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Marriage, Fertility, and Labor Force Participation of Thai Women: An Econometric Study

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PREFACE

This study was undertaken for the AID Office of Population within a project seeking to formulate, test, and integrate the components of a theory of fertility as part of a general view of the family decision-making process. Work was completed under a grant from The Rockefeller Foundation to support research on The Economics of Fertility Determination and Family Behavior.

Most income in developing countries is generated within the family and in some communities only a modest share of it is channeled through the market; nonmarket production within the family is an important source of wealth and welfare, but one we know relatively little about from either a theoretical or an empirical standpoint. Earlier Rand studies of the economic and demographic determinants of fertility[1] argued that a comprehensive framework of family economics was needed to account for variations in fertility over time and space. In this study of Thailand, a simultaneous-equations model is first specified within the severe constraints of regional data from a single census, and then these equations are estimated to account for cross-sectional

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[1] William P. Butz, Research and Information Strategies to Improve Population Policy in Less Developed Countries, R-952-AID, August 1972; Kenneth Maurer and T. Paul Schultz, A Population Projection Model: Description of a Computer Program and Illustrations of Its Policy Applications, R-953-AID, August 1972; Julie DaVanzo, The Determinants of Family Formation in Chile, 1960: An Econometric Study of Female Labor Force Participation, Marriage, and Fertility Decision, R-830-AID, December 1971; T. Paul Schultz and Julie DaVanzo, Analysis of Demographic Change in East Pakistan: A Study of Retrospective Survey Data, R-564-AID, September 1970; A. J. Harman, Fertility and Economic Behavior of Families in the Philippines, RM-6385-AID, September 1970; Marc Nerlove and T. Paul Schultz, Love and Life Between the Censuses: A Model of Family Decision Making in Puerto Rico, 1950-1960, RM-6322-AID, September 1970; Y. Ben-Porath, Fertility in Israel, An Economist's Interpretation: Differentials and Trends, 1950-1970, RM-5981-FF, August 1970; T. Paul Schultz (assisted by Julie DaVanzo), Fertility Patterns and Their Determinants in the Arab Middle East, RM-5978-FF, May 1970; T. Paul Schultz, Population Growth and Internal Migration in Colombia, RM-5765-RC/AID, July 1969; T. Paul Schultz, A Family Planning Hypothesis: Some Empirical Evidence from Puerto Rico, RM-5405-RC/AID, December 1967.

variation in age-specific marriage patterns, fertility, and women's participation in the nonagricultural labor force.

Thailand was chosen for this study because of the substantial role of women in the labor force. In contrast with sub-Saharan Africa, where women also play a major role in the agricultural labor force, Thai women have lagged only slightly behind men in their educational achievement. Therefore, the opportunity for women to find productive employment in the modern sectors of the economy are not obviously constrained in Thailand by a colonial heritage that favored the education of men, as is the case in much of Africa, Asia, and Latin America. The empirical findings of this study should be interpreted as a mere beginning in the task of understanding Thai economic and demographic behavior within an econometric framework. This analysis of Census materials does suggest, however, that the underlying model of demographic behavior is consistent with these cross-sectional aggregate data and that further research based on longitudinal household surve data is warranted.

The authors of this document are listed in alphabetical order The initial research was done and the first draft was prepared by Mrs. Ratajczak during the summer of 1970. Dr. Schultz then undertook substantial additional work and revision with the assistance of Mr. Maurer.

SUMMARY

Estimates are obtained in this report of the relationships between several constraints on the environment within which households function in Thailand and three related forms of "family" behavior: the proportion of women currently married, the average number of children born per woman, and the proportion of women in the nonagricultural labor force. Economic and demographic logic is used to specify the direct determinants of these three interrelated patterns of household decisionmaking, and available data are used to estimate the parameters to the postulated model. Better data would be useful for this exercise, and more extensive study of Thai society would undoubtedly yield a more refined and elaborate model to account for these and other forms of economic and demographic behavior of the household sector.

Aggregate data from 71 administrative units of Thailand (changwats) from the 1960 Census are the observations to which the econometric model is fit. Because of the joint dependency of marriage, fertility, and women's labor force activity, the parameters to this three-equation model are estimated by simultaneous equations techniques. Estimates are reported for six five-year age groups of women in addition to an aggregate group of all women between the ages of 14 and 44. Although not every estimated parameter of the model is as one might have expected, the great majority are of the appropriate sign and statistically significant by conventional standards. The pattern of response elasticities and the coefficients solved for the reduced-form equations are consistent with the outlines of the household decisionmaking process characterized in the report.

Changing levels of men's and women's schooling has substantial effects on completed fertility levels among older women. Men's schooling is associated with delayed marriage and childbearing but greater completed fertility by the time women reach their late 30s. Schooling for women is linked to higher fertility in the 25-29 age cohort but substantially lower fertility at later ages. Increased education among women may also marginally reduce the proportion of

women married, but it may not affect the size of the female nonagricultural labor force significantly. The tendency for women to occupy nonagricultural jobs appears to be largely a function of the local structure of industry and the level of female unemployment. These labor market variables for women also have a pronounced indirect effect on fertility and the timing of marriage.

The extraordinary extension of primary educational opportunities to women in Thailand since the 1930s should have, therefore, hastened the decline in birth rates among older Thai women after the period analyzed here (that is, 1960). Confirmation of this prediction of the model, however, must await analysis of the 1970 Census, since birth registrations are incomplete in Thailand. Thailand already exhibits a relatively modern pattern of moderately late marriage, and women participate extensively in both the nonagricultural and agricultural labor force. Fertility, however, is still high, particularly among older cohorts of Thai women, and shows the anticipated indications of sensitive response to the changing constraints imposed on the family by the broadly distributed effects of the development process.

The search for policy options to cope with rapid population growth often mirrors a natural but nonetheless one-sided view of available policy instruments. It seems simpler to disseminate a better birth control technology, which is already operational in advanced countries, than to promote the processes of social change that will modify parent reproductive goals, about which we know regrettably little. But both sets of policy options -- the "supply" and the "demand" sides -- need quantitative study and evaluation if decisionmakers are to be able to select an efficient mix of birth control and development policies for each unique cultural and developmental setting. This investigation has sought to isolate promising long-run policy options on which further research could focus.

Many directions are proposed for increasing the confidence attached to the policy implications that stem from the empirical findings reported here. Both time series for aggregates and cross-sectional and longitudinal information for individuals would add markedly to our ability to test the hypotheses underlying the simple

model developed in this report. Extending and elaborating the model to include a broader range of endogenous household behavior would also distinctly improve the credibility of the empirical findings for policymaking. Nonetheless, it is clear from even this tentative study of data from a single census that fertility cannot be viewed in isolation from the economic constraints that appear to influence the formation and specialization of the family in Thailand.

ACKNOWLEDGMENTS

Mrs. Marina Mann conscientiously compiled and organized Thai Census data from regions that had eluded earlier searches, and we gratefully acknowledge her help in the progress of the study. Rand colleages G. Brewer and A. Harman contributed many useful suggestions and comments on an earlier draft.

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I. INTRODUCTION

The objective of this investigation is not to test conclusively a firmly specified group of hypotheses concerning the motivations of Thai women to marry, have children, and engage in economic activities outside of the traditional agricultural economy. The purpose is more limited -- that of posing a structure of relatively general propositions about how families respond to different economic conditions. Because we lack detailed information on individual families over time, it may seem unproductive for us to proceed with an analysis of only regionally averaged data from a single population census. Yet the exercise is useful for two reasons. First, it does provide an admittedly weak test of the logical implications of the behavioral approach that has important implications for the formulation of development policy: although it may tentatively reject some hypotheses, it can only suggest promising avenues for further, more intensive study. Second, it demonstrates how even a limited body of aggregate data, such as a single national census, can be used to suggest the manner in which social and economic conditions influence fertility in low income countries. Since the social sciences are accustomed to demanding quite costly specialized survey data to pursue their particular professional interests, it is important to remember that general data sources are still capable of generating insights into the poorly understood relationships between the demographic and economic behavior of households and the development process.

The search for policy options to cope with rapid population growth often mirrors a natural but nonetheless one-sided view of available choices. It seems far simpler to disseminate a better birth control technology, which is already available in other countries, than to modify parent reproductive goals indigenously by processes of social change about which we know relatively little. But both sets of policy options -- the "supply" and "demand" sides -- need quantitative study and evaluation if decisionmakers are to be able to select an efficient mix of birth control and development policies for each unique cultural setting.

If, as is often asserted, familial behavior, involving marriage, reproduction, and women's role in the labor force, is particularly resistant to environmental changes associated with alternative development strategies, then to align development policies to foster the adoption of smaller family size goals may be ineffectual, and public policy would wisely emphasize improvements in birth control technology. Alternatively, popular acceptance of better birth control methods may not independently accomplish substantial reductions in the birth rate unless family size goals are sensitive to the available mode of birth control. Family planning programs may achieve an initial reduction in birth rates, but in the longer run they need to be buttressed by development policies that will motivate an increasing number of parents to seek fewer children.

In this report we investigate the interrelationships among marital status, reproductive patterns, and economic activity of Thai women from the point of view of isolating promising long-run policy options. We have used age-specific data for a cross-section of regions from the 1960 Thailand Population Census to estimate these interrelationships. Indirect as well as direct mechanisms are noted by means of which policy instruments appear to impinge on household economic and demographic behavior; but to attach greater confidence to this model linking policy to behavior will require additional studies of time series as well as better cross-sectional information.

In the second section we briefly comment on the institutional setting that may play a role in the social choices we try to account for. In the third we review the implications of economic theory for behavior in differing environments and suggest a specification for a model. The fourth section contains estimates of the parameters to that model from Thai data. The final section has an outline of some implications of these tentative results. In it we suggest a program of further research that might lead to a better understanding of the population problem in Thailand.

II. THE STATUS OF WOMEN

AN OVERVIEW

Thailand remains predominantly a rural nation, with little regional ethnic diversity but relatively large differences among regions in the mix and productivity of economic activity. In 1960, seven percent of the Thai population of about 27 million lived in towns of more than 50,000 inhabitants (Caldwell, 1967, p. 44). Unlike the Philippines, Malaya, or many other more urbanized low-income countries, Thailand has only one large metropolitan center, Bangkok-Thonburi. From this small base, the urban sector has recently been growing rapidly.[1]

Rice is widely cultivated, but the fertile central region provides most of the country's exportable surplus. The south relies heavily on fishing; and the hilly and remote north and northeast regions have, over the years, intensified and diversified agricultural practices, absorbing some of the recent growth in Thailand's population (Behrman, 1968).[2]

Four-fifths of the nation's labor force is employed in agriculture and fishing; the majority work in villages, within their family, without direct reimbursement for their labors. A Chinese minority, closely associated with commerce, resides largely in urban areas, whereas a small Muslim minority is concentrated in the southern fishing industry. On the northeastern frontier, Lao hill tribes continue to pursue their age-old methods of slash-and-burn agriculture.

SCHOOLING

Literacy and educational attainment in Thailand are high by Asian standards. Education and occupational status of Thai women relative

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[1]For example, Goldstein (1969a) estimates that Bangkok has been growing at five percent per year; and by 1967, one quarter of Bangkok's residents had been born elsewhere in Thailand. Next to Bangkok's nearly three million population in 1970, the second largest city, Chiengmai, accounted for only 89,000 (M. Unhanand et al., 1972).

[2]See Table B-1 for list of changwats by the four major regions of the country.

to men also appear to be notably high. Table 1 shows the marked increase in the rate of primary school completion among women in 1960 aged 30 to 39 (see also Table A-5). Evidently the central government's increased support and reform of the national educational system in the 1930s improved opportunities for women to acquire primary education.[1] A narrowing of the gap between the primary educational attainments of men and women of this magnitude has occurred, if at all, much more recently in most of Asia, the Middle East, and Africa.

The progress of women relative to men at more advanced levels of schooling is less substantial; only five percent of women aged 18 to 21 completed secondary school, compared with nine percent for men (Thailand, Census 1960, Table 11). Nonetheless, women are well represented in the professions, constituting 32 percent of the doctors, 42 percent of the teachers, and 14 percent of the lawyers, among persons aged 25 to 29 (Thailand, Census 1960, Table 17).

MARRIAGE AND THE FAMILY

The family in Thailand is not the strict, authoritarian unit it is in Japan or China (de Young, 1955). Social organization does not revolve around the extended family; variation in individual behavior is accepted, and wide latitude for individual choice is socially approved (Embree, 1950). Marriage is characterized by the informal choice of partners, relatively easy divorce, flexibility of residential patterns, and casual arrangements for care of children (Wijeyewardene, 1967; Graham, 1958). Marriage occurs at a relatively late age in Thailand today where the median age at first marriage for women is 21 and for men 24 (Caldwell, 1967, p. 38). There is some evidence that the age at first marriage has increased a year or two since the Second World War.

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[1] Ingram (1955) notes that the share of government (ordinary) expenditures on education increased from two percent in the 1920s to 11 percent by 1937. The compulsory education act of 1921 had little effect in the rural areas until the educational reforms promulgated in 1932 (de Young, 1955)

Table 1

GROUPS COMPLETING AT LEAST FOUR YEARS OF PRIMARY SCHOOLING, BY SEX AND AGE
(percent)

Age	Males	Females
15-19	79.0	74.4
20-24	74.5	67.4
25-29	69.1	59.2
30-34	68.8	53.2
35-39	58.6	34.5
40-44	47.2	19.4
45+	27.5	6.0

Source: Thailand Population Census: 1960, Table 11.

Table 2

DISTRIBUTION OF FEMALE POPULATION BY MARITAL STATUS
(percent)

Age-Group	Single	Married	Widowed	Separated or Divorced
15-19	86.1	12.5	.2	1.1
20-24	38.6	56.2	.7	4.3
25-29	14.1	79.5	1.4	4.9
30-34	6.7	86.0	2.6	4.6
35-39	4.2	86.5	4.5	4.7
40-44	3.1	82.6	9.2	5.0
45-49	2.5	77.2	15.1	5.0

Source: Thailand Population Census: 1960, Table 4a.

Table 2 shows the marital status of Thai women in 1960 by age group. The incidence of divorce and separation is high in comparison with either high-income or low-income countries. (Regional differences in the proportion of women currently married by age group are shown in Table A-1.) With greater educational and employment opportunities for women in Bangkok than elsewhere in the country, Bangkok women marry later, on average, than in the south, north, and northeast, as might be expected (Thailand, Census 1960, Table 10).

FERTILITY

During the 20th century the number of births per year in Thailand per thousand population has probably fluctuated between 45 and 55, although registration statistics are far from complete. The secular decrease in death rates has contributed to the acceleration in the rate of population growth, which stands today at about three percent per year. The 1970 Census may soon provide the first firm evidence that this very rapid rate of population growth has begun to subside as birth rates have begun to fall. Fertility has been in the neighborhood of six births per woman completing her childbearing years; but regional variation, as documented in the 1960 Census, remains substantial, from 4.5 births for the Bangkok region to 6.5 births for the northeast (see Table A-2). One of our objectives in this report is to account for this interregional variation in completed fertility.

LABOR FORCE PARTICIPATION

The one statistic of Thailand that stands out in international comparisons regarding the status of women is the high rate of economic participation. In the United States, 24.6 percent of women over the age of 15 are economically active; in Malaya, the figure is 29.9 percent, and in the Philippines it is 27.6 percent, as seen in Table 3. In Thailand, however, 81.4 percent of women over 15 are reported as economically active, with participation reaching 87.4 percent in the group aged 40-49 (see Tables A-3 and A-4). Women constitute slightly less than half of the workers in agriculture; and of all women in the labor force, 76.8 percent are unpaid family workers. Regional differences are also important in these respects (see Tables A-3 and A-4).

Table 3

COMPOSITION OF LABOR FORCE IN SELECTED COUNTRIES[a]
(percent)

Country (Year)	Labor Force Participation Rates		Labor Force in Agriculture	Female Labor Force	
	Male	Female		Agricultural	Nonagricultural
Thailand (1960)	89.5	81.4	81.1	47.8	36.5
Ghana (1960)	89.1	56.6	57.9	38.2	40.7
India (1961)	90.2	42.9	69.2	30.8	20.4
Malaya (1957)	87.3	29.9	57.0	24.0	13.7
Philippines (1960)	83.6	[illegible]	60.1	25.2	41.5

[a]Data are derived from United Nations, Demographic Yearbook, 1964, New York, Tables 8 and 9.

Explanations for the unusually active role of Thai women in the labor force are partly a matter of culture (see Boserup, 1970; Embree, 1950; de Young, 1955; Graham, 1958; Moerman, 1968; and Phillips, 1965) but also a matter of how one interprets census definitions. Whether a poor family farmer concludes that his spouse and older unmarried daughters are workers may not tell one a great deal about the number of hours each works in the field, or the permanence of their attachment to the labor force. The entire concept of labor force, as that of unemployment, becomes vague when borrowed from an urban industrial economy and applied to a rural family-farm economy.

In the following analysis of women's role in the labor force, we deal only with women's participation in the nonagricultural sector for two reasons. First, as noted above, the concept of participation is somewhat more concrete in the nonagriculture sector, although family enterprises still exist in all sectors of the Thai economy and unpaid family workers are a large part of the labor force. Second, the interrelationships between women's participation and fertility are premised upon the weak incompatibility of the two. Agricultural household activities and child rearing may actually be complementary. The same may be true for some family retail businesses and domestic service occupations; children are only a minor liability to women holding such jobs. Since only a few percent of Thai women hold professional or clerical jobs that are clearly difficult or costly to combine with family responsibilities, the nonagricultural participation rate is adopted in this study as a proxy for women's involvement in nonfamily activities and therefore for the shadow value of her time allocated to the formation of a family.

Any interpretation of unemployment rates in a predominantly agricultural economy is also hazardous. Among women of all ages, unemployment is less than one percent of the female labor force outside of Bangkok; one might conclude that in a family-farm economy, a woman who is not working is likely to view herself as not in the labor force. In Bangkok, however, unemployment among women in their 20s is about six percent compared with the national figure of .9 percent (Thailand, Census 1960, Table 15). Despite the high measured unemployment rate among urban youth, many young women continue to migrate to Bangkok.

III. ECONOMIC HYPOTHESES

There is a growing body of evidence that much of the variation in reproductive behavior across regions in a low-income country is associated with factors that are thought to constrain parent opportunities and exert predictable effects on desired and actual fertility. Other choices individuals make over their lifetime also have a bearing on fertility, such as marriage and women's labor force attachment. The general economic model of household behavior must be severely constrained to yield refutable propositions about marital, reproductive, and labor force behavior of the household. This rigorous approach is not pursued here; only the outlines of the model are developed and the model's predictive logic is briefly restated (see Schultz, 1969, 1972).

Most social science research presupposes that people act in ord to get things they value, through judicious use of the rules and resources of their environment (Moerman, 1968, p. 28). It is assume here that the rules and values are relatively uniform over the 70 od regions (changwats) of Thailand, although this inescapable assumptic of our research is not easily defended before anthropologists, sociologists, and demographers who are students of Thai society. But it does not seem inappropriate to accept as a working assumption that t timing and extent of the family formation process are subject to som individual choice, with implications for marriage, fertility, and th allocation of a woman's time among childbearing, childrearing, other home production activities, and work in the labor market. The way these types of behavior adapt to environmental change is the subject of this section.

MARRIAGE

The decision to marry can be viewed in several ways. It might be seen as the decision to establish a separate household; however, this need not be the case in Thailand where young couples often remain with parents or where the young may establish a household while working

before marriage. Second, marriage can be viewed as a decision to enter a permanent sexual relationship, with the prospect of forming a family. Whether the relationship will be legal is another decision, although empirically irrelevant for this study of Thailand because legal and consensual marriages are not distinguished by the census.[1] Third, marriage might be seen as an alternative to labor force participation or schooling, although this factor might be less important in a culture where marriage and other activities are less mutually incompatible. Marriage may also be terminated in divorce or separation, providing alternatives that might be relatively more attractive at different stages in a woman's life cycle. From a policy viewpoint, establishing a household and entering a permanent sexual relationship are likely to affect fertility and perhaps the supply of labor to the market economy.

The ratio of marriageable men to women is also expected to influence the incidence of marriage, for the decision to marry the first time and for the decision to remarry if divorced, separated, or widowed. Differential death rates for men and women may change the opportunities for remarriage, and sex-selective migration could further affect the sex ratio in a particular region.

It is anticipated that as alternatives to marriage become more attractive, women at the margin will postpone, reject, or terminate marriage. Obvious alternatives are schooling and nonagricultural labor force participation. Labor force participation in the modern sectors of the economy might delay marriage for women and even reduce its later incidence. Schooling might have much the same effect, directly for the younger women who may continue schooling instead of marrying, and indirectly for older women who may be paid more to participate in labor force activities outside of the home.

The educational attainment of men could exert two offsetting effects on marriage at different periods in the life cycle. Among the young, the investment of time in schooling and on-the-job training

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[1] For analyses of consensual and legal marriage behavior see DaVanzo, 1971; and Nerlove and Schultz, 1970.

might delay the age at first marriage until a man's net market earnings would support a wife and children. But later in the life cycle, male education is strongly correlated with market earnings in most societies; these added resources should increase the husband's demand for a wife and children and increase his attractiveness to the supply of potential wives.

The educational attainment of women relative to men is interpreted as an index of the potential gains that marriage provides husband and wife in developing their respective comparative advantages in market and nonmarket activities. If years of schooling enhances the market productivity of both men and women, but increases their productivity in nonmarket activity by a lesser amount, one may assume that the less schooling women receive relative to men the greater is the comparative advantage of women relative to men in nonmarket activities. Without marriage, both men and women must divide their time between market and nonmarket activities to meet their various needs, whereas with marriage they may combine resources and specialize in the activities for which they are each relatively more productive. Men and women will therefore develop their comparative advantages through marriage where women receive little schooling relative to men; marriage will be less frequent and stable where comparative advantages of the sexes are lessened by more equal years of schooling.

Female migration might exert a variety of effects on marriage, but it is difficult to predict what the net effect will be, since a woman might migrate (1) to search for a husband, (2) to search for economic opportunities, or (3) to follow her husband after marriage.

Data on marriage rates are not available for Thailand by changwat, but the marital status of women by age is tabulated by region in the 1960 Census. Although the use of a marriage <u>rate</u> seems theoretically more appropriate, predicting a <u>stock</u> (which will tend to be correlated with rates over time) might also be a useful exercise.[1]

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[1] For example, policymakers concerned with population growth might be interested in both the stock of married women of childbearing age and the rate of addition to that stock.

FERTILITY

If the satisfactions that parents obtain from their children are treated as an economic good -- child services -- systematic variation in fertility may be interpreted as evidence of systematic variation in parent incomes or the prices of goods and services used directly or indirectly in the family formation process. A rise in income, with tastes and prices held constant, should, therefore, normally increase the demand for child services. The economic framework does not predict, however, whether the number of children will increase, or additional resources will be spent per child, or both. Thus, without further assumptions, the direction of the income effect on observed number of children is ambiguous.

Economic theory also suggests that, with income constant, an increase in the "price" of child services will decrease the quantity demanded. The price of children is positively related both to the opportunity cost of the time parents spend in rearing children and to the resources expended to feed, clothe, and educate them. Benefits of children may also take tangible form in terms of the child's expected contribution to household resources over its lifetime. Unfortunately, each of these components of the "price" of a child are elusive and empirically difficult to measure, but equally important, they are not entirely outside the control of the family. The costs and returns from children reflect in part a decision of parents on the amount of resources they want to invest in each of their offspring. Though fertility is measured as the number of children born alive per woman, healthier, better educated, and more productive children undoubtedly provide parents with more "child services" than do average children. This conceptual and statistical ambiguity of variables representing the "price" of a child in the analysis of the determinants of fertility cannot be resolved here.

Labor force participation by women outside of the home or off of the family farm makes it more difficult to rear children and should increase the opportunity cost of a mother's time allocated to child rearing. Nonagricultural labor force participation is regarded in this study as a proxy for women's participation outside the home and family,

and it is anticipated that this proxy will therefore be inversely associated with fertility.

Child schooling may depress the demand for number of children. The more schooling a child receives, the more resources the parent expends on him before he comes a productive worker and the shorter the time he has left to work within the family. Economic participation by children in the labor force conversely lowers the "price" of children to parents, and is probably associated with higher fertility. The direction of causality underlying this association is, however, far from clear (Schultz, 1972).

A serious difficulty for the analysis of the determinants of the demand for children is that the observed number of children ever born may not adequately represent the number wanted, because of uncertainty in the supply of births, birth control, and child survival. Reliable data on child mortality and on birth control knowledge by region are not available for Thailand around 1960; our analysis must therefore neglect these potentially important sources of variation in completed fertility.

LABOR FORCE PARTICIPATION

Nonagricultural labor force participation may affect marriage and fertility, but decisions on fertility are certainly affected by the prevalence of marriage, and subsequent decisions on labor force participation must take into account past fertility and consequent child care commitments. For example, a woman may feel more economic pressure to participate in the labor force if she is not married, and she may find it difficult to participate outside of the home if she is responsible for rearing small children. If labor force participation and marriage, or labor force participation and child rearing, are relatively incompatible, there will be a negative relationship between them. Yet this may not be true for all types of activities, nor for all age groups. For example, agricultural participation, which is largely as an unpaid family worker, might be readily combined for most of the year with child rearing. Alternatively, completed families may not deter an older woman from nonagricultural participation if her children, regardless of number, are grown up.

Data on participation by work status (for example, self-employed, employee, unpaid family worker) are not available on an age-specific basis for regions of Thailand; age-specific data are available, however, on participation by industry and occupation by changwat. This study concentrates on the determinants of women's participation in nonagricultural labor force activities, since it is anticipated that these types of activities are most likely to occupy the woman's time away from her family and thus be least compatible with the child-rearing duties of a mother.

A positive relationship is expected between women's wages and their participation, since the higher the level of wages, the more attractive is participation. Unfortunately, information on wages by region is not available in Thailand. A proxy for the wages of women by changwat is therefore derived from the industrial structure and sex distribution of employment by changwat, attributing the average gross product per worker by industry for Thailand to each region's employment structure.[1] This approach assumes that men and women have the same average products in a given industry, regardless of region, and that they receive a fixed fraction of this product as wages. Clearly, this wage proxy is inadequate, but it may reflect the regional differences in industrial structure that have some systematic effect on the relative income opportunities available to men and to women outside of the family. An alternative proxy for women's wage might be their educational attainment, where regional differences in demand were assumed to be negligible.

Labor force participation may decline if prospects for getting work do not look promising. A negative association between the participation rate and the unemployment rate would reflect this "discouraged

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[1]There are serious weaknesses in this variable, since it largely tends to reflect industrial structure. Exclusion of the women's wage proxy does not alter the signs on the other coefficients to this equation, although the predictive power of the model is reduced.

worker" effect, although difficulties of measurement may obscure this relationship in a rural, low-income society.[1]

Factors that increase the women's market relative to home productivity, such as increased formal schooling, should also contribute to market participation. The relative educational status of the woman should, therefore, increase her labor market activity as an alternative to home production. But holding wage opportunities in the market constant, increased educational status of women would enhance their productivity in nonmarket activities and thereby weaken their production incentives to participate in the labor market.

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[1] A positive relationship between unemployment and participation might be observed if the "added worker" effect dominates. This effect is seen if females enter the labor force to compensate for lost family income when unemployment is high. It is observed more often in time-series analyses than in cross-sectional analyses, and thus the negative sign is expected here.

IV. SPECIFICATION AND ESTIMATION OF THE MODEL

A model of marriage, fertility, and female nonagricultural labor force participation is formulated and estimated in this section. The model consists of three equations accounting for these interdependent household decisions. Ordinary least square estimates of the parameters to these equations will be biased if these areas of choice are jointly and simultaneously determined. Therefore, we used simultaneous-equations techniques, specifically instrumental variable estimates that assure asymptotically unbiased estimates. The moment matrices are weighted by the number of women of the specific age group and relevant region on which the dependent variable is based.[1]

The following three relationships are assumed to be approximately linear in parameters for women in six age groups:

(1) Marriage is a function of (a) female nonagricultural labor force participation; (b) female migration; (c) ratio of men to women; (d) male years of schooling; and (e) relative schooling of women to men.

(2) Fertility is a function of (a) marriage, (b) female nonagricultural labor force participation, (c) child labor force participation, (d) child schooling, (e) male years of schooling, and (f) female years of schooling.

(3) Nonagricultural labor force participation is a function of (a) fertility, (b) female unemployment, (c) relative schooling of women to men, and (d) women's wage proxy.

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[1] Disturbances in the equations are likely to have differing variance. The expected variance of the estimate of a population mean (marriage, fertility, or participation rate) is inversely proportional to the size of the population sampled. Therefore, the observations on which the regression is based are weighted by the square root of the regional population of women of the specific age group. Neglect of heteroscedasticity of disturbances asymptotically biases upward

The data for estimating the model are derived from the 1960 Census of Thailand for all 71 of the regional divisions or changwats (see Table B-1). The derived variables used in the final equations are defined in Table 4 and their means and standard deviations are reported in Table A-5. Simple correlations between the variables for all women aged 14 to 44 are reported in Table A-6. The complete derivation of the variables from the Census is described in Appendix B. Asymptotically unbiased instrumental variable estimates are reported in Tables 5, 6, and 7. Ordinary least squares estimates are also reported in Tables A-7, A-8, and A-9 to indicate the importance of using the more appropriate simultaneous-equations estimation techniques.

THE MARRIAGE EQUATION

For women 20 years of age and older, the prevalence of nonagricultural labor force participation is inversely related to fertility at conventional levels of statistical significance.[1] Marriage is delayed during the 20s and its ultimate incidence is less in an environment where a larger fraction of women are engaged in nonagricultural activities. Recent in-migration of women is associated with a greater prevalence of marriage, particularly among women under 30 years of age, and the ratio of men to women exerts the anticipated effect on the proportion of women married after the majority have been married. The years of schooling received by men reduces the prevalence of marriage until women reach 30 years of age; among older women there is no

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the estimated variance of the parameters, reducing their t-ratios. Moreover, in the case at hand, additional problems may occur if the variance of the disturbances, which is likely to be related to population size of the observations, is not independent of other variables in the model as is conventionally assumed in the standard linear regression model.

[1]The t-ratios reported in parentheses beneath each regression coefficient in all of the tables are used to test statistical confidence in rejecting the null hypothesis that there appears to be no particular association between the explanatory variable and the dependent variable. Since most of the parameters have a predicted sign, the one-tailed test is generally appropriate. For a large n (degrees of freedom) a t-ratio exceeding 1.67 satisfies a confidence level of 90 percent, and one exceeding 2.39 satisfies a confidence level of 99 percent.

Table 4

DEFINITIONS OF VARIABLES[a]

Marriage rate	Proportion of women in age-group who are currently married
Fertility rate	Average number of children born alive per woman in age-group
Nonagricultural participation rate	Proportion of women in age-group who are economically active in the nonagricultural sector
Agricultural participation rate	Proportion of women in age-group who are economically active in the agricultural sector
Child labor force participation	Proportion of children 11 - 14 years old who are economically active
Child schooling	Average number of years of schooling completed by 10 year old children
Male schooling	Average number of years of schooling completed by men in age-group
Female schooling	Average number of years of schooling completed by women in age-group
Relative schooling	The ratio of female schooling to male schooling
Migration	Proportion of women in age-group who migrated to changwat (of present residence) within the last five years
Sex ratio	Ratio of men to women in age-group
Female unemployment	Proportion of economically active women in age-group who are unemployed
Male wage	Estimated average annual product per employed male (bahts x 10^5)
Female wage	Estimated average annual product per employed female (bahts x 10^5)

[a]See Table A-5 for mean values and standard deviations of variables. All observations are by changwat. For a more complete discussion of how these variables are defined and constructed, see Appendix B.

Table 5

SIMULTANEOUS EQUATION ESTIMATE OF MARRIAGE EQUATION[a]

Age of Women	Nonagricultural Participation (Proportion)[b]	Migration (Proportion)	Sex Ratio	Male Education (Years)	Relative Education (Female/Male)	Constant	F(5,6) Significance t-Ratio Adjustment
15-19	.168	.576	.156	-.0846	-.309	.563	9.06
	(1.67)	(3.72)	(1.08)	(10.4)	(5.58)	(3.49)	.009
							.568
20-24	-.491	1.06	.0457	-.0821	-.106	.932	37.44
	(4.36)	(4.56)	(0.57)	(6.67)	(1.45)	(9.89)	.000
							1.13
25-29	-.422	.503	.215	-.0245	-.0873	.774	43.87
	(7.70)	(3.42)	(3.45)	(3.19)	(1.52)	(9.98)	.000
							1.06
30-34	-.238	.173	.220	.0000334	-.111	.742	24.29
	(7.41)	(1.61)	(5.09)	(0.01)	(2.80)	(14.4)	.001
							.883
35-39	-.158	.231	.183	.00224	-.0719	.722	8.461
	(5.52)	(2.14)	(4.20)	(0.41)	(2.63)	(15.0)	.010
							.655
40-44	-.144	.258	.171	.000980	-.0692	.690	4.987
	(4.91)	(1.85)	(3.70)	(0.16)	(2.25)	(14.3)	.038
							.612
15-44	-.158	.453	.353	-.0515	-.158	.573	60.86
	(2.77)	(2.97)	(5.63)	(6.62)	(2.68)	(7.10)	.000
							1.05

[a]Instrumental variables are migration, sex ratio, child schooling, child participation, male education, female education, relative education, male wage, female wage, and relative wage. Regressions are weighted by the female population for each age group. The numbers in parentheses below each coefficient are the t-ratios. For an explanation of the F-statistics, their significance, and the t-ratio adjustment factor, see Dhrymes (1969).

[b]Endogenous variable.

Table 6

SIMULTANEOUS EQUATION ESTIMATE OF FERTILITY EQUATION[a]

Age of Women	Marriage (Proportion)[b]	Nonagricultural Participation (Proportion)[b]	Child Participation (Proportion)	Child Schooling (Years)	Male Education (Years)	Female Education (Years)	Constant	F(7,4) Significance t-Ratio Adjustment
15-19	.624 (22.6)	.0523 (2.64)	-.0269 (1.52)	.00886 (1.18)	-.00312 (1.15)	-.000664 (0.13)	-.000227 (0.01)	108.7 .000 .483
20-24	1.90 (11.6)	.252 (1.76)	-.0722 (0.72)	-.0103 (0.26)	-.00877 (0.37)	.0183 (0.95)	-.212 (1.37)	17.78 .003 .451
25-29	3.75 (6.15)	-.0692 (0.18)	.156 (0.69)	-.107 (1.21)	-.0458 (0.66)	.155 (1.97)	-.838 (1.46)	31.81 .001 1.01
30-34	3.12 (2.32)	-1.99 (3.28)	.703 (1.88)	-.252 (1.67)	.221 (1.91)	.0840 (0.68)	.484 (0.38)	19.99 .002 .852
35-39	1.99 (0.90)	-4.23 (5.06)	.882 (1.55)	-.177 (0.83)	.461 (3.46)	-.0818 (0.67)	2.40 (1.16)	13.93 .005 .655
40-49	4.86 (1.34)	-4.57 (3.25)	1.18 (1.29)	.133 (0.48)	.600 (3.08)	-.283 (1.28)	.340 (0.10)	9.980 .012 .624
15-49	.710 (1.01)	-1.80 (3.61)	.255 (0.71)	-.0496 (0.35)	.0740 (0.73)	-.0147 (0.13)	2.21 (3.46)	6.344 .030 .654

[a]Instrumental variables are migration, sex ratio, child schooling, child participation, male education, female education, relative education, male wage, female wage, and relative wage. Regressions are weighted by the female population for each age group. The numbers in parentheses below each coefficient are the t-ratios. For an explanation of the F-statistics, their significance, and the t-ratio adjustment factor, see Dhrymes (1969).

[b]Endogenous variable.

Table 7

SIMULTANEOUS EQUATION ESTIMATE OF NONAGRICULTURAL PARTICIPATION EQUATION[a]

Age of Women	Fertility[b]	Female Unemployment (Proportion)	Relative Education (Female/Male)	Female Wage	Constant	F(4,7) Significance t-Ratio Adjustment
15-19	-.141	-2.27	-.0512	4.55	.0203	16.08
	(1.08)	(3.35)	(0.90)	(9.43)	(0.34)	.001
						.513
20-24	-.115	-2.03	-.103	4.93	.151	31.46
	(3.03)	(2.76)	(2.01)	(9.91)	(2.11)	.000
						.506
25-29	-.129	-2.47	-.0855	4.05	.354	42.94
	(3.12)	(1.87)	(1.50)	(7.25)	(2.60)	.000
						.581
30-34	-.102	-1.01	.0324	3.37	.366	36.87
	(2.70)	(0.48)	(0.60)	(5.27)	(2.46)	.000
						.559
35-39	-.0256	-3.32	-.0103	4.40	.110	29.78
	(1.14)	(1.48)	(2.36)	(7.11)	(0.95)	.000
						.450
40-49	-.0162	-2.66	-.0235	4.20	.0796	23.07
	(1.20)	(1.06)	(0.55)	(8.75)	(0.95)	.000
						.438
15-49	-.118	-2.31	-.0852	3.83	.379	27.87
	(1.96)	(1.91)	(1.40)	(5.11)	(2.08)	.000
						.524

[a]Instrumental variables are migration, sex ratio, child schooling, child participation, male education, female education, relative education, male wage, female wage, and relative wage. Regressions are weighted by the female population for each age group. The numbers in parentheses below each coefficient are the t-ratios. For an explanation of the F-statistics, their significance, and the t-ratio adjustment factor, see Dhrymes (1969).

[b]Endogenous variable.

relationship between marriage and male educational attainment. The productive status of women relative to men, as approximated by average years of schooling completed, was proposed as an indicator of mutual gains to specialization in market and nonmarket activities that traditionally occur in marriage. The regression coefficients on the relative education variable are consistently negative as predicted, but their statistical significance is substantial only among teen-agers and women 30 years old and older.

The overall explanatory power of the marriage equation (see the F statistic and its level of significance in the last column) tends to be greater for young women than for old. This might be interpreted as evidence that the economic-demographic model predicts the timing of first marriage more adequately than it does the proportion ever marrying (at later ages) or the proportion of widowed. (See Table 2, p. 5.)

THE FERTILITY EQUATION

The proportion of women married has a substantial and statistically significant effect on fertility, as might be expected, especially among younger women where the timing of marriage is best accounted for by the marriage equation. Nonagricultural labor force participation by women is related to distinctly lower fertility among women, particularly at older ages. However, there is also an unanticipated tendency for fertility to be greater among teen-aged women where nonagricultural participation is greater.[1] The coefficients for the child labor force participation and schooling variables are of the anticipated sign among women nearing the end of their childbearing years, but the relationships are weak and among younger women they are not of the expected sign. Similarly, male and female education variables generally have coefficients of positive and negative sign, respectively, but they do not satisfy conventional standards for statistical significance. Marriage and nonagricultural labor force participation appear to

[1]This is similar to the findings for Taiwan, which suggest birth rates are distinctly lower among teen-aged women in agricultural areas and slightly higher among older women (Schultz, 1972).

influence fertility, but the direct lines of influence from the exogenous variables to fertility are only of the expected sign, and they are rarely substantial or highly significant by conventional statistical standards. We must tentatively conclude that most of the influence of the environment on reproductive behavior operates by means of the effects that the environment exerts on related forms of marital and labor force behavior of women.

The overall predictive power of the fertility equation is greatest for teen-aged women, but this only reflects the close association between the prevalence of marriage and fertility at younger ages. Although all of the equations satisfy the F ratio test for statistical significance at the three percent level or better, the variation in completed fertility among the older women, and among all women combined, is less amenable to explanation.

THE LABOR FORCE PARTICIPATION EQUATION

The impact of fertility on women's participation in the nonagricultural labor force is strongest when women are between the ages of 20 and 34 and most likely to be caring for young children. The female wage and female unemployment rate have the anticipated effect of respectively stimulating and repressing labor force participation. Although the coefficient on the wage variable should be interpreted with caution as a proxy derived from the region's industrial structure, the unemployment effect is nonetheless surprisingly strong. Since measured unemployment appears to be substantial among women only in the more urban areas of Thailand, it was anticipated that this variable would not accurately account for the differential employment opportunities for women in nonagricultural sectors of the economy.

Holding constant women's labor market opportunities (that is, wages and unemployment) it was anticipated that increasing a woman's educational status relative to men would increase the propensity of women to specialize in nonmarket or household activities. These estimates confirm the slight tendency for women's schooling status to be negatively associated with women's participation in the nonagricultural labor force, even though the absolute level of women's schooling is directly linked to labor force participation through the wage.

REDUCED-FORM EQUATIONS

The three structural equations estimated for each age group of women are solved for the restricted reduced-form equations and reported in Tables 8, 9, and 10.[1] The reduced-form equation expresses the sum of direct and indirect effects exerted by each exogenous variable in the entire model on one endogenous variable. For example, the female wage evidently influences marriage (Table 8, ages 20 to 29) through its impact of women's propensity to work in nonagricultural jobs, which in turn reduces the prevalence of marriage. Demographic (migration and sex ratio) and labor market (women's wage, unemployment, and relative education) variables appear to exert the most substantial effects on the proportion of women married, whereas the child "price" effects are generally of the expected sign but not very large.

The reduced-form equations for fertility are consistent with our predictions. The net effect of migration on fertility is concentrated among women in their 20s; the sex ratio has a greater impact after age 25 as do the two labor market variables -- the woman's wage and women's unemployment. As in the structural equations for fertility, male schooling delays marriage and fertility, but after women reach age 30, parents in regions where men are better educated, our proxy for more income, have more children. Women's schooling appears to increase fertility until age 35 and depress it thereafter, while the relative status of women to men decreases the frequency of marriage and reduces fertility at all ages. Child school attendance depresses fertility from ages 20 to 40, whereas if children work more often in the labor force, fertility is notably greater among women aged 30 to 44.

The nonagricultural participation of women is also associated, as expected, with the labor market variables. It is somewhat surprising, however, that women's schooling, or the relative educational status of women to men, does not affect participation more noticeably.

The effects of schooling on Thai behavior are not easily visualized from the estimated model, for in addition to the levels of schooling of both sexes the school achievement of women relative to men

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[1]This technical procedure is described in any recent textbook of econometrics.

Table 8

REDUCED FORM EQUATIONS FOR MARRIAGE

Age of Women	Migration	Sex Ratio	Female Unemploy-ment	Female Wage	Male Education	Female Education	Relative Education	Child Schooling	Child Participation
15-19	.568	.154	-.372	.747	-.0833	.0000153	-.313	-.000205	.000621
20-24	1.18	.0510	1.08	-2.62	-.0922	.00112	-.0636	-.00630	.00441
25-29	.634	.271	1.33	-2.18	-.0341	.0108	-.0641	-.00744	.0108
30-34	.191	.243	.333	-1.11	.00743	.00280	-.133	-.00841	.0235
35-39	.233	.185	.595	-.787	.00439	-.000375	-.0707	-.000809	.00404
40-44	.261	.173	.419	-.662	.00252	-.000721	-.0664	.000338	.00301
15-44	.454	.353	-.664	-.967	-.0513	-.0000486	-.158	-.000164	.000842

Source: Tables 6-8.

Table 9

REDUCED FORM EQUATIONS FOR FERTILITY

Age of Women	Migration	Sex Ratio	Female Unemploy-ment	Female Wage	Male Education	Female Education	Relative Education	Child Schooling	Child Participation
15-19	.351	.0954	-.348	.699	-.0547	-.000649	-.196	.00867	-.0263
20-24	2.18	.0941	1.50	-3.63	-.179	.0198	-.143	-.112	-.0783
25-29	2.40	1.02	5.18	-8.51	-.175	.198	-.236	-.136	.198
30-34	.745	.949	3.83	-12.27	.307	.116	-.600	-.349	.973
35-39	.521	.413	17.1	-22.6	.526	-.0926	-.109	-.200	.998
40-49	1.37	.907	15.3	-24.2	.661	-.309	-.233	.145	1.29
15-49	.334	.260	-8.04	-11.7	.0390	-.0153	-.110	-.0515	.265

Source: Tables 6-8.

Table 10

REDUCED FORM EQUATIONS FOR WOMEN'S PARTICIPATION IN THE NONAGRICULTURAL LABOR FORCE

Age of Women	Migration	Sex Ratio	Female Unemployment	Female Wage	Male Education	Female Education	Relative Education	Child Schooling	Child Participation
15-19	-.0495	-.0134	-2.22	4.45	.00770	.0000914	-.0236	-.00122	.00370
20-24	-.250	-.0108	-2.21	5.34	.0205	-.00227	-.0868	.0128	.00898
25-29	-.310	-.133	-3.14	5.15	.0226	-.0256	-.0549	.0176	-.0256
30-34	-.0756	-.0963	-1.40	4.66	-.0311	-.0118	.0932	.0354	-.0988
35-39	-.0133	-.0106	-3.76	4.97	-.0135	.00237	-.00751	.00511	-.0255
40-49	-.0221	-.0147	-2.90	4.59	-.0107	.00500	-.0197	-.00234	-.0209
15-49	-.00671	-.00523	4.20	6.11	-.000783	.000307	-.000972	.00104	-.00532

Source: Tables 6-8.

appears to exert an important influence. These three variables imply a nonlinear relationship between any change in the level of men's or women's schooling and each of the dependent variables. Table 11 summarizes the elasticities between the years of schooling and Thai behavior, evaluated at mean values for the regression. These elasticities express how a change in men's or women's schooling would proportionately affect fertility, marriage, and nonagricultural labor force participation. For example, increasing the average number of years of schooling received by women aged 40 to 44 from 1.1 to 1.4 is associated with an 11 percent (27% x .409) reduction in number of children ever born from 5.8 to 5.2. Conversely, a 27 percent increase in male schooling from 2.6 to 3.3 years is associated with an increase in fertility from 5.8 to 6.9 children ever born per woman aged 40 to 44. If these estimates were approximately correct, the marked advance of women's educational attainment relative to men's during the 1930s should induce a substantial decline in completed fertility among women 40 to 44 years of age by 1970.[1]

The elasticity of marriage and nonagricultural participation with respect to changes in sex-specific educational achievements are never of the same magnitude as those estimated for fertility among older women (Table 11). As we might have anticipated, Thailand already exhibits a relatively modern pattern of moderately late marriage and substantial female participation in the labor force. Fertility, however, is still very high among the older cohorts of women, and though the educational advance of women does not appear to greatly influence birth rates among younger women (in their 20s) it is likely already to have begun to effect a sharp reduction in the birth rate among women over the age of 30. The 1970 Census of Thailand will confirm or reject this important implication of our analysis.

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[1] Note in Table A-6 that in 1960 the average number of years of schooling is almost three times as great among women aged 25-29 as it is among women 40-44 (2.9 versus 1.1) whereas for men the increase is about 35 percent (3.5 versus 2.6).

Table 11

THE PARTIAL ELASTICITY OF MARRIAGE, FERTILITY, AND NONAGRICULTURAL PARTICIPATION WITH RESPECT TO MALE AND FEMALE SCHOOLING

Schooling	Marriage		Fertility		Nonagricultural Participation	
	Male	Female	Male	Female	Male	Female
Age of Women						
15-19	-.0133	-.0770	-.0107	-.0490	.0130	-.00571
20-24	-.0777	-.0163	-.146	-.0192	.0403	-.0260
25-29	-.0186	-.00840	-.118	.127	.0359	-.0420
30-34	.0357	-.0361	.434	-.0593	-.0510	.0155
35-39	.0170	-.0239	.546	-.129	-.0121	-.000131
40-44	.0131	-.0292	.698	-.409	-.00754	-.00347
15-44	-.0160	-.0459	.0637	-.0474	-.000565	.0000246

Source: Tables 8-10.

V. CONCLUSIONS

This report is intended to be a preliminary empirical exploration of the relationships between several constraints on the environment within which households function and three forms of "family" behavior in Thailand: the proportion of women currently married, the proportion of women working in nonagricultural activities, and the average number of children ever born per woman. Elements of economic and demographic logic are used to specify the direct determinants of each of the three areas of household decisionmaking, although all of the exogenous constraints play a direct or indirect role by means of the interrelationships among the endogenous forms of behavior. Further study of Thai social institutions is required to refine and elaborate the model posited here, but we also need much better data to perform adequate tests of even the implications of this simplified model.

Aggregate data from 71 administrative units of Thailand (changwats) from the 1960 Census are the observations to which we fit the model. Because of the joint dependency of marriage, fertility, and women's labor force activity, the parameters of the three-equation model are estimated with simultaneous-equations techniques. The model is estimated for six five-year age groups of women in addition to an aggregate of all women between the ages of 14 and 44. Although not every estimate is as we anticipated, the great majority are of the appropriate sign and statistically significant by conventional asymptotic standards. The estimates of the three structural equations are reported in Tables 5, 6, and 7, showing the relationships between each dependent variable and those variables assumed to account directly for this form of behavioral variation across regions. Reduced-form equations are solved from the restricted structural equations and are found in Tables 8, 9, and 10. These equations express the combination of direct and indirect effects of all exogenous variables on each of the endogenous forms of behavior. Finally, since sex-specific adult educational attainment is introduced in a nonlinear form, both as independent levels and as a relative status variable, the partial elasticities of

marriage, fertility, and labor force participation with respect to male and female schooling are shown in Table 11.

Changing the level of men's or women's educational attainment has the most substantial effects on fertility levels. Men's schooling is linked to delayed marriage and later childbearing, but by the end of a woman's childbearing years, men's schooling is associated with much higher completed fertility. Female schooling increases fertility in the 25-29 age cohort, but strongly depresses it thereafter. The narrowing of the gap between educational attainments of men and women during the 1930s in Thailand should be found to have helped reduce birth rates among women over the age of 30 after 1960.

Increased education among women may also marginally reduce the proportion of women married, but it may not affect the size of the female nonagricultural labor force significantly. The tendency for women to occupy nonagricultural jobs appears to be largely a function of the local structure of industry and the level of female unemployment (see also Nerlove and Schultz, 1970). These labor market variables for women also have a strong indirect effect on fertility and at least the timing of marriage (Tables 8, 9, and 10).

The proportion of women who have recently migrated into a region appears to increase the proportion married, decrease nonagricultural participation, and increase fertility. The effect of in-migration on fertility is to increase only the birth rate among women under age 30, for thereafter the coefficients in the reduced form fertility equations diminish (Table 9).

In conclusion, we should restate and emphasize the many qualifications that should be attached to these findings. First, the cross-sectional evidence analyzed here from a single census need not parallel the evidence that would emerge from a study of time-series of cross-sections (Schultz, 1972), which might be more appropriate to the goal of predicting the short run effects of alternative development policies on fertility and population growth. Second, our estimates would be offered with greater confidence if the units of observation were a representative sample of individual Thai couples or households rather than regional aggregates; the problems of multicollinearity might be

reduced at the family level, and perhaps there would be less reason to think that we were spuriously attributing causality to an unrelated socioeconomic correlation.

In addition, the model might be extended to improve our understanding of a wider range of related family choices and policy variables. Clearly, migration should be treated as endogenous in such a broader model of family decisionmaking, as might be women's wages, child schooling, and child labor force participation (see DaVanzo, 1971). Additional explanatory variables that are exogenous to the family should be analyzed, such as child mortality, malaria morbidity, school expenditures, and family planning services or the public and private cost of birth control. Although the directions for extending and elaborating the model proposed in this report are many, it should be clear even from this tentative study of data from a single Census that fertility should not be viewed in isolation from the economic constraints that appear to influence the formation and specialization of the family in Thailand.

Appendix A

SUPPLEMENTARY STATISTICAL MATERIAL

Table A-1

MARRIAGE RATES BY AGE GROUP AND REGION[a]

Age of Women	Whole Kingdom	Bangkok Area	Central Region	North Region	South Region	Northeast Region
15-19	12.53	8.10	11.12	16.09	19.10	10.41
20-24	56.24	42.75	52.11	63.38	60.76	56.77
25-29	79.48	70.06	76.72	83.34	82.18	80.28
30-34	85.95	80.52	84.52	88.00	88.37	86.04
35-39	86.28	81.38	85.70	87.39	88.95	86.20
40-44	82.53	78.24	82.32	83.72	85.23	81.99
15-44	61.29	54.78	59.77	67.12	66.21	58.66

[a]Percent of women currently married.
Averages weighted by female population in age group for each changwat.

Table A-2

FERTILITY RATES BY AGE GROUP AND REGION[a]

Age of Women	Whole Kingdom	Bangkok Area	Central Region	North Region	South Region	Northeast Region
15-19	.072	.063	.063	.092	.112	.055
20-24	.862	.717	.779	.993	.918	.858
25-29	2.296	1.958	2.156	2.453	2.223	2.403
30-34	3.786	3.221	3.626	3.880	3.552	4.071
35-39	4.982	4.029	4.794	4.958	4.610	5.491
40-49	5.790	4.549	5.536	5.801	5.215	6.519
15-49	2.677	2.179	2.571	2.842	2.524	2.824

[a]Number of children born alive per woman.
Averages weighted by female population in age group for each changwat.

Table A-3

NONAGRICULTURAL PARTICIPATION RATES BY AGE GROUP AND REGION[a]

Age of Women	Whole Kingdom	Bangkok Area	Central Region[b]	North Region	South Region	Northeast Region
15-19	10.05	28.13	16.84	9.33	7.64	3.93
20-24	10.47	36.62	19.77	10.54	10.75	4.98
25-29	12.38	37.78	19.58	10.09	10.69	4.38
30-34	12.60	38.19	19.65	10.39	10.94	4.77
35-39	12.67	39.65	19.84	10.62	11.19	4.70
40-49	12.41	38.52	19.26	10.21	10.88	4.25
15-49	11.96	36.07	19.04	10.16	10.22	4.47

[a]Percent of women employer in nonagricultural industries.
Averages weighted by female population in age group for each changwat.

[b]Excluding Bangkok.

Table A-4

AGRICULTURAL PARTICIPATION RATES BY AGE GROUP AND REGION[a]

Age of Women	Whole Kingdom	Bangkok Area	Central Region[b]	North Region	South Region	Northeast Region
15-19	73.63	9.30	63.33	78.76	71.91	88.20
20-24	73.05	8.43	62.86	78.94	74.25	88.91
25-29	72.17	7.55	60.90	77.82	73.55	88.63
30-34	72.32	8.40	61.35	77.37	74.15	88.04
35-39	73.72	9.40	63.01	78.57	74.96	88.83
40-49	74.97	10.28	65.49	79.99	77.25	90.02
15-49	73.47	8.85	62.90	78.61	74.26	88.74

[a]Percent of women employed in agriculture.
Averages weighted by female population in age group for each changwat.

[b]Excluding Bangko

Table A-5

MEANS AND STANDARD DEVIATIONS OF VARIABLES IN MODEL

	15-44	15-19	20-24	25-29	30-34	35-39	40-44
I.							
Marriage	.6129	.1253	.5624	.7948	.8595	.8628	.8253
	(.0621)	(.0667)	(.0893)	(.0529)	(.0325)	(.0280)	(.0289)
Fertility	2.677[a]	.07175	.8621	2.296	3.786	4.982	5.790[a]
	(.239)	(.0424)	(.168)	(.231)	(.330)	(.523)	(.741)
Nonagricultural participation	.1196[a]	.1005	.1272	.1238	.1260	.1267	.1241[a]
	(.0940)	(.0776)	(.0939)	(.0998)	(.0984)	(.101)	(.0994)
Agricultural participation	.7347[a]	.7363	.7305	.7217	.7232	.7372	.7497[a]
	(.214)	(.208)	(.222)	(.223)	(.214)	(.210)	(.209)
Male education	3.627	4.221	3.840	3.546	3.589	3.230	2.576
	(.730)	(.786)	(.765)	(.765)	(.678)	(.753)	(.661)
Female education	2.857	3.802	3.246	2.931	2.713	1.881	1.096
	(.689)	(.670)	(.752)	(.711)	(.693)	(.744)	(.557)
Relative education	.7815	.9051	.8418	.8206	.7453	.5628	.4021
	(.0775)	(.0893)	(.0980)	(.0875)	(.0877)	(.120)	(.126)
Sex ratio	.9989	1.021	1.007	.9790	1.016	1.018	1.009
	(.0707)	(.0344)	(.0964)	(.0670)	(.0639)	(.0602)	(.0637)
Migration	.03838	.03841	.04886	.04216	.03581	.03039	.02590
	(.0329)	(.0391)	(.0444)	(.0338)	(.0284)	(.0249)	(.0220)
Female unemployment	.006301	.01154	.009797	.004816	.003229	.002748	.002433
	(.00787)[a]	(.0146)	(.0140)	(.00656)	(.00364)	(.00292)	(.00222)[a]

Table A-5 continued

	15-44	15-19	20-24	25-29	30-34	35-39	40-44
II.							
Child schooling	1.848 (.401)						
Child participation	.4483 (.132)						
Female wage	.03636 (.0212)						
Male wage	.04419 (.0280)						
Relative wage	.8546 (.199)						

[a]The age groups for this variable are 15-49 rather than 15-44 and 40-49 rather than 40-44.

Table A-6

CORRELATION OF VARIABLES IN MODEL[a]

Variable Number and Name	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1. Marriage	—													
2. Fertility	.359	—												
3. Nonagricultural participation	-.216	-.721	—											
4. Agricultural participation	.201	.734	-.957	—										
5. Male education	-.703	-.442	.388	-.426	—									
6. Female education	-.774	-.331	.560	-.576	.936	—								
7. Relative education	-.595	.115	-.174	.133	.401	.687	—							
8. Sex ratio	.515	-.208	.369	-.447	.008	-.152	-.391	—						
9. Migration	.065	-.376	.590	-.669	.467	.321	-.163	.539	—					
10. Female unemployment	-.373	-.579	.712	-.839	.660	.596	.125	.242	.643	—				
11. Child schooling	-.742	-.251	.294	-.257	.839	.873	.563	-.288	.101	.330	—			
12. Child participation	-.111	.581	-.740	.825	-.230	-.074	.322	-.614	-.569	-.640	.177	—		
13. Female wage	-.258	-.744	.925	-.974	.593	.470	-.052	.411	.652	.857	.271	-.813	—	
14. Male wage	-.275	-.736	.904	-.973	.649	.503	-.085	.410	.690	.885	.307	-.786	.945	—
15. Relative wage	.087	.035	-.056	.096	-.228	-.131	.145	.005	-.168	-.166	-.148	-.036	.069	-.250

[a]Data are weighted by female population aged 15 thru 44 for each changwat. Aggregate (i.e., ages 15-44 or 15-49) values are used for age-specific variables.

Table A-7

ORDINARY LEAST SQUARES ESTIMATE OF MARRIAGE EQUATION[a]

Age of Women	Nonagricultural Participation (Proportion)	Migration (Proportion)	Sex Ratio	Male Education (Years)	Relative Education (Female/Male)	Constant	R^2 F(5,65) Significance
15-19	.0597 (0.87)	.656 (4.55)	.204 (1.45)	-.0804 (10.5)	-.316 (5.70)	.510 (3.22)	.680 27.57 .000
20-24	-.234 (2.90)	.739 (3.27)	.0383 (0.45)	-.0957 (7.95)	-.0579 (0.77)	.934 (9.48)	.659 25.14 .000
25-29	-.234 (4.49)	.225 (1.25)	.217 (2.88)	-.0403 (4.73)	-.00435 (0.07)	.748 (8.11)	.639 23.01 .000
30-34	-.131 (4.10)	.0041 (0.03)	.226 (4.50)	-.0132 (1.95)	-.0607 (1.37)	.738 (12.5)	.592 18.84 .000
35-39	-.0780 (2.70)	.152 (1.23)	.161 (3.29)	-.00689 (1.20)	-.0550 (1.80)	.757 (14.2)	.486 12.31 .000
40-44	-.0781 (2.57)	.143 (0.96)	.163 (3.26)	-.00288 (0.44)	-.0713 (2.16)	.702 (13.5)	.401 8.71 .000
45-49	-.0693 (1.56)	.354 (2.36)	.344 (5.46)	-.0585 (8.09)	-.124 (2.15)	.573 (7.10)	.808 54.80 .000

[a]The regressions are weighted by the female population for each age group. The numbers in parentheses below each coefficient are the t-ratios.

Table A-8

ORDINARY LEAST SQUARES ESTIMATE OF FERTILITY EQUATIONS[a]

Age of Women	Marriage (Proportion)	Non-agricultural Participation (Proportion)	Child Participation (Proportion)	Child Schooling (Years)	Male Education (Years)	Female Education (Years)	Constant	R^2 F(6,64) Significance
15-19	.649	.0415	-.0233	.00697	-.00213	.00175	-.0138	.984
	(38.4)	(2.72)	(1.63)	(1.06)	(0.83)	(0.43)	(1.01)	644.
								.000
20-24	2.05	.292	-.0652	-.00253	-.00361	.0206	-.348	.932
	(21.7)	(2.43)	(0.71)	(0.07)	(0.16)	(1.12)	(3.59)	146.
								.000
25-29	4.24	.186	.207	-.105	-.0667	.186	-1.30	.809
	(11.0)	(0.61)	(1.00)	(1.25)	(1.02)	(2.55)	(3.52)	45.1
								.000
30-34	5.04	-1.47	.851	-.233	.163	.152	-1.31	.759
	(5.72)	(3.33)	(2.66)	(1.64)	(1.52)	(1.34)	(1.57)	33.5
								.000
35-39	5.35	-3.42	1.20	-.160	.402	-.0118	-.719	.780
	(3.74)	(5.31)	(2.45)	(0.80)	(3.23)	(0.10)	(0.54)	37.9
								.000
40-49	4.11	-4.69	1.13	.130	.614	-.308	.991	.712
	(1.92)	(4.60)	(1.53)	(0.48)	(3.24)	(1.53)	(0.52)	26.4
								.000
15-49	1.82	-1.23	.635	-.0985	.0343	.102	1.19	.619
	(3.71)	(2.99)	(2.08)	(0.74)	(0.36)	(1.03)	(2.64)	17.4
								.000

[a]The regressions are weighted by the female population for each age group. The numbers in parentheses below each coefficient are the t-ratios.

Table A-9

ORDINARY LEAST SQUARES ESTIMATE OF NONAGRICULTURAL PARTICIPATION EQUATION[a]

Age of Women	Fertility	Female Unemployment (Proportion)	Relative Education (Female/Male)	Female Wage	Constant	R^2 F(4,66) Significance
15-19	-.144 (0.95)	-2.45 (2.63)	-.0562 (0.73)	4.64 (6.97)	.0292 (0.36)	.661 32.18 .000
20-24	-.0629 (1.41)	-3.96 (3.29)	-.0519 (0.64)	5.88 (7.39)	.0498 (0.50)	.714 41.18 .000
25-29	-.0507 (1.32)	-2.65 (1.31)	-.0574 (0.66)	3.94 (5.46)	.151 (1.08)	.675 34.23 .000
30-34	-.0407 (1.24)	-1.13 (0.38)	-.0470 (0.56)	3.23 (4.71)	.196 (1.40)	.635 28.68 .000
35-39	-.0250 (1.08)	-.192 (0.05)	-.0549 (0.80)	3.34 (4.57)	.156 (1.28)	.649 30.56 .000
40-49	-.0204 (1.37)	.368 (0.09)	-.0250 (0.37)	3.10 (5.05)	.133 (1.41)	.625 27.51 .000
15-49	-.0102 (0.24)	-3.79 (2.18)	-.108 (1.20)	4.66 (6.09)	.0847 (0.59)	.681 35.22 .000

[a]The regressions are weighted by the female population for each age group. The numbers in parentheses below each coefficient are the t-ratios.

Appendix B

DATA SOURCES AND DERIVATION OF VARIABLES

The primary source of data used in this study is the Thailand Population Census: 1960 (a summary volume for the whole kingdom, and 71 individual changwat volumes). All data for changwats used to estimate the model were taken from the individual changwat volumes (Table B-1). Although the Census is quite rich in demographic data, it is unfortunately lacking in any information on wages or income. Because of this limitation, the three variables pertaining to wages (female wage, male wage, and relative wage) are derived from aggregate data for the entire country, as described below. All other variables are derived from published Census data on the changwat level. Fourteen basic variables, defined in Table B-2, were first collected for each of the 71 changwats; ten of these variables refer to specific age groups from 15 to 44, with the exception of birth and labor force data, for which the oldest age group extends through 49. The actual variables used in the model are defined in terms of the basic variables, as shown in Table B-3. All variables used in the final model are age-specific, with the exception of the child participation and schooling rates, and the three wage variables.

Since no information on wages or income is available on the changwat level, wage proxies were constructed, using available information on employment by industry for persons aged 11 and over. Ten industrial sectors were formed by matching the sectors of economic activity in Table 18 of the Census with the sectors of income in Table 212 of the Thailand Statistical Yearbook: 1965. The number of males and females employed in each industry is available for each changwat and for the whole kingdom. Differences in income between economically active males and females and among changwats was assumed to be a function of differences in the industrial structures of the labor force. From the total income by industry and the total number of persons economically active in each industry, an average product for each industry is reported in Table B-4. If each person economically

active in an industry received the average national product for that industry, regardless of sex or changwat of residence, an estimate of the average wage received by economically active males and females can be calculated from the sex-specific industrial structure of employment in each changwat. From these estimates of male wage and female wage, a relative wage was defined as the ratio of the female wage to the male wage for the changwat. It follows that these variables are actually indices of the sex-specific industrial structure of the changwat, each industrial sector being weighted by the corresponding national average product. The wage variables, therefore, neglect regional differences in income within a given industry and differences in wages due to sex. If, however, we assume that females in an industry receive some fixed proportion of the wage received by men in the industry, the proportion being independent of industry or location, it then follows that the male and female wage proxies differ from the "true" wages by only a constant factor which cannot affect either the sign or the significance of the coefficient estimated for that variable in the regression model.

Table B-1

LIST OF CHANGWATS BY REGION

Central Region

1 Phranakhorn[a,b]
2 Thonburi[a]
3 Nonthaburi[a]
4 Pathumthani
5 Nakhronpathom
6 Ratburi
7 Phetburi
8 Singhburi
9 Kachanaburi
10 Chonburi
11 Chanthaburi
12 Chai-nat
13 Prachuabkirikhan
14 Cha-Choengsao
15 Samutsakhorn
16 Samutsonghram
17 Samutprakan
18 Lopburi
19 Suphanburi
20 Phranakhornsri-ayuthaya
21 Angthong
22 Nakhornnayok
23 Trat
24 Saraburi
25 Prachinburi
Rayong

theastern Region

Kalasin
Khon-kaen
Chayaphum
Nakhornphanom
Nakhornratchsima
Nongkhai
Buriram
Mahasarakham
Roi-et
Loei
37 Srisaket
38 Sakonnakhorn
39 Surin
40 Ubonratch-thani
41 Udornthani

Southern Region

42 Chumphorn
43 Ranong
44 Suratthani
45 Phang-nga
46 Nakhornsrithamrat
47 Phuket
48 Krabi
49 Phatalung
50 Trang
51 Satun
52 Songkhla
53 Pattani
54 Yala
55 Nara-thiwat

Northern Region

56 Kamphaengphet
57 Chieng-rai
58 Chiengmai[a]
59 Tak
60 Nakhornsawan
61 Nan
62 Phichit
63 Phitsnulok
64 Phetchbun
65 Phrae
66 Mae-hongson
67 Lampang
68 Lamphun
69 Sukho-thai
70 Uttaradit
71 Uthai-thani

[a]Urban areas.
[b]Bangkok.

Table B-2

DEFINITIONS OF BASIC VARIABLES

Variable	Age Groups	Definition	Source[a]
CEB	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 14-44	Total number of children ever born	Table 14
F	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44, 40-49, 15-49	Total female population	Table 3
FCM	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	Number of females currently married	Table 4
FEA	15-19, 20-24, 25-29, 30-34, 35-39, 40-49, 15-49	Number of females economically active	Table 15
FEAA	15-19, 20-24, 25-29, 30-34, 35-39, 40-49, 15-49	Number of females economically active in agriculture	Table 19
FED	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	Total number of years of school completed by females	Table 11
FLFW	15-19, 20-24, 25-29, 30-34, 35-39, 40-49, 15-49	Number of unemployed females (i.e., those economically active) but looking for work	Table 15
FMG	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	Number of females who have moved from another Changwat within the past five years	Table 6
M	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	Total male population	Table 3
MED	15-19, 20-24, 25-39 30-34, 35-39, 40-44 15-44	Total number of years of school completed by males	Table 11
TEA11	11-14	Number of children economically active	Table 15

Table B-2 (continued)

Variable	Age Groups	Definition	Source[a]
T10	10	Number of persons aged 10	Table 3
T10ED	10	Total number of years of school completed by persons aged 10	Table 11
T11	11-14	Total population aged 11-14	Table 3

[a]Location of data in Thailand Population Census: 1960, Changwat volumes.

Table B-3

DERIVATION OF VARIABLES USED IN THE MODEL

Variable	Age Groups	Derivation[a]
Marriage rate	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	FCM / F
Fertility rate	15-19, 20-24, 25-29, 30-34, 35-39, 40-49, 15-49	CEB / F
Nonagricultural participation rate	15-19, 20-24, 25-29, 30-34, 35-39, 40-49, 15-49	(FEA - FLFW - FEAA) / F
Agricultural participation rate	15-19, 20-24, 25-29, 30-34, 35-39, 40-49, 15-49	FEAA / F
Child participation rate	11-14	TEA11 / T11
Child schooling	10	T10ED / T10
Male schooling	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	MED / M
Female schooling	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	FED / F
Relative schooling	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	(FED / F) / (MED / M)
Migration	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	FMG / F
Sex ratio	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 15-44	M / F
Unemploymen	15-19, 20-24, 25-29, 30-34, 35-39, 40-49, 15-49	FLFW / FEA

[a]The basic variables from which the variables in the model are derived are defined in Table B-2.

Table B-4

CALCULATION OF AVERAGE PRODUCT BY INDUSTRY

Industry	Income Sectors Included[a]	Persons Included[b]	Total Product[c]	Number of Persons	Average Product[d]
Agriculture	Crops, Livestock, Forestry	Crops and livestock Forestry and logging	07,102	11,223,430	.0185
Fishing	Fishing	Fishing Hunting, trapping, and game propagation	9,786	110,952	.0882
Mining and Quarrying	Mining and Quarrying	Mining and quarrying	7,653	29,568	.2588
Manufacturing	Manufacturing	Manufacturing	58,820	471,027	.1249
Construction	Construction	Construction, repair, and demolition	20,103	68,813	.2921
Utilities	Electricity and Water	Electricity, water, and sanitary services	2,271	15,535	.1462
Transportation and Communication	Transportation and Communication	Transportation, storage, and communication	39,485	165,939	.2380
Trade	Wholesale, Retail	Wholesale and retail trade	96,602	770,230	.1254
Finance	Banking, Insurance, and Real Estate	Banks and other financial institutions, insurance, and real estate	12,756	9,674	1.3186
Services	Public Administration and Defense Services	Services, including government services	7,801	655,271	.1191

[a]Sectors included from Thailand Statistical Yearbook: 1965. Table 212, "Gross Domestic Product, by Industrial Origin, 1957-1965," pp. 459-460.

[b]Sectors included from Thailand Population Census: 1960. Table 18, "Economically Active Population 11 Years of Age and Over, by Work Status, by Industry and by Sex," pp. 44-50 in Whole Kingdom volume, various pages in individual changwat volumes.

[c]100,000 baht per year.

[d]100,000 baht per person per year.

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