average number of workers per household will decline steadily over the next several decades. The decline will be greatest by far for households with elderly heads and so, as the share of households with members over 65 increases, there will be a decrease in the number of workers supporting these older household members. Because this will not happen until well into the 21st century, later retirement and increased productivity for those employed

Figure 4. The Educational Attainment of Male Workers, Aged 25-29



may take the edge off this problem by then. The possibility exists, of course, that as they become more financially independent the elderly will want to maintain their own household.

Households headed by female workers will also experience a significant decline. One result may be a large increase in the number of working women. However, for some time to come, in the Thai context (with the elderly present), there will not be the same child care problems faced elsewhere with increased female labor force participation. A potentially more important negative development is the substantial decrease in the number of workers in female headed households.

A final negative possibility arising from the decline in workers per household is that households will become increasingly vulnerable to unemployment. One worker households are much more impacted if one worker loses a job than are two or three worker households. And, there will be few non-working adults in households with elderly or single heads to take up the slack.

Turning to the relation between forecasts of labor demand and the above forecasts of labor supply, there will be a continuing but diminishing excess supply of labor in Thailand through 1990, assuming GDP growth of 6% (which seems likely). After that there will be growing excess demand, amounting to 3.9% of the labor supply in 1995, 11.7% in 2000, 22.4% in 2005, 36.6% in 2010 and 54.9% in 2015. Taking account of both male and female elasticities of supply and of the elasticity of demand for labor in the long-run (when it is possible to substitute capital for labor)

with continued 6% growth in GDP there will be very large future increases in both real wages and employment. Even with more and more productive capital and an older, better educated, and, hence, more productive, labor force, it does not seem possible that there can be anything but large increases in unit labor costs in response to excess demands of the magnitude forecast. This contrasts with the recent past when, despite the low open unemployment, real wage gains have been relatively minor, helping make possible the rapid industrial and trade growth achieved in the 1980s.

Table 5. Projection of Labor Supply and Labor Demand.

	Supply	Demand ¹	Excess Supply(+)	Demand ²	Excess Supply(+)
1985	26,841 ³	25,853 ⁴	988	25,853	988
1990	30,503	29,965	538	29,965	538
1995	34,367	33,684	683	35,695	-1,328
2000	38,058	37,865	193	42,522	-4,464
2005	41,384	42,565	-1,181	50,654	-9,270
2010	44,185	47,848	-3,663	60,343	-16,157
2015	46,407	53,787	-7,380	71,882	-25,475

Note: 1. Based on 4 percent GDP growth (1991-2015).
 2. Based on 6 percent GDP growth (1991-2015).
 3. Actual labor force in 1985 was 26,847.3 thousand persons.
 4. Actual employment obtained from N.S.O., Labor Force Survey, 1985.

Under the above circumstances, the male and female real wages will be eight and two-thirds times the 1990 level in 2015 if the demand for labor is highly wage inelastic (0.1) and slightly over three times the 1990 level if the demand for labor hits the highest elasticity level (0.3) deemed likely (based on several studies). These large changes will not begin until the last five years of this century but will accelerate rapidly thereafter. Under the first of these scenarios, the unemployment rate will be no more than 1.2% of the labor force in 2015.

On the positive side, the increase in real wages will increase the size of the domestic market with increased economies of scale possible. As a preliminary step in the process of becoming internationally competitive in the production of consumer goods, a growing domestic market can play an important role and one complementary to the adjustment in factor proportions required by real wage increases.

In sum, using the HOMES approach some very significant developments in the Thai labor force can be foreseen. Most importantly, real wages are expected to increase several times between 1990 and 2015, even taking account of the substitution of capital for labor and the real wage elasticity of the labor supply. The increasing scarcity of labor and associated changes in unit labor costs will lead to rapid changes in Thailand's comparative advantage and in the relative profitability of

different lines of economic activity. Clearly, being forewarned of these possibilities is very valuable to both private and public planners.

HOMES SECTORAL FORECASTS

Housing sector

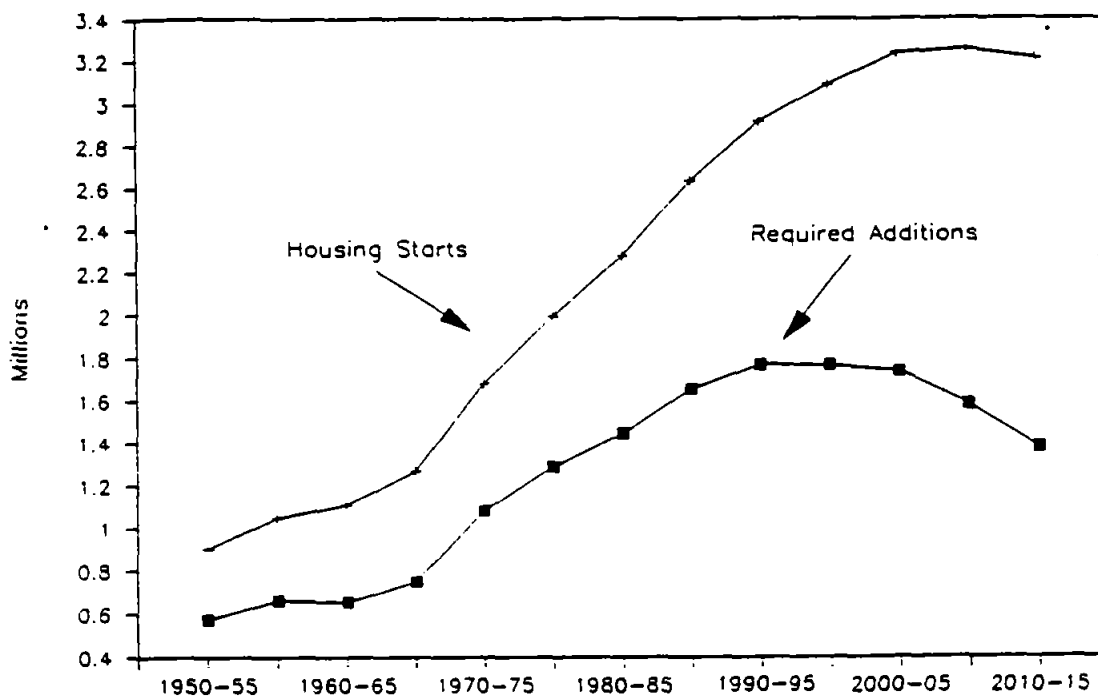
From the standpoint of national welfare, the amount and quality of housing services provided is a major concern everywhere. HOMES forecasts of households provide information necessary to project the demand for housing and the construction of new dwelling units, assuming a perfectly elastic supply of dwellings.¹⁰ This information includes the number and characteristics of households in future and the household income elasticity of demand for housing (derived from the HOMES analysis of the consumer expenditures). The latter can be paired with forecasts of real income growth to project the total demand for housing and to divide the resulting change in demand between growth factors and demographic factors. With estimates of vacancies, withdrawals and other supply side variables, the number and type of dwelling unit required can also be forecast. Finally, with the aid of housing price data the forecasts of the number and type of housing starts can be turned into estimates of real residential construction.

Based on quite conservative assumptions, the housing stock necessary to maintain present housing standards in Thailand will be increased by 111% between 1985 and 2015 by demographic changes only, with the peak in requirements for additional dwelling units coming around the turn of the century. With adjustment for withdrawals, the peak in housing starts will come a decade later. If the urban and rural populations maintain their present proportions, the growth in demand will be largely for single family owner-occupied units and located in rural areas. On the other side, because of changes in the age composition of the housing population, the demand for rental units will soon begin to decline. However, if the urbanization of the population continues, given the much higher rental occupancy and multi-unit dwelling occupancy rates, there is strong possibility of a boom in rental (and condominium) housing in the early 21st century.

Because of the systematic differences in the quality, size, location, and tenure of housing demanded in different age classes, the "typical" dwelling units occupied by households in different age classes are not perfect substitutes. Thus, the changing age composition of demand can have an independent impact on housing markets. In this context, the growth in demand in Thailand for dwellings meeting the tastes of the mid-life 35-59 age group is particularly noteworthy. By 2015, dwellings required for this age group will be 253% of the present level. Since generally, heads in this age class have less postponable housing demand, tend to spend more

¹⁰For an extended discussion of the material covered in this section see Burnham O. Campbell and Nipon Poapongsakorn, "Housing Demand and Residential Construction in Thailand" in Mason, A. and Campbell, B., eds., *Demographic Change and the Thai Economy*, 1989 unpublished ADB/EWPI manuscript.

Figure 5. Housing Starts



on furnishings and other housing appurtenances, require better quality or at least larger housing, and are more often home owners than are heads in other age classes, the significance of this growth is apparent. On the other side, demand by the 15-34 age group has already peaked and will, in incremental terms, become negative in the next century. Thus, housing specialized to their needs could be in excess supply. Obviously information of this sort is useful both for private and public planning.¹¹

In terms of real residential construction, assuming an income elasticity of one and that the entire housing stock is upgraded with income growth, by 2010-15 real residential construction will be fifteen times the 1980-85 level. Most (about 75%) of this increase will come from income growth rather than demographic change or growth. Expansive as these forecasts are, they do not take account of the apparent housing backlog developed in the last two decades, nor do they take account of the possible demand for second dwellings or the potential growth in the number of households and the undoubling of existing households in response to growth in per-capita income and taste changes. With supply very likely not perfectly elastic relative to the sort of excess demands projected, there is a general likelihood that housing prices will increase and increase more rapidly than the general price level —

¹¹In the present application of HOMES to housing markets in Indonesia, the decision to occupy separate quarters and the decision to rent or own are explained on the basis of household characteristics and other relevant variables available in survey data. The relation between the characteristics of housing occupied and these same "explanatory" variables is also being investigated using probit techniques.

Figure 6. The Age Profile of Housing Needs

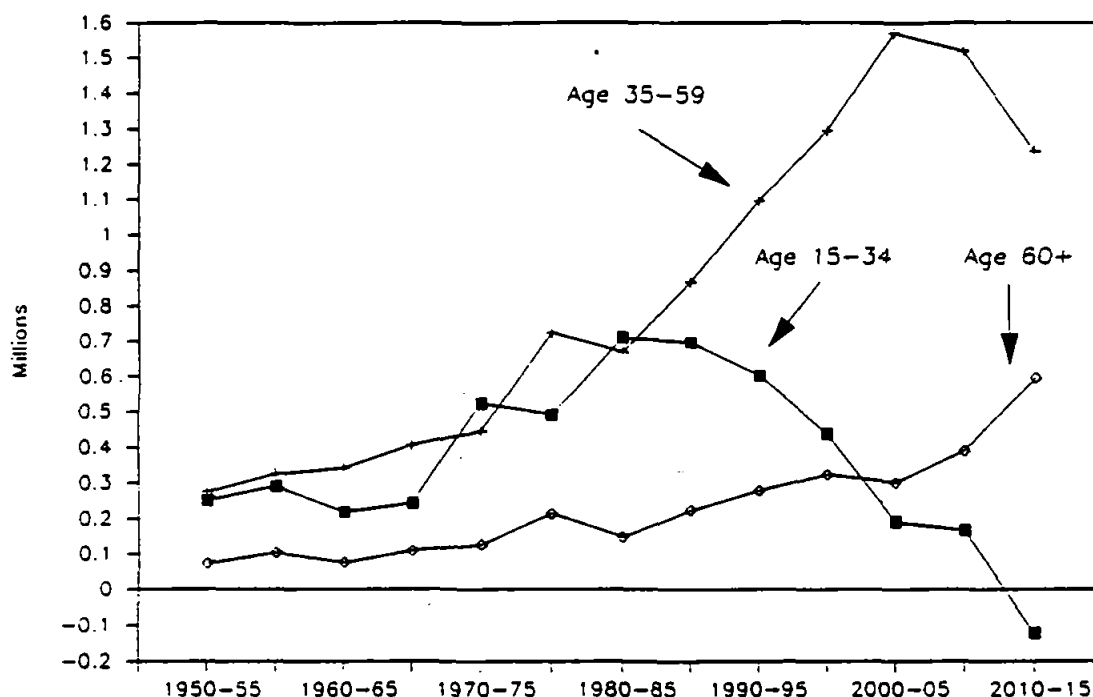


Table 6. Real Residential Construction: Adjusted for Income Elasticity of Housing Demand and Growth in Per-Capita Income (MI's of Baht; at 1970 prices).

Year	Constant Quality	Income Adjusted		Actual
		New Units	Housing Stock	
50-55	18,114	10,635	13,712	
55-60	21,360	13,769	18,284	
60-65	21,183	16,549	29,150	15,224
65-70	24,515	24,515	47,330	20,965
70-75	32,962	39,248	61,848	23,854
75-80	40,617	61,716	107,572	31,332
80-85	45,703	82,300	129,048	52,082
85-90	53,347	116,250	190,101	
90-95	59,494	160,539	279,433	
95-00	63,731	206,131	348,560	
00-05	66,435	259,903	465,504	
05-10	65,391	312,708	608,818	
10-15	60,634	358,056	778,000	

just as consumer expenditures on housing will increase relative to the total growth in demand as income grows.

The changes forecast in the nature of Thai households, especially the decline in average size and the decrease in the number of children per household, will have offsetting effects on housing markets. The decline in average size and in children per household should raise the relative demand for rental and condominium units and so reduce, relatively, the average cost of new dwellings. However, the fact that, at the same income, smaller households spend a larger portion of their income on housing suggests that all or more than all of the saving in dwelling unit size will be put back to raise the quality per square foot.

These conclusions do not take account of the infrastructure and other effects (including environmental effects) of the forecast increases in housing demand nor do they make any adjustment for removing the existing quality backlog. In addition to the real resources used in constructing and improving the dwelling unit required by the growth in the required housing stock and in the quality of the housing stock, Thailand's economic and social welfare will be impacted in several other, perhaps equally or more important ways, by the residential construction developments forecast. These include the greater land area absorbed (at least twice as much as currently) for housing purposes, the increased infrastructure necessary to service the additional land and new housing required, the greater on-going expenses to maintain this larger infrastructure and housing stock, and the growing market for household furnishings and appliances. Base estimates of requirements in all of these markets can be tied to the housing demand forecasts, facilitating both private and public planning.

Education

In the last several decades the Thai educational system has faced a double challenge — improving the quality and level of education achieved by the average Thai child and rapidly expanding the school system to accommodate population growth. However, starting in the present decade the underlying demographics of schooling began to change quite sharply. The population belonging to the age groups from which primary and secondary school students are drawn is essentially not growing at all. And beginning in 1995, the primary and secondary school age population is expected to decline by as much as 100 thousand potential students per year.

Enrollment trends will be affected by changes in enrollment ratios as well as changes in the school age population.¹² Forecasts of school enrollment rates are based on the forecast probability that an individual in a particular age and sex group will be in school. The forecast probabilities are based, in turn, on regression estimates using survey data in which school enrollment varies with individual characteristics, *e.g.*, age and sex and household characteristics such as household

¹²The discussion in this section is based on, Mathana Phananimai and Andrew Mason "Enrollment and Educational Cost in Thailand" in Mason, A. and Campbell, B., eds., *Demographic Change and the Thai Economy*, 1989, unpublished ADB/EWPI manuscript.

income, the number and ages of other household members and the educational attainment of parents. The resulting regression equations are combined with HOMES based forecasts of the determining factors to yield estimates of the probability that individuals in each age group will be enrolled in school. These values are multiplied, in turn, by projections of the population in each school age group to forecast the numbers enrolled.

Percentage-wise, using the above HOMES based methodology, the greatest increase in enrollment ratios is forecast for those aged 18–24. Enrollment among these young adults is expected to increase from 9 to 21% or by 2 and 1/3 times from 1985 to 2015, with most of the increase occurring in the next 15 years. Those aged 15–17 will also experience a large increase in school enrollment, rising rather steadily from 28% to reach 49% by 2015. Finally, enrollment among those aged 12–14 is expected to increase from 65 to 78%, spread evenly over the next 30 years. Only those aged 5–11 are forecast to experience no increase in school enrollment rates as schooling is essentially universal among them, in any case.

The single most important determinant of school enrollment turns out to be the educational attainment of the head, with per capita household income an important determinant of enrollment in the secondary and tertiary levels. Children of farm families, who have a higher opportunity cost, are less likely to attend school, whereas children from entrepreneurial households are very likely to enroll. The presence of young children, given per-capita household income, discourages school enrollment by older siblings, whereas the presence of the older children encourages school enrollment.

Taking account of both projected numbers and enrollment ratios, primary school enrollment will almost certainly be relatively constant until 1995 and, at that time, begin a steady and fairly significant decline. Secondary school enrollment is projected to increase substantially over the next decade and a half, rising from under 2.3 million in 1985 to over 3.3 million in 2005. But, starting shortly after the turn of the century the growth in secondary school enrollments will level off and experience no additional gain. Enrollment at the closed universities should nearly triple between now and 2015, reaching 1.2 million students in that year. All told, total school enrollment will increase from 9.8 million in 1985 to 11.4 million in 2000, but will decline to 10.7 million by 2015.

The associated trends in public expenditure on education will depend on the quality of education provided. In the lower end benchmark case, assuming no increase in unit costs, demographic changes will raise public costs from 37 million baht in 1985 to 41 million baht in 1990, an increase of 2.2% per annum, and to 45 million baht in 1995, a rise of only 1.8% per annum. Such rates of increase are far less than the expected growth in real GNP and suggest that education will become much less of a burden, providing an opportunity to improve the quality of education to meet the challenges of the 21st century without increases in taxes.

Other sectors

In addition to the results reviewed above, the HOMES methodology was also

Table 7. Summary of School Enrollment Projections, 1985–2015.

School Level	1985	1995	2000	2005	2010	2015
Primary	7,137	7,161	6,811	6,555	6,384	6,066
Lower Secondary	1,306	1,692	1,861	1,788	1,731	1,685
Upper Secondary	957	1,059	1,134	1,173	1,106	1,081
Academic	564	676	733	759	715	699
Vocational	393	383	401	414	391	382
Higher Education	966	1,178	1,335	1,415	1,427	1,443
Closed ¹	396	549	673	720	696	675
Open	570	629	662	695	731	768
Total	10,366	11,090	11,141	10,913	10,648	10,275

1. Closed University includes associate degree training.

used to forecast the pattern of consumer expenditures by sector and public and private health outlays.¹³ Looking first at the former, HOMES based analysis shows that in the next three decades consumer expenditures will be characterized by a shift in spending power from young to middle-aged households. Between 1985 and 2015, the share of purchasing power of young households will decline by nine percentage points from 37 to 28%. Households with a head aged 35–49 will experience a five percentage point gain. Those with a head aged 50–64 will increase their share by three percentage points, and those with a head aged 65 or older by just under one percentage point. One result of these shifts is that expenditure patterns will be affected as the structure or composition of final aggregate demand will shift towards the goods and services most favored by households with the greatest spending power.

And, the HOMES analysis shows that spending patterns will undergo major changes. Most significant is the dramatic decline in the importance of food and non-alcoholic beverages — from over half of the family's budget in 1980 to only one-third of the budget in 2005. The resources thus released in relative terms are devoted to a number of areas. During the same period expenditure on housing is forecast to increase its share of the budget from 19.4 percent to 22.3 percent; apparel to increase from 6.6 percent to 7.5 percent; medical care to increase from 3.5 percent to 4.3 percent; and discretionary expenditures to increase from 19.4 percent to 32.0 percent.

¹³Details of the results and of the methodology used in deriving the results for the consumer expenditure and health sectors are given in Andrew Mason, Varai Woramontri and Robert M. Kleinbaum, "Consumer Expenditures in Thailand: An Application of HOMES" and in Naohiro Ogawa, Nipon Poapongsakorn, and Andrew Mason, "Population Change and the Costs of Health Care in Thailand" in Mason, A. and Campbell, B., eds., *Demographic Change and the Thai Economy*, 1989, unpublished ADB/EWPI manuscript.

In the health sector HOMES was used together with rates of health care utilization to obtain aggregate estimates of the number of inpatients and outpatients and the distribution of these patients between public and private care facilities. Forecasts of health care costs were derived by applying unit costs for inpatients and outpatients to the forecast numbers of such patients by age and sex and household characteristics. Expected developments on the demand side of the care market resulting from social, economic, and demographic change were projected using the HOMES based estimates of the future allocation of household expenditures. Finally, the distribution of key diseases between members of different types of households was forecast with implications for the possible household internalization of health care.

IV. SUMMARY

The applications briefly summarized for Thailand demonstrate the importance of demographic factors as contributors to various dimensions of social and economic activity. They show that both the optimal composition and the amount of goods and services of different kinds provided by the public or the private sector, will be affected by changes in the number and demographic character of a country's households. Likewise, they demonstrate that key dimensions of the macroeconomy, including the labor force, employment and wages and aggregate rates of saving will change with the aging of the population and changes in average household size and other household features.

The importance of demographic factors to social and economic development planning have been appreciated for some time. Many countries regularly prepare population projections as input to their five year development plans and to other long range planning documents. The incorporation of demographic factors into the planning process has been limited, however, by the absence of more complete information about households and their characteristics. Among others, labor force participation, school enrollment, saving behavior, the demand for health services, and the demand for housing are all influenced by the number and characteristics of households. Reliable forecasts in each of these sectors is possible only when the importance of the household is recognized and incorporated into the forecasting process. Likewise, the impact of social and economic policy can only be reliably determined when potential responses by households are carefully evaluated.

The major contribution of the HOMES project to date has been to show how more detailed household characteristics can be projected and brought to the planning process. However, as with any new methodology, the full potential of household demographic data can be realized only through extensive interaction between members of the research and planning community.

From a planning standpoint, as the brief list of key results presented underlines, taking account of the relation between changes in the number and characteristics of households provides information about the future that is extremely useful for both private and public decision makers. Because of the relative reliability with which the number of households and their characteristics can be forecast several decades

ahead, the HOMES methodology provides an indispensable base for looking at what the future holds in store for all economic variables sensitive to demographic change. Moreover HOMES is understandable and easy to use, allowing the easy variation of assumptions to trace different future scenarios; an indispensable attribute in our uncertain world for any research methodology.

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