SOME FACTORS AFFECTING BIRTH RATES IN TAIWAN: AN EMPIRICAL STUDY

by

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Abstract

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Taiwan has experienced the most rapid economic development in its history in recent years. Based on capita income, it has gone from a developing country to a developed one in this period. The population structure of the country is similar to that of Western Europe and American and will be affected by problems associated with an aging population in the near future. The birth rate of Taiwan has fallen continuously every year since 1951. Only 227,000 infants were born in 2004, which is almost 12 percent less than those born in 2003. The number of births per woman of 1.2 in 2004 is the lowest in Taiwan's history.

According to Organization for Economic Cooperation and Development (OECD) report (December 2004), a declining birth rate poses many problems. The labor force will decline; average income will shrink; social welfare expenditures will fall; and younger persons will face increasing taxes required to support the elderly. The OECD found that modern women like to have children but they worry about the high cost of raising children. The purpose of my research is to understand the economic and demographic underpinnings of the long- term reduction in the birth rate in Taiwan. This is an essential first step in formulating policies to reverse the trend.

In my research, I will focus on three issues: (1) the relation between higher

education by women and fertility, (2) the relation between the availability of family planning services and fertility, and (3) the relationship between infant mortality and fertility. My data pertain to 361 townships and districts of Taiwan for the period from 1976 through 2002. I will collect the data from two publications of the government of Taiwan: Population for Townships and Districts and the Family Planning Reference Book. Compared to previous research in this area, the advantages of my study are that I cover a longer period of time and include the most recent data.

Using this long time series of town cross sections, I will estimate the effects of male schooling, female schooling, and the percentage of the male labor force employed in agriculture, infant mortality, and the availability of family planning services on age-specific birth rates. My statistical methods will include fixed-effects and first-difference regression models. My ultimate aim is to see how much of the dramatic decline in fertility in the period at issue can be accounted for by trends in each of the factors just mentioned. When combined with projections concerning, for example, the future growth in female schooling levels, these estimates can be used by policy makers to gauge the amount of subsidies required to reverse the trend in fertility or to encourage increases in family size.

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Chapter 1 Introduction

1.1 Introduction

The crude birth rate is lingering between 40 ‰ before 1950 in Taiwan. In 1952, this rate increase to 47‰ , then after that it becomes decreasing all the way down to 23‰ in 1973 (and only 12‰ in 2004). Because of this dramatic change on birth rates and abound of systematic population data in Taiwan, there are a lot of social scientists, demographic scholars and economists been attracted to this area to study the women bearing behavior in difference aspects. The purpose of all studies provided guidance to the government to make its proper decision on population policies (Chang and Tsao, 1981).

A number of studies of the determinants of fertility in Taiwan have been published since the mid 1960s. Some employ historical macro-time series; others employ data for individual household at a moment in time; and others employ data for areas of the country over time (Freedman et al., 1972; Jejeebhoy, 1978; Liu, 1966; Chang, 1976, 1979; Hermalin et al., 1979; Schultz, 1973). Crude birth rates, age-specific fertility rates, and total fertility rates (the number of births that 1,000 women would have in their lifetime if at each year of age they experienced the birth rates occurring in a specified year) have been employed as outcomes. In addition some researchers have compared actual and ideal number of children based on surveys (Hermalin, 1974; Hermalin et al., 1979; Nair and Chow, 1980). These studies have investigated the effects of such factors as family planning services, household income, and adult schooling levels (Liu, 1965; Collver et al., 1967; Sun 1973; Hermalin, 1973; Freedman, 1975; Mueller, 1972). The empirical techniques employed in this literature include multiple regression analysis, factor analysis,

and path analysis (Freedman et al., 1963; Liu, 1965; Collver et al., 1967; Hermalin, 1968; Chang 1976, 1978; Schultz, 1973; Hermalin et al., 1979).

1.2 Research Motivation

Taiwan has experienced the most rapid economic development in its history in recent years. Based on capita income, it has gone from a developing country to a developed one in this period. The population structure of the country is similar to that of Western Europe and American and will be affected by problems associated with an aging population in the near future. The birth rate of Taiwan has fallen continuously every year since 1951. Only 227,000 infants were born in 2004, which is almost 12 percent less than those born in 2003. The number of births per woman of 1.2 in 2004 is the lowest in Taiwan's history.

The news (January, 2005) from TVBS (The Television Broadcast Station in Taiwan) indicates that, Taiwan's birth rate is the same as that of Italy. The latter country has the lowest birth rate among countries that are members of the Organization for Economic Cooperation and Development. Low birth rates pose large problems for OECD countries. If the number of children ever born to women between the ages of 15 and 44 (the total fertility rate) falls below 2.1, total population will fall within two generations. Among high-income countries, only Iceland, New Zealand, and the United States of America have fertility rates greater than 2. The average rate is 1.8 for the countries of Northern Europe and less than 1.5 for other high-income countries. Low fertility will become a potential problem for many countries in the near future.

According to OECD report (December, 2004), a declining birth rate poses many problems. The labor force will decline; average income will shrink; social welfare

expenditures will fall; and younger persons will face increasing taxes required to support the elderly. The OECD found that modern women like to have children but worry about the high cost of raising them. The purpose of my research is to understand the economic and demographic underpinnings of the long-term reduction in the birth rate in Taiwan. This is an essential first step in formulating policies to reverse the trend.

Chapter 2 Literature Review

2.1 A Retrospective Look at Fertility Theory

Before Malthus[1], issues on population elicited a series of wide concerns and discussions. During that time, the writing "An Essay on the Principle of Population, as It Affects the Future Improvement of Society, 1798" marked the end of fertility theory as unexamined ideas. Thereafter, scholars began a series of systematic and scholastic studies on the question of population. This not only opened up a new era for contemporary demography; it also had a profound influence on later demographic studies (Becker, 1960). After economists and sociologists have conducted the most in-depth studies on population issues in which fertility plays a central role. Just like other theories in social science, demography or fertility theories, the uprisings and revolutions that came about were due to economic, social and environmental changes. In the 18th century, the Industrial Revolution in England led to booming economies and new developments in society. At the same time, high birth and low mortality rates allowed the population to grow rapidly. Condorcet and Godwin (1965) were thinkers who examined the deve-

[1] Malthus did not emphasize the role of relative prices, but did assume for the most part that parent demand for children was a "normal" increasing function of real wage.

lopmental conditions at the time from an optimistic viewpoint. They believed technological advancements aided in the rise and development of societies, which were able to maintain and support rapid population growth. However, Malthus saw some of the disadvantages to society at the time, such as extreme disparities between the rich and poor, fewer opportunities for the working class to earn their living, etc. He criticized Condorcet's opinions. The population theory that developed emphasized two main issues, the first being that strong sexual attraction between the two sexes is inevitable, and the other that food is, of course, essential in maintaining human survival. The increase in the food supply was far lower than of that in the population; therefore lack of food would ultimately limit population growth. With the exception of preventive or (positive) limiting factors, the population shall grow as the food supply increases. It stops when demand for food becomes higher than supply. The so-called preventive limiting factors as proposed by Malthus include voluntary limits imposed by humans. Natural limits relating to "misfortune" include contagious diseases, war, famine etc., and other than late marriages, "guilt-related limits" such as incest, infanticide etc. Malthus was not optimistic about how population growth might be restricted by these two kinds of limits (Yu, 1987). Criticisms of the population theory of Malthus came mostly from two areas. One criticism that was established was based on the fact that actual population changes are inconsistent with Malthus's expectations. In the modern era, birth rates have gradually decreased causing population growth to slow down (Yu, 1987). In some advanced countries, no increase (0%) or even negative growth rates have occurred. These phenomena cannot be explained by Malthus's population theory; furthermore, based on it, Malthus hinted that land production technologies led to diminishing returns. Later,

researchers emphasized factors such as advances in technology, and increases in productivity in the industrial sector, which compensated for the phenomenon of diminishing returns. Some academics went so far as to completely reject the existence of such phenomenon (Yu, 1987).

2.2 Economic Fertility Theory, after Malthus

Malthus's population theory emphasized that birth rates are determined by the "supply" factor[2]. With improvements in contraception, the demand and supply aspects have reversed positions when it comes to the birth rate. Fertility has become a controllable variable. Towards the end of 1950, economists stepped into this arena again hoping to discuss birth rate issues by means of individual economic analysis. The recent widely discussed issues came from Gary Becker's economic analysis of birth rates. Becker (1960) skillfully applied new classical individual theory to the analysis of birth rates and so has had a profound influence on it. Birth rates pose particular difficulties in economic analysis. For instance, children cannot be traded freely. They must be "produced for own use"; producers are consumers. Uncertainty during childbirth is also an uncertainty for consumers. Fertility is not a "market activity"; as compared to other durable assets, "a down payment" for purchasing a child is lower while the "production period" is relatively longer and with lower mobility. Most importantly, fertility times and their quantity cannot be directly controlled (Becker, 1960; Willis, 1974). These features are precisely why such phenomena cause difficulty in economic analysis and cannot be sensibly discussed from the viewpoint of economics. This also explains why Malthus's

[2] Many social scientists have rejected the contemporary relevance of Malthusian theory and have looked elsewhere for a theory of fertility.

theory can only be established by passionate quasi-biological concepts of the opposite sex (Leibenstein, 1974). Other than late marriage, abortion and abstinence, disease, famine and war also contribute to the control of population. Contraceptive information and improvements in contraception have become universal in recent years. People have greater choice and freedom when it comes to fertility. Thus new economic theories must be provided in this area. The timely participation of the Chicago School led by Becker helped to oppose Malthus's biological points of view, and to argue for fertility as a calm, rational and carefully planned human choice and behavior.

The unexpected appearance of The Chicago School led to gradual developments from it called "New Home Economics". Economists began to explore further and expand on time distribution, labor capital and non-market behavior such as health, birth rates, education and marriage issues that were once avoided. Its developments in terms of birth rate theory intruded into areas of social psychology connected with population issues in the past few decades. After all, the question of whether fertility issues should reach their conclusions through economic theories or be overruled by other sciences such as psychology, sociology etc. is still being argued. Compared with other economic behavior, fertility is subject to more rituals, social pressure, religious faith, customary practices and sexual attraction. It makes economics seem rather useless to some extent. Therefore, the handling of the question of the issue of birth rate theory and means is a matter that still needs to be settled.

2.3 The Theory of the Demographic Transition

Before 1960, sociologists and demographic experts relied on isolated pieces of knowledge when it came to discussing population issues. The Theory of Demographic

Transition is considered an exception. This theory states that population changes are divided into three phases: (a) before modernization, (b) modernization and (c) completion of modernization. In the first phase, standards of living are low, production tools are primitive, the mortality rate high and life span short. Therefore, only races with high birth rates manage to survive. The second phase serves as the foundation of modernization: people have improved sanitation and nutrition, disease is controlled to some extent thus lowering the mortality rate and extending life span. People begin to live longer but the high birth rate continues. Only in the third phase do people start to leave behind high birth rates finally leading to a society with both low birth rates and low mortality. Without a doubt, the lowering of mortality is purely the result of technological advancement and the lowering of birth rates is due to social changes other than the spread of contraception. Therefore, this way of lowering birth rates plays a central role in such a theory.

After rigorous debate, satisfactory explanations were offered; including: financial independence and higher educational attainments of women, continuous lowering of neonatal mortality rates, changes in religious belief - including lack of it - protection for child workers, revolutionary changes in the family, more people living in cities, improvements in contraception, changes in social and economic structures, etc. These factors lack a systematic and precise structure, which inevitably leads to “false predictions”. Other theories are also seeking reasonable explanations for the third phase as it actually occurs. For example, Leibenstein (1957) once proposed a model based on economic theory to explain the “bounds” of birth rate behavior. He believed the multiplying number of child to the power of n brings a family three benefits and two costs (anti-use). The benefits include: “consumption”, “work or income” and “safety”.

"Direct costs" include food, shelter, clothing and recreational expenses. "Indirect costs" include: giving up of income or other opportunities necessary for bringing up a child.

Generally speaking, a child to the power of n has a figure less than a child to the power of n-1; as income increases, use (benefits) decreases. As for the question of anti-use (costs), an increase in income does not decrease the cost since although direct cost increases with income increase, "anti-use" does not necessarily follow this pattern. Indirect costs play an important role here. Under normal conditions, this theory infers that as n increases, those that are willing to give birth have a "boundary income" decrease. (Meaning once such income is exceeded; there is no willingness to bring up a child to the power of n.) Thus as income increases, n (the highest number of children people are willing to have) decreases.

2.4 The Chicago School

Leibenstein first made use of cost benefit analysis to analyze the process of decision making in birth rates in 1957. However, due to limitations of natural born defects and applications, the later development of this theory did not have much influence. In 1960, Becker of the Chicago School published a series of bibliographies that elicited massive feedback [3]. Those academics that used Becker's cost benefit analysis were given the name of the Chicago School. The Chicago School features the use of traditional consumer demand theory to analyze childbirth behavior. Children are regarded as a kind of commodity, which emphasizes "economic factors like cost, income etc. and their significance in the process of decision making in birth rates. Theoretically speaking,

[3] Harvey Leibenstein and Gary Becker (1960) were the first to examine the usefulness of microeconomic analysis for understanding reproductive behavior.

children should not be treated as inferior goods. But in reality, income often contradicts this. In view of the theories of the Chicago School, Leibenstein and Easterlin proposed several corrective opinions. Such corrections are more realistic but also hinder their own theory's analytical abilities.

In Becker's major breakthrough, he pointed out: "expenditures spent on child" do not equal the "cost of bringing up a child". It is a product of "cost" and child quality. "Quality" refers to a combination of expenditure items for child under a constant cost. When considering having children, one not only do the couple have to decide on the "quantity of children", they also have to consider how much they have available to spend on them – whether to choose quality milk, send the children to kindergarten, hire tutors, learn the piano etc. As long as their values of morality do not intervene, consumers are usually willing to "spend more" for the same unit item. It signifies that they gain more subjective use from it. Thus it can be defined as a "high quality" object. This applies as much to children, as to other items. Keeping factors like education and contraception in mind, Becker firmly believes that as income increases, childbirth increases positively although in the long run, relatively speaking negativity is observed.

Becker regards the demand for children as a durable demand for consumer goods. Just like any other consumer goods, they are determined by demand of the whole family unit system. He has noticed the differences between child quality and quantity. He believes that the quality and quantity of children should belong to the "normal goods". The flexibility of child quality is higher than the flexibility of quantity. In actual cross-examination observational data, birth rates and income are normally connected. It is due to the uneven distribution of contraceptive information among different income groups

that the real outcome observed is underestimated (Yu, 1987).

Becker believed in a positive outcome. In other words, children are not inferior goods. In later case study analysis however, researchers have not been able to come to a unanimous conclusion. Perhaps we can say that “low quality” children are inferior goods just like low quality cars and foods are inferior. But this does not imply “children are inferior goods”. Nevertheless, since child quantity (N) and quality (Q) cause relative changes as NQ changes, increases in income elicit changes in efficacy function. In fact, as Q and N change, N and Q change their relative costs as well. As a result, income changes affect N and Q and are reflected in cost efficacy. Therefore, the wealth flexibility of child quantity e_N can well be negative but N does not necessarily mean “inferior goods” (Willis, 1974).

When we distinguish quantity and quality and the differences between expenditure and cost, conceptually, this leads to rather significant strategic meanings. It is especially true in underdeveloped countries where birth rate theories without exception, have arrived from highly developed countries. Their goal is to “explain” why birth rates decline especially when “income increases, birth rates decrease”. In underdeveloped countries, this study aims to actively seek ways to lower birth rates. If people attempt to adopt economic means to lower birth rates such as income tax reduction regulations etc. [Council for Economic Planning and Development (CEPD), Taiwan, 1981], it is necessary to first understand the efficacy of “price” before estimating the outcome of such measures.

In later developments of the Chicago School, “Time Allocation Theory” was integrated into the original birth rate theory to further state the relationship between child

quality and quantity. Theoretically, based on their relationship, they tried to explain the reason for the inconsistent results with the actual figures. In Becker's model (1965), an individual household unit is not only a consumer but is also a producer. By using time and market goods the ultimate consumer goods are produced. Child quality and quantity are regarded as consumer goods. Therefore individual households acquire their demands through income under production function limitations and arrive at an enlarged efficacy function in order to meet the demand for market goods and optimum time allotment. Other than objective function, there are also many other limitations. In order to simplify the process of analysis, Becker introduced two important concepts, namely, full income and shadow cost. Using them he hoped to combine the many limitations into one income formula. Full income is the total amount of income gained through full time devotion to the labor market by a family. Shadow cost refers to the implied costs of consumer goods. Therefore, consumer goods and relative shadow cost equal total income. Assuming production technology is a constant return to scale while the possibility of joint production of consumer goods is eliminate, shadow cost is determined by external factors and is not affected by quantity changes in consumption. Consequently, we can easily analyze full income and shadow cost changes statistically and see how they affect parent demand for child quality, quantity and other consumer goods. Methodically, it is the same kind of analysis as traditional consumer theory analysis (Yu, 1987).

When the Chicago School later developed and applied efficacy function and income limitations into formal child quality, it also emphasized time cost effects on child cost. For instance, the opportunity cost changes as income or educational attainment change. Meanwhile, "income" should also be used in Potential Income. Birth rate

researchers criticized the Chicago School for overlooking the hobby variable. In other words, they had ignored the norms proposed by sociologists. Some argue that as income increases, societal pressure forces people to spend more. Becker's quality and the act itself are not voluntary and therefore Becker's "quality" principle must be rejected. It is meaningless since "efficacy" itself is subjective.

Willis (1973), Becker and Lewis (1973), Becker and Tomes (1976) abandon the hypothesis of the impossibility of joint production of consumer goods. Joint production of child quality and quantity is allowed. Assuming each child has the same quality, a child can render his services, which is the child's multiplied quality and quantity sum. This product sum is produced through time and market goods. Child quality and quantity enter the formula of full income through multiplicative means. Child quality and shadow cost come to a positive ratio. A more straightforward explanation for this is that as child quantity increases, the quality of an additional child brings about higher expenditures because they have to be shared among more children. As child quality increases, greater expense is incurred because better costs more, therefore, as income increases, it not only directly elicits higher quality and quantity demands of a child, since increases in the former and latter will also cause increases in child quantity and shadow cost. It causes the actual income to be lower than expected. Fertility income flexibility in actual observation underestimates the actual income flexibility. To conclude, the Chicago School emphasized economic factors such as cost and income and their roles in childbirth decision-making. It implied that parents have absolute control over birth rate results, and the hypothesis that preferences are constant and stable was established.

2.5 Leibenstein's theory -- SIG model

In 1957, Leibenstein also proposed a model to explain why income increases resulted in decreases in birth rates in 1974. Linbenstein made criticisms of the theory proposed by the Chicago School. He believed that income changes brought about cost efficacy on child quantity. But it was not significant enough to explain income and fertility and their negative relevance. Leibenstein believed that people always enjoy setting up demarcations in pursuit of their own kind. Different social classes are in search of different goals. Under untraceable pressure, people who belong to a single class have to do their best. This kind of class is called the "Social Influence Group" or in short, SIG. SIG refers to people with similar social and cultural backgrounds. Their efficacy functions are inter-related. Prior to reaching their desired goals, their last bound efficacy increases upon their last consumption. Linbenstein explained how fertility and income arrive at negative relativity from the SIG point of view. He believed that every family in society belongs to a different SIG according to its social background or financial status and that every SIG voluntarily chooses certain target goods and expects its members to reach certain consumption standards (Yu, 1987). Before such standards are met, there will be a phenomenon of target goods increasing marginal utility. Therefore those who belong to the same SIG will have the same preferences. Different SIGs have different consumption goals, thus different preferences. For a SIG that belongs to a higher class, a set of higher consumption standards is expected. These will conflict with birth rates and the bringing up of children. As a result, there will be lower birth rates. Those that belong to the same SIG, income and birth rates exhibit a direct ratio. Therefore based on a cross-examination of data, we have observed that birth rates and income relatively speaking have a negative relationship. Based on the time data, since more and more families are

climbing up the social ladder causing birth rates to decrease (in a kind of negative feedback), we have observed that economic developments and birth rates changes are connected in this way so the higher the class the higher the “target consumption” ratio. In addition to this, other “target” consumption goods display a bound efficacy increase in the last phase. In other words, the higher the SIG is, the less the fertility. Looking at it from the perspective of a SIG with higher income, expenditures increase too (including the bringing up of a child). People choose to minimize the number of children because of this phenomenon. However, people who belong to the same SIG encounter the same “target consumption”, as a result, the higher the income, the more birth rates decrease. Leibenstein’s SIG theory basically follows Becker’s analysis mode. There are just different preferences. According to his theory, preferences will be the same in every family that belongs to the same SIG but different SIGs will form different preference modes (Yu, 1987)

2.6 Theory of Easterlin, Pollak and Wachter

According to the bibliography of Easterlin et al., (1980), its theoretical structure is mostly a continuation of the theoretical model of The Chicago School. However, Becker et al., overlook two important factors, one of which is internal preferences, the other being natural fertility, which is the providing factor for birth rates. According to them, preferences mostly arise from two causes. One, (intra-family, values and concepts) are passed on from generation to generation. Other families are affected by two, the socialization process, and a family’s preferences for a certain birth rate. The so-called natural fertility refers to any possible conception and birth rates in a society with no modern contraceptive measures. Easterlin et al., propose this concept hoping to

distinguish between optimal fertility and desired fertility with the optimum birth rates taking limitations such as demand, supply, timing, income, production skills, birth function, infant mortality etc., into consideration. This greater efficacy brings about the standard birth rate, since with no contraception available, and taking the actual costs into account, the demand aspect solely determines birth rates.

Easterlin (1969, 1978), Easterlin et al., (1980) place importance on preferences, natural birth, optimum birth, cross examination analysis and the reasons for variations in birth rates at different times. When natural birth is greater than the expected birth standard, there will be a motive for contraception to be used. Whether or not contraception measures really take place depend on the cost of contraception and income size. If the benefits of contraception are less than its costs, then natural birth standards will be realized. However, on the contrary, if the benefits of contraception are greater than its costs, contraceptive measures will be implemented (Yu, 1987). The realized fertility is also the optimum birth standard. Through manipulation of factors like supply and preferences, natural birth determines the actual birth standard. Therefore, as we observe the cross examination of fertility behavior, the ratio of the various families' modes will determine the ultimate birth rates. With regard to the time data, as the social economy develops, the ratio of these family constitutions will change and affect the population migration process. So, Easterlin et al., (1980) claim that these family modes and their behavior regarding birth rates have to be demarcated because they are either being manipulated by the supply aspect or the preference factor of the supply aspect.

Surveying the aforementioned economists such as Becker, Easterlin and Leibenstein and their birth rates theories, it is found that Becker places emphasis on

economic factors like income and cost and their roles in determining birth rates. Easterlin et al., place importance on preferences and the intra-supply factor and how they affect fertility. Leibenstein emphasizes how different cultural backgrounds form social groups that have different preference modes. In short, controversy has arisen from the different ideas about preferences, economic factors and the supply aspect (Yu, 1987).

In regard to the role played by economic factors on fertility, Esaterlin et al., believe that as production technology violated the fundamental hypothesis of the Chicago School the analysis tools (i.e. a fixed remuneration scale and no joint production) which the Chicago School possessed, would lose their value. This is so because as shadow cost is subject to external variables it will also be affected by consumption quantity. As preferences grow internally, they affect shadow price (Pollak and Wachter, 1975). Therefore, they believe that basing shadow price on analyzing fertility behavior is meaningless. Barnett (1977), Deaton and Muellbauer (1981) however, argue against such claims. They believe that as much as shadow price is subject to consumption quantity, it is still a good tool for analysis. It can be used in actual case studies in estimating the relationship between variables and structure. For example, Becker and Lewis's (1973) "child quality-quantity" model abandons the possibility of inability of joint production for child quality-quantity and arrives at the conclusion that child quality is affected by child quantity and vise versa. A matrix equation was established as a result. Child quality and quantity serve as internal variables and their inter relationships were being discussed.

As for preferences and their effects on birth rate decisions, Deaton and Muellbauer (1981) point out that whether preference is internal or external is quite subjective. When the restrictive and demarcate function cannot be properly observed, there is no way to

demarcate them clearly. So, the setting of preferences and restrictions are the reply to the subjective judgments of economics. According to Schultz's (1981) definition, when two families are faced with the same price, inborn nature, and production technology, they come up with different birth giving behaviors. We then call these two families "families with different birth rates preferences". Preferences are therefore defined as "residual" and cannot be explained by economic restrictions. In actual case studies, variables are often used to explain behavior in regard to fertility such as age of first marriage, educational attainments, etc. They reflect preferences to a certain extent. Since we cannot absolutely be certain which variables are "absolute preference variables", in actual case study explanations, it is unnecessary to persist in establishing preference variables as done in theory.

With regard to the supply aspect and its role in birth rates, it is generally believed that in regions with poor sanitation, high costs of contraception and high infant mortality, fertility is more strongly affected. For further discussions on this, we can refer to bibliographies of Schultz (1981), Ben Porath (1975, 1980), Preston (1978) and Rosenzweig and Schultz (1983). Since the theory model of The Chicago School is more concise, most fertility case studies and analysis are based on its theoretical structure; there are not many who use Easterlin et al.,'s (1980) model in their bibliographical case studies except for Behrman and Wolfe (1984) and Chang (1984, 1986) etc.

Chapter 3 Bibliographic Discussion of Taiwan Birth Rates

3.1 Case Studies

Data on permanent residence in Taiwan can be traced back to the beginning of the 19thcentury (Liu, 1973), but most studies on fertility started after Taiwan gained its

independence after 1952. Data that was useful and combined with other data for systematic analysis had to be retrieved after 1958. Freedman et al., (1963) based their studies on permanent residence data from 1958-1961. They analyzed age, level of urbanization, educational attainments of men and women, employment ratio in the agricultural sector and other modernization indexes (such as letters posted, telephone calls) and their relationships to various birth rates. They adopted cross-sectional or related analysis for use on two or three variables. Units observed were 22 counties and cities in the Taiwan region. Liu (1965) and Collver at el., (1967) in 1961 further made use of data and divided the subject into smaller units like districts and towns of cities. Multiple variables and cross-section or multiple regression analysis were used for further discussion and analysis. Collver at el., (1967) discussed changes in gross birth rates and their deter-mining factors at the same time from 1961-1964. Data from 1965 was investigated by Liu Ke-Chi (1966) using household units in evaluating the accuracy of permanent residence records in twain. He made analysis of 2,000-2,500 households by acquiring the gross birth rates and studying the average number of people that are alive. He also made comparisons of his data with the actual recorded data of permanent residence.

Paul Schultz (1973) made the most concise and comprehensive analysis of birth rate data of permanent residents in Taiwan. He not only made use of anglicized fertility data between the period of 1964 – 1969 in various towns, and districts of cities, he also pooled the time and space chart within the six year period. “Birth rates standards”, “differences in birth rates” and “transformation of birth rates” were pooled for analysis. Finally he discussed the differences in birth rates in 1964-1969 in order to further

understand the mobility and structure of the differences in birth rates and the imbalance and change models. Basically speaking, the structure of data analysis in this dissertation, I followed the method as Schultz made, but used the different periods: one is from year 1976 to 1981, and another one is from year 1997 to 2002.

Permanent residence data were used in conducting studies on birth behavior of Taiwanese women (Lin, 1977 and Chang, Su-Mei 1976, 1978). The former based the study on 331 towns and districts of cities using multiple regression analysis to measure the gross birth rates and changes that occurred between the periods of 1968-1973, the latter adopting the statistical methods of the matrix equation and factor analysis, to discuss the general birth rate in the 21 counties and cities. The variables are considered to be “income, infant mortality rates, rate of women in the work force”. Based on the results of factor analysis, she listed three types of factors that affected birth rates namely, “mortality rates, social, economic and population policies.

Hermalin (1973) mainly made evaluations of family planning and its efficacy. The actual analysis between the periods of 1966-1969 was of the rate of different age groups, the gross birth rates, birth rates of those with spouses, and rate of those without spouses. In order to demarcate the policy and efficacy of family planning, he divided the 361 regions into three categories based on pre-family planning birth rates and multiple regression analysis was done accordingly. Afterwards, Hermalin (1974) not only discussed the results of factors that determine birth rates in actual case studies in the 1960s, he also determined the birth rates and spouse trends based on total data, observation time and age. While discussing birth ratio for his analysis in 1961, Collver et al., (1967) also discussed the marriage rate of people between ages of 20-24 using

multiple variables to determine the results (Chang and Tsao, 1981).

3.2 Start Off With Variable Explanations

In much of the literature on fertility in Taiwan, we can sort them into different aspects which are described as follows:

A. Time: between 1905 and 1945, gross birth rates almost remained unchanged at 42 ‰ (Liu, 1973). Thereafter, they began to decrease. After 1956, various birth rates (gross, general, regular and age-grouped birth rates) started to drop. It was a general drop regardless of city, or town from 1905-1945 (Freedman et al., 1963; Collver et al., 1967; Hermalin, 1974). The gross, total, general and birth rates of different age groups in Schultz's (1973) studies of the combined data model between 1964 and 1969 showed that during this short period, a decreasing trend was also observed.

B. Income: data collection was difficult since general case studies can only be conducted using substitute variables. For example, educational attainment of the husband (Schultz, 1973) or mortality rate (Liu, 1965; Schultz, 1973) and its income efficacy may be significant (Liu, 1965) or it may not significant (Schultz, 1973). Based on data analysis using the matrix equation in 1973, income had significant positive effects (Chang, Su-Mei 1976). Other data studies usually show that such efficacy was at a minimum (Mueller, 1972).

C. Mortality rates: some bibliographies show that mortality rates are not a significant variable for birth behavior (Collver et al., 1967). But most believe that decreases in mortality rates will significantly lower birth rates (Liu, 1965; Schultz, 1973; Lin, 1977; Chang, Su-Mei 1976). This is especially true for women aged over 30 (Hermalin, 1974).

D. Marriage and people with spouse rates: in various birth rate studies, the gross birth rate possesses a unique function. From the point of view of fertility study, focus should be placed on the analysis of birth rates of those with spouses or those without (Hermalin, 1974). But sometimes, for other reasons, the marital condition has to be listed as one of the variables. Normally, in regions where there are high numbers of married people, birth rates also increase (Lin, 1977; Hermalin et al., 1979). Changes in spouse rate mostly happen to young women between the ages of 15 to 24. Spouse rates decrease with time and increase with women aged over 30. For women under 24 years of age, a spouse rate increase helps in increasing birth rates significantly (Hermalin, 1974). Educational attainments and spouse rates are reciprocally related. Rural women used to have higher spouse rates than urban women but, because of late marriages, the situation is now reversed. At the same time, women who marry late tend to have fewer children. A multiple regression analysis conducted in 1961 shows that the most important factor affecting spouse rates for women between the ages of 20 and 24 is net transfer rate and gross mortality rates followed by population density (Collver et al., 1967), women's educational attainments and employment in the agricultural sector.

E. Ages of women: between 1950 and 1970, the most obvious drop in birth rates occurred in women over 30 years of age. The 15–19, 20–24, 25–29 age groups remained unchanged. Lower age groups even showed an increase in birth rates (Freedman et al., 1963; Collver et al., 1967; Schultz, 1973).

F. Educational attainments of men and women: The connection between the educational attainments of men and birth rates of women is unclear. Analysis of these two variables shows negative relevance (Schultz, 1973) or no relevance at all (Liu, 1965).

Schultz made a final analysis of birth rate changes and the results showed positive relevance which he believed to be true (Schultz, 1973). As for the educational attainments of women, other than a positive regression coefficient the rest showed changes in the opposite direction. Be it analysis of the two variables (Freedman et al., 1963) or of multiple variables (Liu, 1965), results showed that total birth rates, total birth rates changes (Lin, 1977), general birth rate age groups(Chang, Su-Mei 1976) , birth rates of married people (Hermalin et al., 1979), ideal birth rates (Hermalin, 1974) or even birth rates of second timers (Hermalin et al., 1979), idealistic or actual birth rates (Hermalin, 1974), differences are related negatively. Women aged between 15 and 24 show the only exception where there is no significant relevance (Collver et al., 1967) or positive relativity (Schultz, 1973).

G. Proportion of women in the work force: other than the earlier analysis of the two variables that showed working women had lower birth rates than other women (Liu, 1966), other studies seemed to show that whether women are working or not, there is no connection with low birth rates and the birth rate is positively related (Hermalin, 1974). However Chang Su-Mei (1976) and Lin (1977) came to the conclusion that women living in regions with a higher market ratio tend to have higher birth rates.

H. Urbanization: a more generalized anticipative theory states that the faster the speed of urbanization in a particular region, the lower the birth rate (Freedman et al., 1963). Between 1958 and 1961, this situation was true for Taiwan. Based on multiple variable data analysis in 1961, fertility in urban areas decreased (Liu, 1965). Afterwards, fertility in the country dropped faster than in the city (Collver et al., 1967). According to analysis of the data, urban and rural areas showed minor differences in birth rates

(Hermalin, 1974) and their characteristic differences remained constant. It explains why birth rates differences were narrow and why urbanization does not constitute the determining factor for fertility in Taiwan (Lin, 1977).

I. Proportion of agricultural employment: this had minor impacts on birth rates during the early times (Liu, 1965), because the country had higher birth rates and yet they decreased faster (Collver et al., 1967). Data from 1965 and 1973 showed that this had significant positive relevance to birth rates ((Liu 1966; Lin, 1977). From the point of view of age group birth rates, there was a constant trend since 1960. That is, young women aged 15-24 had lower birth rates in the country while women aged above 25 had a higher rate (Collver et al., 1967; Hermalin et al., 1973; Schultz, 1973). No obvious result is acquired either through Schultz's (1973) variable or Chang, Su-Mei's (1976) matrix equation analysis.

J. Family planning: the devotion of each member in measuring family planning variables does not significantly effect on birth rates. As regards these, there are three trends: First, family planning decreases birth rates but it easily fades out and becomes ineffective until it a negative effect arises. Second, the other trend affects women above 30 years of age. Young women however, show a tendency toward increasing birth rates (Schultz, 1973). Third, the third trend is more obvious in regions of fertility (Hermalin, 1973; Schultz, 1973). Another kind of family planning index is the rate of acceptance of contraception. All studies found that such an index is a strong variable in lowering fertility (Hermalin, 1973; Chang, Su-Mei, 1976; Hermalin et al., 1979).

K. Other variables: in early studies, family traits were not shown to be significant (Liu 1966). The migration variable had minor effects or was manifested in other ways

(Lin, 1977). The male and female adult ratio does not explain the differences in birth rates (Liu, 1965). Population density was thought to be a very important variable in lowering birth rates in early studies (Liu, 1965; Collver et al., 1967). Data analysis in 1973 showed insignificant results (Lin, 1977). In addition to this, Hermalin et al., (1979) found that the number of married years, willingness to have children, whether they want birth control, number of children and education etc., are important variables in order of importance when explaining the reasons for having children. The existing number of male children has no significant effects. Unfortunately the willingness to have children did not coincide with theory and expectations, which is difficult to understand (Chang and Tsao, 1981).

Chapter 4 Trends in Taiwan, 1970 – 2000

4.1 Taiwan's Economic Developments

In the past 50 years or so of development, the economic structure has rapidly changed. The changes have been brought about mainly by international competition and growth in the productivity of various industries. Before 1960, Taiwan's agricultural sector had a higher gross production ratio than the industrial sector. For instance, in 1952, the former occupied 32.2% and the latter 16.7%. By 1960 the former dropped to 25% and the latter increased to 23.7%. The following year, gross production of the agricultural sector became lower than the industrial sector. From this, it is observed the economic mode was mainly agricultural prior to 1960. During this time, the export trade, agricultural products and agriculturally processed products had a higher monetary value than industrial products. Meanwhile, Taiwan‘s external trade was in deficit and its value decreased year by year. During this stage, Taiwanese economic growth rate was on average 9.21%, while

the agricultural growth rate was 4.24%, industrial growth rate 12.39% and the service industry growth rate 9.08%。

In 1963, gross production in the industrial sector began to surpass the industrial sector. It is commonly known as the “industrialization era”. By 1980, gross production in the industrial sector reached a rate of 47.1%. From 1961 to 1980 Taiwan’s economy grew the fastest. Even though there were two major crisis that affected its growth, Taiwan managed to maintain a growth rate of 10% per year for 20 years.

After 1980s, Taiwan’s economic, social and political conditions and relationship with Mainland China began to encounter major changes. Taiwan’s economy was transformed from being a controlled and protected one to open and liberalized. In the 1980s, Taiwan’s industrial structure experienced the most major changes. Labor intensive industries were no longer the mainstream; instead, capital intensive high technology ones took over.

Taiwan’s economic growth rate dropped from 10% in 1961 to 7.15% in 1980 and continued to decrease from 1980 to 2000. During this period, the agricultural sector performed the least ideally. Its average growth rate was 0.63%, and its GDP ratio dropped to 4.31%. The industrial sector had a growth rate of 5.99%, which was far lower than the 14% of 20 years previously and its GDP ratio increased to 41.37%.The service industries had the highest growth rate of 8.85% on average. Their GDP ratio also increased to 53.85%, which surpassed the industrial sector by far. From 1950-2000, Taiwan‘s economic development and performance showed an economic growth rate of 8.13% on average. During this long 50-year period, the agricultural growth rate was 2.71% on average, which was higher than the natural rate of increase of the population. However,

between 1980 and 2000, agricultural growth was not only affected by decreases in productivity, the industrial growth rate was 9.46% on average. As for the service industry, which is strongly linked to the industrial sector, the average growth rate was 8.65%.

During the Asian financial crisis beginning in July, 1997, Taiwan was adversely affected. The economic growth rate decreased from 6.7% in 1997 to 4.6% in 1998. In 2001, Taiwan's economic performance was not as strong as other Southeast Asian countries. Aside from a 2.2% decrease economically, its export rate also decreased to 17.2%. Unemployment began to climb and by the end of 2001, it had reached 4.6% .Taiwan has limited natural resources and a high population density. It is therefore incapable of self-sufficiency. Trade with other countries was the only hope of economic development. Through massive increases in investment, industrial development prospered. From 1950 to 1980 the output of goods and labor was 16.5% and the domestic demand growth rate was 10.97% on average. At this stage, the average growth rate was 10.05%, the domestic growth rate 7.51% and over all, from 1950 to 2000 the economic growth rate in Taiwan was such that it was now considered a highly economically developed country (Ministry of Economic affair,Taiwan 2004).

4.2 Fertility and Population Trends

In terms of population, based on a statistical investigation done by the Directorate-General of Budgeting, Accounting and Statistics (DGBAS), in the past 10 years, although families in Taiwan are mostly made up of parents and unmarried children, there has been a sharp decline from 56.6% in 1992 to 47.7% in 2002. The proportion of singles and couples (Dinks, i.e. double income, no kids) and single parent families has increased in recent years. This is especially true for Dinks with a percentage of 4.4%. It is higher than

Figure 1

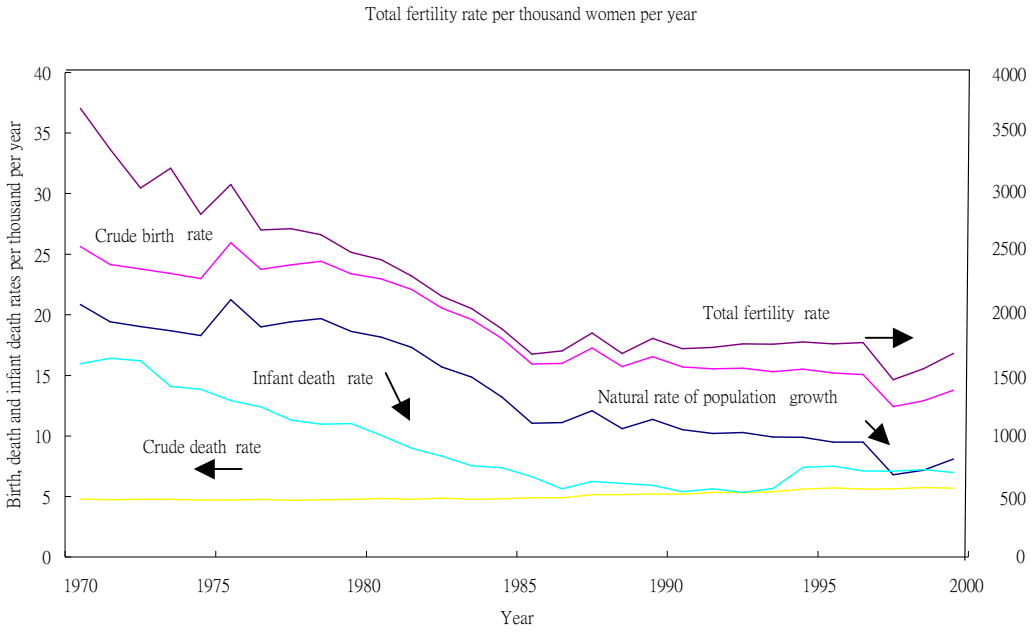

Figure 1 – Annual registered vital statistics: Taiwan 1970-2000 (Source: Taiwan Ministry of the Interior 2001, table 10, 15, 24 and 33).

Figure 2

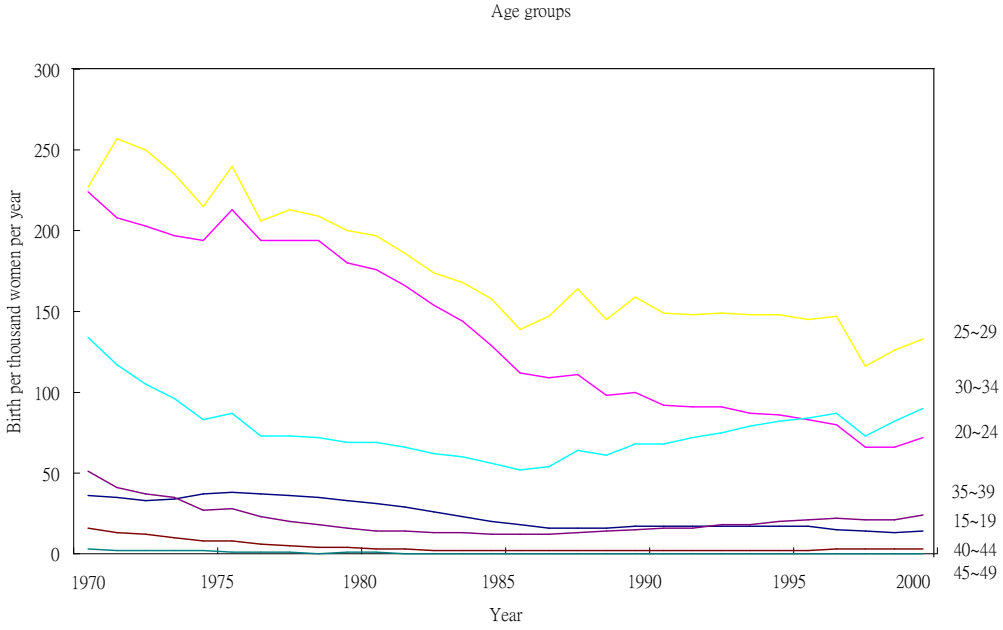

Figure 2 – Age-specific birth rates: Taiwan (source: Taiwan Ministry of the Interior 2001)

singles at 1.9% and single parent families at 1.7%. There are fewer families that rise children and more Dink families. Taiwan's birth rates rank the lowest in the world. Some even choose not to get married or else have late marriages. Divorcees and Dink groups have increased. Many academics fear that Taiwan will become an old people's country in the future. What's worse, since there are less young people in the work force, economic developments will be sub-sequentially affected until the government is left with insufficient tax such that it must increase tax rates in order to maintain the proper operation of governmental agencies. Statistics from the Directorate-General of Budgeting, Accounting and Statistics (DGBAS) show that due to increased number of years of female education, those who participate in the work force have increased with the result that people are marrying later. On average, every woman has fewer children in her lifetime. In 2002, the birth rate decreased to 11.1 and Taiwan population growth in 2004 was 3.7%, which is a new low in recent years. In 2004, the population of people aged from 0-4 years old was 19.8%, which was a decrease of 2.2% as compared to 1998.

In recent years, the marriage rate in Taiwan has continued to drop. According to the statistics of Ministry of the Interior, the percentage of married couples in Taiwan between the ages of 20-29 dropped from 23.2% in 2000 to 20.3% in 2002. The marriage rate of individuals above the ages of 15 (including single, divorced or widowed) dropped from 2.4% in 2000 to 2.2% in 2002. There are 7.6 couples in every 1000 people on average. Last year, this figure decreased sharply to 5.8 couples. This is a phenomenon that has seldom occurred in the past 10 years. From analysis of different age groups, it is observed that once the age of 30 is reached, people are less willing to get married. The main reason for this among the ones who wanted to marry but have not done so is for men, financial

instability which accounted for 30% and for women, having found no suitable partner which accounted for over 40%. More and more women now have higher educational attainments and self-satisfaction serves as the main driving force for them. Many women worry that educating their young might affect their performance at work, and so choose not to have children (Ministry of the Interior, Taiwan 2004).

The Department of Health, Executive Yuan, Taiwan, has conducted investigations and found out that nearly 30% of people support the idea of not having children regardless of their gender. More than half of these only want to have one child due to financial reasons. These factors include: “lack of financial stability and ability to bear children” showing that the financial situation is still the main consideration for childbirth. Late marriage, wanting to be single, high costs of raising children, safety concerns about children regarding the social environment have resulted in the record low rate of childbirth. Last year, the birth rate went below a 10/1000 low and Taiwan became the lowest birth rate region. In the past 10 years, age of first marriage increased causing the birth giving age to be postponed. In 1990, the age for first giving birth of Taiwanese women was 23 years old with an average of 2.5 children. By 1992, the age for first giving birth increased to 26.5 years old with an average of 1.2 children. As compared to other advanced countries, though their birth rate is dropping year by year the process is rather slow as regards time. However, in the last three years, the number of babies born has decreased by over 40% in Taiwan (Department of Health, Executive Yuan, Taiwan, 2004).

Chapter 5 Hypotheses of Economic Model of Fertility

Many characteristics of fertility behavior have made it difficult to analyze fertility within a choice-theoretic framework: (1) Children and competing household activities

both require the expenditure of parental time in addition to money. (2) The wide variation of parental expenditure of time and money on bearing and rearing children observed from family to family and culture to culture suggested that the parents' obligations to children do not burden an exogenously determined program of expenditure per child. (3) The motives for having children may include both the indirect satisfaction they may forbid by working in the household or family business and the direct satisfaction children are expected to provide their parents. Thus, fertility is motivated by consumption, saving, or investment consideration. (4) Parents are both demanders and suppliers of children. Childbearing and child rearing are non-market activities in which there are few transaction prices to provide information to the outside observer about the cost of children to supplies or the value of children to suppliers. (5) The parental obligation to a child tends to be a long-term one, extending, something, beyond the parents' lifetimes. (6) Imperfect fertility control and child mortality pose additional constraints on family fertility behavior and add further dimension to family choice. Parents can not exercise direct control over the number and timing of children they will bear and rear to maturity. Similarly, the probability of survival of a child will depend on choices made by parents as well as on environmental condition outside their control (Willis, 1973).

The mainproblem to be resolved i n analyzing fertility as a form of economic behavior is how to define conceptually satisfactory measures of the costs and satisfactions of children to their parents in manner consistent with the distinctive characteristic of fertility behavior. Becker (1965) and Lancaster (1966) argue that a family's utility is not received directly from its consumption of market goods or leisure.

Lancaster (1966) suggested a new approach to consumer theory and especially the pioneering work of Becker, Mincer (1963) and others on the allocation of time and human capital provide a theoretical framework within the cost and satisfactions of children to their parents may be formulated in a more satisfactory way than is possible within the conventional theory of consumer choice. Becker assumes that the family combines time supplied by family members with goods and services purchased in the market to produce within the household the more basic "commodities" which are the true objects of utility (Willis, 1973).

5.1 Empirical Formulation of the Model for Taiwan

Because of Family Planning Program is very successful to reduce fertility in Taiwan during the years between 1964 and 1984, the whole program had been changed to a new project by Taiwan's government. After 1984, it becomes difficult to find data source, which like VHEN, PPHW and CODR (Contracted Doctor) of Family Planning program, in this dissertation, in order to get newly data from pre-made model, therefore, I still follow Schultz's method and use only one independent variable (Obstetrician/ Gynecologist) to instead of three variables of Family Planning Program in the second part (year 1997-2002) of the original model.

According to Schultz's paper in 1973, only the bases of a formal model of birth rates determination can be tested against Taiwan data. The object is to specify a relation between the fertilityparents want and the income , price, and information constraints that are not themselves determined at the same time with the objective number of births. A single reduced-form equation is therefore analyzed here: In equation (1), analysis period years from 1976 to 1981 and equation (2), analysis period years from 1997 to 2002 that

between birth rate in year t, b_t, and the lagged values of (1) the child-death rate, D (price and return effects); (2) the proportion of the male labor force employed in agriculture, A (relative price effects); (3) male school attainment, E^m (price, income, and information effects); (4) female school attainment, E^f (price, income, and information effects); and (5) three classes of family-planning fieldworkers employed by the health and family-planning programs, H, F and C [(information and price effects), in equation (2), O instead of H, F and C]. These variables and the time lags τ and τ' are defined in table 1 and table 2. The correlations among the variables and their means and standard deviations are shown in table 3 (the result of year 1976-1981) and table 4 (the result of year 1997-2002). None of the explanatory variables is available on an age-specific basis in these two tables. Assuming the relation is approximately linear[4], the equation to be estimated is of the following form:

Part Ⅰ (1976 - 1981) :

$$\begin{aligned} b_t = {} & \alpha_0 + \alpha_1 D_{t-\tau} + \alpha_2 2A_{t-\tau} \\ & + \alpha_3 E_{t-\tau}{}^m + \alpha_4 E_{t-\tau}{}^f \\ & + \alpha_5 H_{t-\tau'} + \alpha_6 F_{t-\tau'} + \alpha_7 C_{t-\tau'} + e_t \end{aligned} \qquad (1)$$

Part Ⅱ (1997 - 2002) :

$$\begin{aligned} b_t = {} & \alpha_0 + \alpha_1 D_{t-\tau} + \alpha_2 2A_{t-\tau} \\ & + \alpha_3 E_{t-\tau}{}^m + \alpha_4 E_{t-\tau}{}^f \\ & + \alpha_5 O_{t-\tau'} + e_t \end{aligned} \qquad (2)$$

The relative magnitudes of the parameters, α's and expected signs, and the choice of lags are discussed below. The disturbance term, e_t, when the observations are

[4] Alternative nonlinear formulations of similar models are discussed and estimated for the Taiwan data elsewhere (Schultz 197l0). Cross-sectional findings do not change substantially nor do the tests of hypotheses depend on which of these functional specifications of the model is adopted.

appropriately weighted is assumed to be normally distributed with zero mean, constant variance, and uncorrelated with the explanatory variables

The dependent variable in the fertility equations estimated is birth rates for an age group of women divided to two parts for the years 1976-1981 and 1997-2002. If one is not to wait decades until today's younger parents in Taiwan have completed their childbearing years in order to estimate the effects of changing environmental constraints on their completed fertility, research must in the interim analyze current birth rates for evidence of the contribution of specific dimensions of economic change and population policies. Formally, several unverified assumptions are required to assure that the aggregate flow of births across groups of women if different ages respond in the same way to differences, in the determinants of fertility as does the stock, of children-ever-born across individual women. Thus the closest approximation to the economically prescribed dependent variable is the birth rate among women at least 30 years of age. Because these women are frequently completing the formation of their families, they are primarily engaged in the marginal childbearing decisions for which the economic model is relevant (Schultz, 1973).

There are four interrelated reasons why one expects fertility and child mortality to be associated: child mortality may be influenced by fertility and the proportion of child-bearing occurring to women at high risk; fertility may respond to expected or ex-perienced child mortality; both fertility and mortality may be affected by common observable factors; and finally, both may also be influenced by unobserved factor that generate a correlation between disturbances in equations determining fertility and child mortality (Schultz, 1978). In the other sides, child mortality appears to increase the cost

Table 1
Definitions or Variables for 361 Administrative Regions of Taiwan
(Years from 1976 to 1981)

B_t	=	The number of births per thousand women of specific age group in year t.
D_t	=	The reciprocal of the probability of survival from birth to age 15 estimated from age-specific death rates in year t.
A_t	=	The proportion of the male labor force employed in the agricultural sector in year t.
E_t^m	=	The proportion of men 12 years and over with at least a primary school certificate in year t.
E_t^f	=	The proportion of women 12 years and over with at least a primary school certificate in year t.
H_t	=	Number of man-months of VHEN (Village Health Education Nurse) employed by the family-planning program per thousand women aged 15-49 from 1975 to year t.
F_t	=	Number of man-months of PPHW (Pre-Pregnancy Health Workers) employed by the family-planning program per thousand women aged 15-49 from 1975 to year t.
C_t	=	Number of CODR (Contracted Doctor) holding contracted with the family-planning program per thousand women aged 15-49 from 1975 to year t.
e_t	=	Independently, normally distributed random disturbance.
τ	=	Combined behavioral and biological lag between the change in an environmental constraint on desired fertility and the change in birth rates.
τ'	=	Biological lag between change in birth control practice and birth rate. α's = Parameters of the model to be estimated.

Sources: Taiwan Ministry of the Interior, The Taiwan Demographic Factbook, various annual issues since 1976; Taiwan Population Studies Center, The Demographic Reference : Taiwan, various years since 1976; and Taiwan Provincial Institute of Family Planning Reference Book, 1984.

of rearing a child to maturity. All things considered, the longer their child survives (O'Hara 1972), an overall decline in mortality should make childbearing more attractive, if we can assume that parents feel themselves better off. But if the marginal return from having additional surviving children diminishes and becomes negative for small increases in the size of surviving family, the relation between fertility and child mortality will embody two partially offsetting price changes -- a decline in the cost of rearing a surviving child and a decline in the marginal return. The observed behavior of parents will provide information on the relative weight parents attach to the costs of rearing a child who dies compared with the elasticity of their demand for surviving children. Highly inelastic demand for surviving offspring implies that there should exist

Table 2
Definitions or Variables for 361 Administrative Regions of Taiwan
(Years from 1997 to 2002)

b_t	=	The number of births per thousand women of specific age group in year t.
D_t	=	The reciprocal of the probability of survival from birth to age 15 estimated from age-specific death rates in year t.
A_t	=	The proportion of the male labor force employed in the agricultural sector in year t.
E_t^m	=	The proportion of men 12 years and over with at least a primary school certificate in year t.
E_t^f	=	The proportion of women 12 years and over with at least a primary school certificate in year t.
O_t	=	Number of Obstetrician per region per thousand women aged 15-49 from 1996 to year t.
e_t	=	Independently, normally distributed random disturbance.
τ	=	Combined behavioral and biological lag between the change in an environmental constraint on desired fertility and the change in birth rates.
τ'	=	Biological lag between change in birth control practice and birth rate. α's = Parameters of the model to be estimated.

Sources: Taiwan Ministry of the Interior, The Taiwan Demographic Factbook, various annual issues since 1997; Taiwan Population Studies Center, The Demographic Reference : Taiwan, various years since 1997; and Taiwan Department of Health, Annual Report, 2004.

in equilibrium a positive association between birth rates and anticipated or experienced child death rates. Changes in this child-death adjustment ratio would also affect the returns to human capital investments in a child, increasing the probability that a positive association will exist between birth rates and child-death (Schultz 1971; O'Hara 1972).

The reduced-form equation (1) and (2) discussed here cannot attribute a partial association between fertility and economic sector to any particular class of differential input prices or to differential returns to schooling, but both sets of relative prices might account for higher fertility in rural regions of many low-income countries when other demographic and economic factors were held constant. The cost of rearing any specific number of children might be lower in rural than in urban areas, while, in traditional agriculture, the rate of return to schooling children may be depressed relative to the return anticipated by parents in the more dynamic urban sectors of the economy.

Agricultural composition of the male labor force is intended to capture relative price effects. This disparity in the returns to education could arise from higher direct and opportunity costs of obtaining schooling for the dispersed farm population, or from lesser productivity gains for the better-educated in agricultural in comparison with nonagricultural activities. However, it need not follow that childbearing and marriage would occur earlier in the agricultural sector, the scarcity of capital and land has often been attributed a role in delaying marriage in the rural sector when the urban sector is prospering (Schultz, 1973).

The measure of schooling considered here approximates the median accomplishments of the adult population. Plausible supposes regarding the relative value of sex-specific time inputs into the rearing of numbers of children imply $\alpha_4 < \alpha_3$, and past studies of birth rates might lead one to conjecture that $\alpha_3 \geq 0$, and $\alpha_4 < 0$, if this variable adequately reflects the lifetime value of husband and wife time in market and non-market activities. A serious practical problem with joint estimation of the partial association between birth rates and male and female schooling is the collinearity between the sex-specific schooling rates (Schultz, 1973).

Information about the nature and local availability of modern birth control methods is provided by the two classes of family-planning field personnel; this should decrease birth rates among older women by decreasing the information costs of avoiding additional unwanted or ill-timed births. But the reverse effect might occur among younger women, who may adopt a more concentrated pattern of childbearing when they are provided with a reliable means of birth control (Keyfitz, 1971). Activities that seek to spread a given set of information to a fixed population of potential demanders are

likely eventually to experience decreasing returns to effort. This anticipated nonlinearity in the relation between family-planning activity and its effect on birth rates is documented in another study (Schultz, 1971) but is neglected here for simplicity.

The impact of personnel allocated to family planning on completed fertility will depend upon at least three factors: (1) the advantage of the program's new birth control technology compared with that indigenously available, in terms of individual search and use costs; (2) the elasticity of parent demand for numbers of children; and (3) the distributional efficiency of the program imparting new knowledge of birth control and subsidizing its use among those segments of the population with a more elastic demand for children and least initial access to adequate birth control technology (Schultz,1973).

5.2 Temporal Specification

Consequently, lags and adjustments of a biological and behavioral nature interpose themselves between the observed environment characterized in the model and the observed fertility the model seeks to predict. Anticipations about the future are not always fulfilled: it takes an uncertain amount of time to have a child, and children die unpredictably. In other words, what should be the values of τ and τ' in equation (1) and (2)? Most environmental conditions that modify parents' preferences for children change slowly, at least at the regional level considered here. Death rates, on the contrary, are subject to substantial year-to-year variation and cannot be predicted accurately within a small community.

Additional desired children for some time, regardless of their personal experience of child mortality, although the death of a child may motivate her to seek an additional offspring. Some sequential models of fertility determination would imply a mechanism

by which the unanticipated death of a child to a still-fertile mother may influence her to have a somewhat higher fertility than she would otherwise have had. If the mother of the deceased child is older, say in her late thirties, when a sizable proportion of her cohort intends to avoid further births, her seeking another birth will sharply distinguish her from others in her cohort within a relatively short time. Experimentation with various discrete [see τ in equation (1) and (2)] and simple distributed lags for Taiwan suggests the association between regional child-death, rates, and subsequent fertility is statistically strongest after the lapse of 2-4 years, particularly among women 30-44 years of age (Schultz, 1971). Lacking better evidence, not only the child-death ratio but also the schooling and agricultural variables that must affect birth rates with a behavioral biological lag are lagged 3 (τ=3) (Potter, 1963). The bias introduced by this approximation for what undoubtedly should be a more complex distributed-lag (Schultz, 1973).

Family planning program inputs represent a dynamic model specification. The temporal link between fertility and environmental conditions and that between fertility and birth control information should differ. Current practice of birth control influences birth rates 9 months hence; the lag between adoption of more effective birth control methods and their maximum impact on birth rates is likely to be no more than 1 year. Therefore, program inputs are lagged only 1 year (τ'=1). Furthermore, the program is likely to have a persisting effect on contraceptive knowledge in the community, slowly depreciating as people forget or move away and as new generations of parents grow up or move in. Thus, all past program inputs must be considered as possible determinants of the target population's current knowledge of birth control methods. Time series as yet are too short for an empirical exploration of the declining time dimension of program

input effectiveness. A first approximation is simply to ignore the depreciation effect and treat the total of all past program inputs as a determinant of current effective knowledge of birth control in the community (Schultz, 1973).

Chapter 6 Analysis methods

6.1 Cross-sectional Evidence

There is substantial variation in the explanatory power of the model across years and age groups and in the size and statistical significance of the regression coefficients of each explanatory variable [5] (Schultz, 1973). Ordinary least-squares estimates on equation (1) and (2) are reported for 1977 and 1981 in table 5, and on equation (2) are reported for 1998 and 2002 in table 6, for which the moment matrices were weighted by the observed number of women in the specific age group in the region.

The strong statistical association between child-death rates and birth rates of women aged 30 and over confirms this hypothesis; the strength of the association with teen-age birth rates suggests two subsidiary tentative hypotheses. The birth rates and child death ratios are strong positive relative (significant) in both parts of analysis, except 1981, age 25-29 has a negative relative. Age-specific 45-49 of women shows low birth rates for all 361 regions and almost zero in latterly years. In the short run, it was anticipated that the link between fertility and child mortality would be more pronounced among older mothers; this seemed plausible because they were more likely already to have the number of surviving offspring they wanted and would, therefore, weigh heavily

[5] 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 variable and the birth rate. 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 1.65 satisfies a confidence level of 95 percent, and one exceeding 2.34 satisfies a confidence level of 99 percent.

the survival or death of these earlier children in their decision whether to have an additional child.

Societies also traditionally adjust to the heavy incidence of childhood mortality by promoting early marriage, and though this pattern may stem from desired fertility goals, it is likely to become institutionalized and only slowly adapt to sudden changes in death rates or in other constraints on the family formation process. The aggregate association observed in Taiwan between child-death rates and subsequent teen-age birth rates may, therefore, represent long-term regional differences in the proportion of married teen-age women (Schultz, 1971). Examination (in the next section) of time series may help to determine whether this relation observed in the cross section of aggregates is due to misspecification of the model's temporal dimensions or neglect of intermediary causal relations involving, for example, the timing of first marriage.

Life-cycle commitments of a mother may depend to a substantial degree upon the survival of her first born. The dislocation of her life may be somewhat less if a subsequent child dies later in the formation of her family. It may be assumed that teen-age mothers more frequently experience the loss of their first born than other age groups and are thus motivated more strongly to shorten the interval to their next birth. This logic could account for a strong replacement link at the family level between child mortality and the teen-age birth rate.

Local reliance on agricultural employment is often positively associated with total fertility rates, but t ratios are not substantial. Differences in the age pattern of fertility in agricultural regions are more pronounced, however. Birth rates among teenage women are decidedly lower in agricultural areas, but distinctly higher among women aged 20-25,

during 1976-1981 period and somewhat higher during the first half of the period among all women over age 29. Year 1997-2002 get similar result as period 1976-1981. It means both periods have a stable pattern to run. Agricultural employment is a significant factor affecting birth rates in this study. These findings do not confirm the importance of relative price effects operating between the agricultural nonagricultural sectors of Taiwan, but they do suggest that the timing of marriage and births may be modified by the availability of complementary agricultural resources.

I have similar result as Schultz's from cross-sectional regression in education factor. That is the consistently negative coefficient of male school and the positive coefficient of female schooling. Although collinearity may be called upon to excuse these unexpected results, and the schooling variable may be criticized as a proxy for the value of parent-time, the results nonetheless cast doubts on the adequacy of static cross-sectional evidence of the economic determinants of fertility in a rapidly changing environment.

As industrialization has proceeded, the historic tendency has been for the value of women's time to increase relative to market goods and for women's participation in the paid labor force, to increase. If proper controls were available for husband's wage rate, nonhuman wealth, and child-death rates in a regression model accounting for variation in fertility. Except for birth rates among women aged 20-24 and 25-29 in period 1976-1981 and 25-29 in period 1997-2002, the negative partial association with male schooling is statistically notable in every year and age group. Increasing the proportion of men with a primary school certificate from 50 to 60 percent in a community is associated with approximately a 10 percent reduction in births. Increased schooling for

women is associated with lower teen-age fertility, but noticeably higher birth rates among women the age between 20 to 29 in two different parts. Although the teen-age pattern might have been predicted, the expectation from economic theory is for educated women to have fewer births after age 30. Better-educated women would tend to have fewer births in their lifetimes. But in all likelihood, the better-educated women would concentrate these fewer births in the first decade of their marriages and possibly exhibit higher birth rates in their mid- and late twenties compared with less educated women. These expectations are not confirmed by the cross-sectional estimates based on the levels of birth rates in Taiwan (Schultz, 1973).

Family Planning Program inputs are most consistently linked to lower birth rates among women 30 years old and over. Among these prime candidates for family-planning assistance, the distribution of field personnel is strongly associated with substantial declines in age-specific birth rates. The differential age effects are visible, even from the simple linear estimates of the family-planning program reported in table 5. A very different pattern of program effectiveness emerges from the study of birth rates among women less than 30 years old. In the first year or two of the national program, field personnel elicited several reductions in these younger age-specific birth rates. After 1966 the tendency became increasingly statistically significant for birth rates among women aged 15-29 to be higher in regions intensively canvassed by family-planning program fieldworkers. This evidence is consistent with the hypothesis advanced earlier that where reliable birth control methods are understood and made more accessible, marriage may not be further delayed; and child spacing, if more widely practiced at all, may produce oscillations in birth rates among younger women.

Another implication of these results that is seen more clearly in the nonlinear formulation of the model (Schultz 1971) is that one class of fieldworker—the Village Health Education Nurse (VHEN)—was more effective in reducing birth rates in the early years of the program than the other class of fieldworker—the Pre-Pregnancy Health Worker (PPHW). The VHEN is instructed to disseminate the principles and practices of home economics, family sanitation and hygiene, and family planning to the entire village population. The observed pattern of differing age-specific effectiveness of these two classes of fieldworker is, therefore, not implausible, on the other hand, the PPHW is trained in the family-planning program to systematically contact and recruit mothers, generally in their thirties, with a recently recorded birth. Contracted Doctor (CODR) also helps women in the Family Planning Program. The data year from 1976-1981 is the end of this program, and the VHEN factor is very small affecting the birth rates (not significant) in this study comparing with Schultz's in 1973.

6.2 Time Series of Cross Sections

Reproductive behavior occurs sequentially, and the confines on child-bearing exert diverse influences on many other areas of economic and demographic decision making in the household sector. Exploration of the time dimension of this process and its complex ramifications on other household choices is warranted. Though these abstractions have proved a powerful generalizing device where none has existed before, little attention has been given to the question of what economic theory and statistical techniques can say about models of dynamic behavior that might be refuted or confirmed by empirical evidence (Nerlove, 1970). Economic models of the determinants of fertility tend to be formulated and tested in static terms. Parents are viewed as deciding

in a single period on the appropriate number of births needed to yield them an optimal lifetime number of children.

Discrete lags between fertility and the explanatory variables were introduced to approximate the average time for reproduction to respond and for birth control information to take effect. But the stochastic nature of the reproductive process and the numerous neglected features of the individual that could affect reaction times suggest that a distributed lag would be more appropriate to the study of changes in fertility. Yet identification and estimation of these lag structures are difficult because of the limited availability of time-series information and the strong positive serial correlation of such relevant characteristics of regional populations as wages, nonhuman wealth, industrial structure, and schooling (Schultz, 1973).

The estimates from cross sections using discretely lagged levels will tend to understate long-run responses because a single annual observation approximates the appropriate weighted distribution of past observations with substantial error. On the other hand, a discrete 3-year lag overstates short-run responses and creates the erroneous impression that the estimated response would occur in 3 years, whereas in all likelihood it would longer. To improve the temporal specification and estimation of the dynamic behavioral relationship accounting for reproductive behavior, one needs the combined information of time series and cross sections (Schultz, 1973).

6.3 A Two-Component Model of Disturbances

The statistical properties of the estimates of equation (1) and (2) are determined by the nature of the disturbances in the model, e_{it}, where i refers to region. The disturbance term presents both the net effects of numerous factors that have unavoidably

been omitted from the analysis and errors of measurement and approximation in the form of the behavioral relationship. It is reasonable to assume that many of these effects are specific to regions and relatively time-invariant as a first approximation, then, the disturbance term might be decomposed into two independent elements, a region-specific time-invariant effect, u_{it}, and a region- and time independent effect, v_{it}. The stochastic structure for the disturbance in equation (1) and (2)then is expressed:

$$E\, e_{it}\, e_{i't'} = \begin{cases} \sigma^2 = \sigma_\mu^2 + \sigma_v^2, & i=i', t=t' \\ \sigma_\mu^2 & , i=i', t \neq t' \\ 0 & , \text{otherwise,} \quad E\, e_{it} = 0, \text{ all } i \text{ and } t. \end{cases}$$

Let the parameter $\rho = \sigma_\mu^2 \,/\, \sigma^2$ be defined as the proportion of the variance of the disturbances accounted for by the region-specific component. It may be shown (Nerlove, 1971) that generalized least .squares for a model with this form of variance-covariance matrix amounts to using transformed values of the variables, which are a weighted combination of the original observations and the deviations from regional means. These weights can be expressed as a simple function of ρ. Several methods for estimating p have been considered; the two-stage method used here appears to show least bias, least mean-square error, and greatest overall robustness against specification error (Nerlove, 1971).

Fitting equation (1) and (2) to the pooled time series of cross sections, weighted estimates are reported in table 7 and 8, for the levels of the original variables, in table 9 and 10, for the deviations of these variables from regional means, and in table 11 and 12, for the transformed variables based on the values of ρ.

The estimates based directly on the variable levels are similar whether analysis is

limited to individual years (table 5 and 6) or the pooled timed series of cross sections (table 7 and 8). Additional information contained in the time-series dimension of these data is extracted only when the relative importance of the two disturbance components is estimated and used to obtain the transformed variable estimates of the model parameters. In the total fertility equation based on the transformed variables, the coefficients for the child-death factor and male schooling remain significantly different from zero and of the appropriate sign, but their size are about half of those implied by the analysis of levels. This confirms that direct cross-sectional estimates of short-run responses are seriously biased upward. The total fertility effect from agricultural composition is significant from both periods, and there is a tendency for agricultural regions to have higher birth rates for women between the ages of 25 and 29 and somewhat lower birth rates.

Of greater importance is the shift in sign of the coefficients estimated for female schooling in both periods which age-specific 20-24 and 25-29 in year 1976-1981 and age-specific 20-24, 25-29 and 30-34 in year 1997-2002. In the total-fertility-rate equation, female schooling now depresses fertility as does male schooling. In all but the teen-age birth-rate equation, female schooling is associated with lower birth rates. Although the behavior of the estimates for female schooling has been partially resolved by the analysis of pooled time series of cross sections, the economic prediction that the coefficient on women's schooling, as a proxy for the value of their time, should algebraically be less than the coefficient on men's schooling is confirmed by the transformed estimates only for the birth-rate equation for women aged 25-29 (Schultz, 1973).

The transformed variable estimates based on the time series of cross sections also indicate that family-planning information has twice (year 1997-2002 around three times) the effect on birth rates as that implied by the estimates based on the levels, reducing total fertility rates 4 percent rather than 2 percent in period 1976-1981. This should also have been anticipated, for these program inputs are not subject to the same dynamic specification errors that biased upward the coefficients on gradually changing environmental constraints. Among all women over the age of 24, birth rates are significantly inversely related to the allocation of both classes of family-planning field personnel. Among the younger women, the reverse is indicated. On balance, the program's effect has been to reduce the number of births even though it may accelerate the tempo of fertility among some younger women, at least in the short run.

6.4 First-Difference Model

Another approach to the analysis of time series where omitted variables are thought to bias estimates of short-run response is to assume that region-specific, relatively time-invariant effects can be removed by first-differencing the basic model over time. Assume a model of the form

$$b_{it} = \alpha_0 + \sum_{k=1}^{n} \alpha_k X_{ikt} + \sum_{j=1}^{m} \beta_j Y_{ijt} + e_{it}$$

where the X_{ikt} are n observed short-run determinants of birth rates and the Y_{ijt} are m unobserved long-run determinants of birth rates, and e_{it} is a normal random error independently distributed with respect to time and region. If the Y_{ijt} (do not change, say within a 5-year period, but tend to be correlated with specific X_{ikt}, which do change, then the cross-sectional regression on levels will spuriously attribute the effect of Y_{ijt} to

X_k's and bias estimates of the short-run response of birth rates to the observed short-run factors.

Absolute differences between cross sections several years (δ) apart provide, then, another test of the model's specification and a further procedure for evaluating how rapidly reproductive behavior responds to specific short-run changes in economic and demographic determinants of the desired number of children. The estimated equation becomes

$$b_{it} - b_{i,t-\delta} = \sum_{k=1}^{n} \alpha_k (X_{ik,t-\tau} - X_{ik,t-\tau-\delta}) + V_i ,$$

where $V_i = e_{it} - e_{i,t-\delta}$.

Using the maximum available value of δ for the Taiwan data of 5 years, this reformulation of equation (1) and (2) states that only changes experienced in the explanatory variables from 1976 to 1979 (or to 1980 for family-planning inputs) affect changes in birth rates from 1976 to 1981[6]. And for the year 1997-2002, explanatory variables from 1997 to 2000 affect changes in birth rates from 1997 to 2002. This procedure sharply reduces multiple-collinearity among the explanatory variables and the statistical significance of regression coefficients for the reasons mentioned earlier (Fisher, 1962). Comparisons across methods of estimation may rely on the standard error of estimate (SEE), given the maintained model specification, since when the intercept is forced through the origin no obvious interpretation attaches to R^2.

The weighted estimates of the first-differenced form of equation (1) and (2) are

[6] Because of greater year-to-year variability of a stochastic nature in child-death rates estimated for small communities, the first-differenced child-death adjustment factor is based on 2-year averages at the beginning and end of the 5-year period, i.e., $[(D_{1973} + D_{1974}) - (D_{1978} + D_{1979})]/2$.

reported in table 13 and 14. The child-death factor is positively associated with birth rates to a statistically significant extent only among women aged 20-24—those in the groups thought to be most responsive, in the short run, to such changes in the regime of child mortality in year 1976-1981. In year 1997-2002, child-death factor is negatively associated with birth rates. Changes in agricultural composition of the labor force are apparently related to changes in birth rates in 1976-1981 case, but it is not significant for the case of 1997-2002. For the first time the coefficient of male schooling is positive for birth rates between ages 20 and 49, which is consistent with expectations that the income effect would exceed the substitution effect for the value of male time in year 1976-1981. It is a totally different story of the year 1997-2002. Women's schooling may increase birth rates from ages 15 to 24, but it substantially reduces those rates thereafter. From 25 years of age and over, the algebraic value of the coefficient on women's schooling is less than that on men's schooling, as expected on economic grounds. The family-planning personnel may contribute to a slight increase in birth rates among women aged 15-19, but reduce birth rates substantially among women aged 25-44, as anticipated.

The predictions of the general economic model that can be tested with these data for Taiwan are confirmed when the initial static model is differenced over time, although the magnitudes of the response estimates are smaller than those based on the individual cross sections and similar to those based on the combined time series of cross sections. Since first-differencing an economic behavioral relationship is often a severe econometric test for specification error.

6.5 Disequilibrium and Change in Birth Rates

If elements of an economic theory of fertility have some empirical validity in predicting long-run desired equilibrium levels of fertility toward which parents gravitate then unexplained deviations of birth rates from those predicted by the theory should contain information about the magnitude of reproductive disequilibrium present across populations. More specifically, the information disseminated by the family-planning program is likely to be in greater demand. These disequilibrium regions are likely to experience more substantial declines in birth rates as a function of the subsequent allocation of family-planning personnel.

A second hypothesis would suggest that where positive disequilibrium was substantial initially, a greater response of birth rates could be expected to subsequent changes associated with a further reduction in desired birth rates. This conjecture would be consistent with the assumption that the rate of adjustment in birth rates was a positive function of the extent of disequilibrium between actual birth rates in the previous period and desired birth rates in the current period.

To test these simple concepts of disequilibrium and change in birth rates, the 361 regions of Taiwan were divided in half, based on the algebraic size of residuals from regressions on 1978 birth-rate levels for period 1976-1981 and 1999 birth-rate levels for period 1997-2002. The absolute differences in birth rates between 1976 and 1981, and between 1997 and 2002, were then regressed on the differenced explanatory variables. The regression results for the half of the sample with primarily negative residuals[7] which Schultz calls the "equilibrium" regions and those for the sample with primarily

[7] To obtain sub-samples of approximately equal size, i.e., 180 and 181, the dividing line between the two groups of residuals does not turn out to be exactly zero.

positive 1978 and 1999 residuals, which will be called the "disequilibrium" regions, are shown in table 13, 15, and 17 for year period 1976-1981 and in table 14, 16 and 18 for year period 1997-2002.

The first hypothesis is confirmed; the regression coefficients for the family-planning personnel variables are algebraically smaller for the disequilibrium regions than for those regions presumed to be closer to equilibrium. It is also interesting to note that the effect of the program personnel to increase the teen-age birth rates is also greater across the disequilibrium regions.

The second hypothesis is more difficult to assess, largely because the data are less appropriate. To test the stock-adjustment model, information is required on the initial stocks or number of living children of women of specific ages. Explicit stochastic models of dynamic behavior are now needed to make sense of these results and to proceed with the analysis of other time-series evidence on reproductive behavior that will permit economic analysis to be beyond the static notion of long-run equilibrium (Schultz, 1973).

Chapter 7 Conclusions and Discussion

Statistical evidence at the household level suggests that fertility and child mortality are related to factors specified by economic models of family resource allocation and behavior. Several of these factors, such as women’s education and family planning, appear to decrease both fertility and child mortality, leaving in doubt what net effects these human-capital and social-welfare program have had on the recent slowing of world population growth. The specific factor includes family planning program, human capital endowments of men and women, and other economic structural determinants of the cost

and benefits of children. Education of women raises the cost of childbearing and reduces fertility; education of men may increase of decrease fertility less than will the education of women. It is widely conjectured that the net cost of childrearing is greater for parents residing in urban than in rural areas and the opportunities for parents to monitor their children in productive work is greater than in an agricultural setting than in a nonagricultural one. The family planning variables are not a random experimental treatment. It is rather a complex social outcome that reflects both exogenous public initiatives to subsidize the supply and diffusion of contraception and the endogenous response of parents who demand better means to avoid unwanted births.

Childbearing age for women concentrates on 20-29 and it is the same for two different periods. Age 30 becomes an obvious point for women. Before age 30, Women education is negative relation with birth rates and after age 30, the moving direction becomes opposite direction (positive). Child-death rate and agriculture factor are positive and significant with fertility in two different periods. Especially, in agriculture factor part, I get different result from Schultz's. Economic progress, less male work for agriculture, and people get higher standard of living, which improve to higher living style and reduces fertility and child-death rate. Male education is negative to birth rates. Higher education for men is lower the birth rates of women. Family Planning Program data can not be explained on VHEN and the data sources are too small to affect birth rates variable. PPHW and CODR are still working well to explain the birth rates in the period 1976-1981 of this study. In year 1997-2002, Obstetrician variable is negative to birth rates in both cross-sectional and pooled time series regression which is expected.

It is wholly unsatisfactory to argue that "people" behave rationally in the interest of their

children and grandchildren. They obviously do so only as individuals, and there exists no mechanism that would insure that individual decisions somehow add up to a social optimum. To clarify the nature of such an optimum as affected by the population, and to devise efficient machinery that would help achieve it, should be a prime task for economists.

Table 3

Simple Correlation Among Variables,† Years 1976-1981

Variable Levels	Total Fertility Rate‡ (1)	Age-Specific Birth Rates 15~19 (2)	20~24 (3)	25~29 (4)	30~34 (5)	35~39 (6)	40~44 (7)	45~49 (8)	Child-Death Adjustment (ratio) (9)	Agricul. Composition (proportion) (10)	Male Education (proportion) (11)	Female Education (proportion) (12)	VHEN (13)	PPHW (14)	CODR (15)
	Variable Difference 1981-1976														
1978:															
(1)	...	.494	.555	.537	.658	.554	.461	.231	.149	.163	-.098	.035	-.055	.030	.125
(2)	.592	...	.226	-.045	.040	.036	.097	.203	.144	.144	-.003	-.017	-.024	-.021	.154
(3)	.619	.518	...	.113	.166	.130	.228	.032	.057	.014	-.107	-.037	.029	-.054	.023
(4)	.547	-.140	.302	...	.191	.130	-.041	-.021	-.003	.125	-.120	-.073	-.103	.018	.020
(5)	.715	.293	.029	.272	...	.525	.539	.168	.179	.050	.014	.138	-.031	.052	.113
(6)	.666	.477	.064	.019	.690	...	.228	.171	-.084	.093	-.037	.117	.011	.085	-.042
(7)	.615	.538	.171	-.096	.606	.771	...	.194	.282	.033	-.042	.108	-.017	.087	.174
(8)	.269	.363	.031	-.085	.315	.302	.305	...	.041	.167	-.055	.026	.028	.015	-.048
(9)	.509	.610	.269	-.078	.385	.561	.631	.206	...	.036	-.019	.054	-.062	-.039	.409
(10)	.643	.531	.578	.306	.281	.357	.367	.123	.413	...	-.129	-.042	-.076	.023	.078
(11)	-.201	-.193	-.086	-.019	-.170	-.221	-.176	-.079	-.099	-.299	...	.654	-.057	.044	.028
(12)	-.438	-.315	-.436	-.263	-.155	-.198	-.209	-.041	-.238	-.603	.678	...	-.004	.065	.039
(13)	.053	.011	.077	.055	.015	.001	-.028	.009	-.046	-.052	.034	.005	...	.030	.015
(14)	-.493	-.505	-.385	-.112	-.268	-.357	-.391	-.166	-.436	-.582	.119	.347	.120	...	-.065
(15)	-.158	.063	-.280	-.314	.072	.045	.157	.197	.084	-.194	-.001	.145	-.017	.012	...
Mean	2996.496	43.867	210.366	225.684	81.272	28.288	8.809	1.014	1.988	.478	.782	.562	.236	1.243	2.382
Standard deviation	533.164	20.854	39.573	43.462	32.757	27.428	12.648	2.131	1.191	.237	.066	.096	.725	.814	2.899
1981-1976 differences:															
Mean	-766.233	-7.213	-38.723	-51.543	-28.332	-19.449	-6.906	-1.080	-.382	-.004	.045	.070	.472	.046	-.362
Standard deviation	488.995	39.118	29.627	42.847	30.755	21.937	12.761	3.214	1.138	.054	.012	.020	1.912	.265	3.159

NOTE – Variable level in 1978 appear below the diagonal; variable differences, 1981-1976 appear above it.

†Weight by the number of women between the age of 15 and 49 in each observed region.

‡The total fertility rate (which is 5 [the age interval] times the sum of the age specific birth rates) represents a cross-sectional proxy for completed fertility expected per thousand women surviving to age 50.

Table 4

Simple Correlation Among Variables,† Years 1997-2002

Variable Levels	Total Fertility Rate‡ (1)	Age-Specific Birth Rates 15~19 (2)	20~24 (3)	25~29 (4)	30~34 (5)	35~39 (6)	40~44 (7)	45~49 (8)	Child-Death Adjustment (ratio) (9)	Agricul. Composition (proportion) (10)	Male Education (proportion) (11)	Female Education (proportion) (12)	Obstetrican (ratio) (13)
	Variable Difference 2002-1997												
1999:													
(1)	...	.409	.553	.555	.480	.187	.025	-.050	.116	.055	-.233	-.249	.024
(2)	.671	...	.097	-070	-.061	-.126	.040	-.070	.109	-.043	-.011	-.019	.044
(3)	.790	.600	...	-.014	.055	.037	-.061	.030	.036	.059	-.144	-.167	-.011
(4)	.619	.111	.220	...	.104	.020	.007	-.046	.010	.038	-.192	-.198	.001
(5)	.188	-.225	-.212	.206	...	.054	-.088	-.052	.054	.051	-.027	-.043	.011
(6)	.221	.216	.035	-.119	.174	...	-.114	-.018	.192	.010	-.138	-.163	.033
(7)	.262	.351	.055	.042	.037	.370	...	-.041	-197	.025	-.015	.022	-.022
(8)	.130	.184	.107	.023	-.065	.033	.089	...	.018	-.075	-.083	-.057	.016
(9)	.378	.499	.329	.041	-.059	.185	.310	.192	...	-.131	-.051	-.091	-.041
(10)	.685	.507	.689	.449	-.129	-.139	.091	.066	.252	...	-.162	-.130	.013
(11)	-.183	-.022	-.222	-.129	-.025	.045	.122	-.107	.149	-.172	...	.834	.003
(12)	-.317	-.037	-.356	-.313	.001	.171	.138	-.035	.078	-.483	.703	...	.009
(13)	-.406	-.262	-.356	-.352	.086	.061	-.126	-.107	-.168	-.385	.115	.222	...
Mean	1708.837	22.435	81.806	135.931	78.299	20.172	2.920	.205	1.025	.379	.816	.712	.262
Standard deviation	294.220	17.392	33.482	24.638	15.700	7.101	3.159	.813	.821	.212	.040	.080	.409
2002-1997 differences:													
Mean	-415.152	-4.870	-22.684	-41.776	-13.133	-.717	.141	.008	-.042	.019	.096	.087	.031
Standard deviation	198.721	17.832	19.544	21.692	16.756	8.087	3.753	.837	.855	.082	.035	.039	.160

NOTE – Variable level in 1999 appear below the diagonal; variable differences, 2002-1997 appear above it.

†Weight by the number of women between the age of 15 and 49 in each observed region.

‡The total fertility rate (which is 5 [the age interval] times the sum of the age specific birth rates) represents a cross-sectional proxy for completed fertility expected per thousand women surviving to age 50.

Table 5

Cross Sectional Regressions on Birth Rate Levels, Years 1976-1981

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Family Planning Program Man-Months (Cumulative Inputs to Prior Year) VHEN	PPHW	CODR	R^2 / SEE
Total fertility rate:†									
1977	2550.736	269.564**	894.614**	213.581	-1117.888*	50.609*	-44.065	3.743	.581
	(7.795)	(12.065)	(5.691)	(.398)	(-2.481)	(2.224)	(-1.137)	(.422)	(458.797)
1981	2474.497	151.836**	914.067**	-654.454	253.404	-.065	-48.237	-12.916	.455
	(8.817)	(6.006)	(7.164)	(-1.473)	(.741)	(-.006)	(-1.676)	(-2.011)	(352.619)
Age-specific birth rates for ages:									
15~19									
1977	30.321	6.690**	37.505**	-36.340	20.760	-.084	-3.398*	1.971	.497
	(2.463)	(7.958)	(6.341)	(-1.800)	(1.224)	(-.098)	(-2.332)	(5.903)	(17.262)
1981	35.546	12.264**	32.407**	-51.353	24.617	-.026	-4.709	.993	.538
	(2.769)	(10.606)	(5.552)	(-2.528)	(1.573)	(-.056)	(-3.578)	(3.381)	(16.130)
20~24									
1977	168.141	3.809*	58.141**	151.797**	-183.797**	2.458	-3.275	-1.853**	.436
	(7.254)	(2.407)	(5.221)	(3.993)	(-5.758)	(1.524)	(-1.193)	(-2.948)	(32.499)
1981	133.376	5.764**	72.255**	82.352*	-73.380**	1.183	-2.671	-1.643	.458
	(6.067)	(2.903)	(7.210)	(2.361)	(-2.731)	(1.478)	(-1.182)	(-3.257)	(27.694)
25~29									
1977	190.894	2.915	37.289**	144.381**	-177.236**	5.278**	-.284	-2.592**	.248
	(6.557)	(1.467)	(2.666)	(3.024)	(-4.421)	(2.607)	(-.082)	(-3.284)	(40.815)

* Regression coefficient is significant. at .05.

** Regression coefficient is significant. at .001.

† Definition note is the same as table 3 and the rest tales are the same, too.

Table 5 (Continued)

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Family Planning Program Man-Months (Cumulative Inputs to Prior Year) VHEN	PPHW	CODR	R^2 / SEE
1981	181.482	-8.062**	42.235	109.048**	-105.432**	-.609	2.137	-2.661**	.221
	(6.919)	(-3.413)	(3.542)	(2.627)	(-3.298)	(-.639)	(.795)	(-4.434)	(32.952)
30~34									
1977	80.599	13.160**	24.473*	-84.650*	48.850	2.002	-1.123	1.505**	.330
	(3.813)	(9.118)	(2.410)	(-2.442)	(1.678)	(1.361)	(-.449)	(2.626)	(26.639)
1981	82.175	4.554**	10.004	-102.311**	99.374	-.527	-.557	-.500	.291
	(4.638)	(2.854)	(1.242)	(-3.649)	(4.602)	(-.820)	(-.307)	(-1.234)	(22.259)
35~39									
1977	31.471	19.909**	12.435	-93.365**	44.057*	.377	.436	.949	.585
	(1.937)	(17.950)	(1.593)	(-3.505)	(1.969)	(.333)	(.226)	(2.155)	(22.776)
1981	44.045	9.244**	15.723*	-105.786**	64.495**	-.120	-2.285	.750*	.544
	(3.254)	(7.582)	(2.555)	(4.938)	(3.909)	(-.244)	(.101)	(2.421)	(17.008)
40~44									
1977	5.518	6.063**	9.416**	-33.165**	24.969**	.066	-1.072	.588**	.553
	(.858)	(14.770)	(3.260)	(-3.364)	(3.015)	(.157)	(-1.506)	(3.607)	(8.430)
1981	17.543	5.585**	9.540	-57.179**	36.377**	-.028	-1.420*	.369*	.410
	(2.807)	(9.922)	(3.355)	(-5.778)	(4.765)	(-.123)	(-2.216)	(2.579)	(7.850)
45~49									
1977	3.563	1.367**	-.377	-5.941	-1.181	.026	-.097	.180*	.230
	(1.368)	(7.686)	(-.269)	(-1.391)	(-.329)	(.145)	(-.313)	(2.555)	(3.651)
1981	.469	1.030**	.526	-5.304*	4.128*	.066	-.158	.103**	.206
	(.297)	7.245	(.733)	(-2.123)	(2.145)	(1.153)	(-.977)	(2.846)	(1.984)

Table 6

Cross Sectional Regressions on Birth Rate Levels, Years 1997-2002

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Obstetrician (Ratio)	R^2 / SEE
Total fertility rate:							
1998	1510.679	122.977**	915.017**	-1147.820**	909.814**	-117.658**	.526
	(7.118)	(6.580)	(11.815)	(-2.878)	(3.455)	(-3.727)	(229.163)
2002	2191.761	111.925**	844.523**	-1456.930**	378.370**	-104.358**	.523
	(7.222)	(6.792)	(11.092)	(-3.144)	(1.533)	(-3.301)	(235.779)
Age-specific birth rates for ages:							
15~19							
1998	7.067	4.157**	53.066**	-100.454**	105.557**	-4.710*	.419
	(.545)	(3.642)	(11.221)	(-4.124)	(6.565)	(-2.443)	(13.993)
2002	53.957	7.709**	37.372**	-116.545**	67.685**	-3.387	.454
	(3.295)	(8.670)	(9.170)	(-4.660)	(5.083)	(-1.986)	(12.722)
20~24							
1998	23.753	14.783**	96.579**	-24.929	51.044*	-9.252**	.591
	(1.150)	(8.128)	(12.814)	(-.642)	(1.992)	(-3.011)	(22.301)
2002	123.527	9.743**	91.280**	-111.317**	23.881	-10.610**	.579
	(4.449)	(6.462)	(13.104)	(-2.625)	(1.058)	(-3.668)	(21.571)
25~29							
1998	102.422	1.269	31.447**	59.848	-52.528*	-7.715**	.476
	(5.603)	(.788)	(4.714)	(1.742)	(-2.316)	(-2.837)	(19.740)

Table 6 (Continued)

Cross Sectional Regressions on Birth Rate Levels, Years 1997-2002

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Obstetrician (Ratio)	R^2 / SEE
2002	99.728	2.555*	39.615**	40.658	-48.491*	-7.135**	.300
	(4.131)	(1.949)	(6.541)	(1.103)	(-2.470)	(-2.837)	(18.756)
30~34							
1998	126.981	1.269	-1.235	-90.336**	24.976	-.983	.240
	(10.048)	(1.140)	(-.268)	(-3.803)	(1.593)	(-.523)	(13.646)
2002	102.746	.046	-3.561	-23.287	-10.827	-.115	.122
	(5.782)	(.047)	(-.799)	(-.858)	(-.749)	(-.062)	(13.807)
35~39							
1998	37.511	2.027**	2.640	-61.397	42.961**	-.939	.318
	(5.018)	(3.080)	(.968)	(-4.370)	(4.632)	(-.844)	(8.072)
2002	53.937	2.075**	.083	-65.986**	30.094**	-.378	.332
	(5.822)	(4.123)	(.036)	(-4.663)	(3.994)	(-.392)	(7.198)
40~44							
1998	4.006	1.008**	-.064	-10.294*	8.401**	.010	.336
	(1.824)	(5.213)	(-.075)	(-2.494)	(3.084)	(.031)	(2.371)
2002	5.364	.176	3.636**	-15.690**	13.095**	.010	.303
	(1.575)	(.953)	(4.255)	(-3.017)	(4.728)	(.030)	(2.646)
45~49							
1998	.395	.083	.568*	-2.003	1.551	.058	.161
	(.530)	(1.258)	(2.085)	(-1.428)	(1.676)	(.520)	(.806)
2002	.906	.082	.180	.779	.237	.070	.130
	(1.042)	(1.731)	(.826)	(.586)	(.335)	(.076)	(.676)

Table 7

Regression on Pooled Time Series of Cross Section Levels, Years 1976-1981

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Family Planning Program Man-Months (Cumulative Inputs to Prior Year) VHEN	PPHW	CODR	R^2 / SEE
Total fertility rate:	4941.087	144.843**	838.250**	-2638.460**	-838.429**	11.401	-62.342**	-7.833**	.561
	(26.434)	(18.416)	(12.547)	(-9.835)	(-4.777)	(1.807)	(-4.778)	(-2.636)	(31.133)
Age-specific birth rates for ages:									
15~19	38.652	7.022**	33.078**	-37.440**	15.455	.233	-4.498**	1.032**	.295
	(4.899)	(14.918)	(9.459)	(-3.115)	(1.678)	(.588)	(-5.677)	(5.802)	(9.243)
20~24	264.013	3.167**	59.595**	-31.749	-103.473**	1.220*	-2.194*	-1.353**	.452
	(21.230)	(5.419)	(12.493)	(-1.746)	(-8.229)	(2.568)	(-2.253)	(-6.123)	(23.235)
25~29	341.430	1.991**	24.256**	-93.110**	-99.591**	.125	.196	-1.358**	.583
	(20.582)	(2.916)	(4.149)	(-3.925)	(-6.491)	(.228)	(.173)	(-5.264)	(33.381)
30~34	160.133	6.831**	18.319**	-138.430**	16.981	.312	-2.239**	.140	.470
	(14.359)	(13.277)	(4.332)	(-8.517)	(1.524)	(.749)	(-2.613)	(.718)	(24.595)
35~39	78.152	8.416**	20.501**	-110.555**	24.033**	.158	-3.255**	.254	.427
	(9.469)	(21.160)	(6.373)	(-9.122)	(2.833)	(.488)	(-4.906)	(1.695)	(21.659)
40~44	19.538	4.628**	9.161**	-38.277**	12.825**	-.098	-1.535**	.329**	.355
	(5.463)	(25.008)	(6.288)	(-7.199)	(3.336)	(-.642)	(-4.958)	(4.694)	(17.369)
45~49	3.055	.742**	.984*	-7.083**	3.383**	.006	-.216	.057**	.112
	(3.362)	(12.859)	(12.859)	(-5.066)	(3.089)	(.127)	(-2.225)	(2.612)	(5.240)

Table 8

Regression on Pooled Time Series of Cross Section Levels, Years 1997-2002

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Obstetrician (Ratio)	R^2 / SEE
Total fertility rate:	1713.447	63.708**	795.232**	-193.155	-199.980	-80.935**	.558
	(16.289)	(10.898)	(23.184)	(-1.092)	(-1.673)	(-6.648)	(31.087)
Age-specific birth rates for ages:							
15~19	20.393	5.984**	44.440**	-84.241**	72.716**	-4.289**	.205
	(3.706)	(14.186)	(20.428)	(-8.613)	(10.153)	(-4.925)	(9.661)
20~24	179.852	7.351**	85.807**	-15.318	-19.311	-7.573**	.423
	(8.620)	(12.755)	(26.496)	(-.965)	(-1.744)	(-6.323)	(22.102)
25~29	318.622	-.577	31.155**	43.601**	-72.673**	-3.861**	.623
	(14.846)	(-1.173)	(10.584)	(2.805)	(-7.023)	(-3.766)	(36.939)
30~34	85.218	.243	-4.464*	4.129	-13.018	.587	.355
	(14.053)	(.599)	(-2.016)	(.392)	(-1.741)	(.698)	(17.667)
35~39	23.535	1.622**	1.054	-28.180**	26.526**	-.297	.388
	(8.094)	(7.178)	(.909)	(-5.438)	(6.970)	(-.636)	(8.826)
40~44	12.159	2.542**	1.839**	-18.099**	10.015**	-.148	.198
	(2.437)	(6.635)	(4.530)	(-4.591)	(7.618)	(-.880)	(4.603)
45~49	.285	.698**	.202*	-.814	.599	-.239	.045
	(1.028)	(3.414)	(2.016)	(-1.899)	(1.862)	(-.569)	(2.101)

Table 9

Deviation From Regional Means, Years 1976-1981

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Family Planning Program Man-Months (Cumulative Inputs to Prior Year) VHEN	PPHW	CODR	R^2 / SEE
Total fertility rate:	2434.876	296.728**	759.189**	-329.435	-121.671	64.225*	-36.808	-17.033*	.654
	(9.918)	(14.116)	(6.272)	(-.840)	(-.360)	(2.439)	(-1.285)	(-2.420)	(328.407)
Age-specific birth rates for ages:									
15~19	19.735	12.070**	28.059**	-35.410	30.906	.759	-3.335*	-.862*	.565
	(1.669)	(11.921)	(4.813)	(-1.875)	(1.901)	(.598)	(-2.416)	(2.542)	(15.818)
20~24	167.587	6.180**	55.219**	100.470**	-116.841**	6.202**	-4.824*	-2.344**	.526
	(8.887)	(3.827)	(5.939)	(3.335)	(-4.506)	(3.066)	(-2.192)	(-4.334)	(25.228)
25~29	193.418	-1.879	34.865**	121.426**	-127.490**	4.439	.066	-3.132**	.482
	(7.659)	(-.869)	(2.800)	(3.010)	(-3.671)	(1.639)	(.022)	(-4.324)	(33.784)
30~34	78.845	15.304**	14.754	-109.696**	87.510**	1.569	.625	.194	.398
	(4.999)	(11.333)	(1.898)	(-4.355)	(4.036)	(.927)	(.340)	(.430)	(21.097)
35~39	24.080	17.558**	13.136	-98.685**	69.026**	.062	.257	.638*	.664
	(2.287)	(19.478)	(2.531)	(-5.869)	(4.768)	(.055)	(.209)	(2.113)	(14.083)
40~44	2.669	8.622**	5.970**	-38.528**	29.069**	-.138	-.202	.364**	.725
	(.593)	(22.378)	(2.691)	(-5.361)	(4.698)	(-.286)	(-.386)	(2.819)	(6.019)
45~49	.641	1.492	-.165	-5.464**	3.487**	-.047	.052	.011	.632
	(.740)	(20.124)	(-.387)	(-3.952)	(2.929)	(-.505)	(.510)	(.433)	(1.158)

Table 10

Deviation From Regional Means, Years 1997-2002

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Obstetrician (Ratio)	R^2 / SEE
Total fertility rate:	2000.264	262.464**	638.664**	-838.185*	-42.785	-89.080**	.699
	(9.039)	(12.721)	(9.870)	(-2.339)	(-.212)	(-3.687)	(167.594)
Age-specific birth rates for ages:							
15~19	47.872	20.636**	26.268**	-109.870**	52.883**	-2.033	.679
	(3.642)	(16.838)	(6.835)	(-5.161)	(4.404)	(-1.417)	(9.954)
20~24	93.119	24.967**	78.093**	-58.275**	-8.350	-8.454**	.783
	(4.888)	(14.056)	(14.020)	(-1.889)	(-.480)	(-4.065)	(14.482)
25~29	93.698	-1.111	39.222**	93.636**	-70.924**	-9.428**	.388
	(4.547)	(-.578)	(6.510)	(2.806)	(-3.768)	(-4.191)	(15.605)
30~34	110.857	1.086	-11.437**	-19.125	-18.821	1.445	.226
	(8.419)	(.885)	(-2.971)	(-.897)	(-1.564)	(1.005)	(9.972)
35~39	49.558	4.936**	-4.591	-62.005**	28.225**	.555	.252
	(7.132)	(7.618)	(-2.260)	(-5.509)	(4.446)	(.731)	(5.263)
40~44	4.888	1.847**	.034	-11.513**	7. 973**	.108	.370
	(2.634)	(10.678)	(.063)	(-3.831)	(4.703)	(.532)	(1.405)
45~49	.062	.132**	-.144	-.485	.457	-.092	.068
	(.141)	(3.261)	(1.130)	(-.688)	(1.149)	(-.194)	(.329)

Table 11

Transformed Variable, Years 1976-1981

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Family Planning Program Man-Months (Cumulative Inputs to Prior Year) VHEN	PPHW	CODR	R^2 / SEE
Total fertility rate:	685.557	-27.068	350.435*	1209.033*	-838.798*	23.576	-128.003**	-21.300**	.346
	(1.858)	(-1.406)	(2.320)	(2.201)	(-2.103)	(1.485)	(-3.971)	(-2.924)	(17.091)
Age-specific birth rates for ages:									
15~19	2.204	.736*	8.453**	6.232	1.389	.067**	-1.303**	-.385	.123
	(.464)	(2.459)	(3.895)	(.834)	(.244)	(.264)	(-2.583)	(-3.405)	(5.762)
20~24	25.424	1.213	41.365**	49.422	-11.827	-.066	-4.690*	-1.835**	.181
	(1.131)	(.895)	(4.126)	(1.440)	(-.448)	(-.058)	(-2.054)	(-3.580)	(8.556)
25~29	112.710	2.636	-.749	-35.300	-11.644	1.237	-4.768	-.927	.248
	(4.144)	(1.754)	(-.065)	(-.863)	(-.383)	(.989)	(-1.890)	(-1.631)	(13.757)
30~34	68.458	1.353*	3.720	-83.575**	44.342**	.593	-3.779**	-.035	.175
	(7.419)	(2.420)	(.902)	(-5.930)	(4.083)	(1.257)	(-4.013)	(-.166)	(8.221)
35~39	20.017	.654**	4. 146**	-23.002**	9.786*	.079	-1.673**	.040	.321
	(5.192)	(3.173)	(2.588)	(-3.991)	(2.315)	(.467)	(-4.845)	(.513)	(15.692)
40~44	5.127	.436**	2.680**	-8.614**	4.910**	-.038	-.622**	.015	.191
	(4.101)	(5.825)	(4.829)	(-4.522)	(3.361)	(-.605)	(-4.941)	(.548)	(9.024)
45~49	1.452	.137**	.195	-2.121**	.615	-.003	-.030	.016*	.123
	(4.274)	(6.388)	(1.258)	(-4.063)	(1.508)	(-.169)	(-.824)	(1.988)	(5.779)

Table 12

Transformed Variable, Years 1997-2002

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Obstetrician (Ratio)	R^2 / SEE
Total fertility rate:	33.379	-47.237**	597.785**	1106.372**	-577.342*	-96.971**	.392
	(.152)	(-3.033)	(7.199)	(2.870)	(-2.081)	(-3.007)	(14.240)
Age-specific birth rates for ages:							
15~19	2.934	.943**	12.510**	10.363*	-14.573**	-.866	.178
	(1.009)	(3.826)	(10.279)	(1.970)	(-3.707)	(-1.709)	(3.683)
20~24	8.271	.087	36.612**	40.838*	37.329**	-4.636**	.149
	(.787)	(.104)	(8.581)	(2.168)	(-2.681)	(-2.666)	(6.973)
25~29	2.140	-3.228*	21.011**	100.130**	-35.295	-9.770**	.239
	(.129)	(-2.614)	(3.257)	(3.411)	(-1.652)	(-3.828)	(11.393)
30~34	2.832	1.212	-8.511*	65.101**	-24.332*	-2.693	.132
	(.317)	(1.664)	(-2.345)	(4.050)	(-2.042)	(-1.798)	(6.184)
35~39	7.411	.581**	3.545**	-11.535**	11.812**	-.528	.196
	(3.002)	(2.812)	(3.456)	(-2.588)	(3.556)	(-1.242)	(4.493)
40~44	1.050	.251**	.731**	-3.371**	3.548**	-.090	.122
	(2.282)	(6.640)	(3.865)	(-4.073)	(5.775)	(-1.152)	(5.671)
45~49	.038	.021**	.244**	-.487**	.529**	-.012	.235
	(.350)	(2.825)	(6.304)	(-2.763)	(4.127)	(-.835)	(11.325)

Table 13

Regression on Absolute Differences of Birth Rates: 1981 Less 1976

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Family Planning Program Man-Months (Cumulative Inputs to Prior Year) VHEN	PPHW	CODR	R^2 / SEE
Total fertility rate:	514.327	64.890*	1636.722**	6658.334*	-2697.461*	21.452	-62.817	14.434	.299
	(4.543)	(2.452)	(3.007)	(2.408)	(-1.457)	(1.530)	(-.646)	(1.543)	(454.647)
Age-specific birth rates for ages:									
15~19	3.398	1.622**	33.284**	-18.424	55.950	.223	1.759	.384*	.093
	(1.507)	(3.083)	(3.077)	(-.335)	(1.521)	(.802)	(.910)	(2.066)	(9.036)
20~24	20.382	5.046**	4.085	366.539*	-9.564	.063	7.249	.515	.077
	(3.220)	(3.417)	(.134)	(2.375)	(-.093)	(.080)	(1.336)	(.986)	(25.372)
25~29	40.133	4.679*	30.188	646.003**	-298.409*	2.727*	-13.845	.550	.067
	(4.453)	(2.225)	(.698)	(2.940)	(-2.029)	(2.448)	(-1.791)	(.740)	(36.125)
30~34	40.224	8.502**	59.716	248.454	-377.842**	.148	-7.528	-.630	.149
	(6.214)	(5.629)	(1.922)	(1.574)	(-3.577)	(.185)	(-1.356)	(-1.180)	(25.948)
35~39	16.554	5.482**	77.341**	103.177	-115.632	-.406	-.833	.719	.153
	(3.420)	(4.855)	(23.225)	(.874)	(-1.464)	(-.679)	(-.201)	(1.802)	(19.398)
40~44	4.316	7.487**	30.540**	53.905	-54.222	-.428	-.312	-.346	.392
	(1.809)	(13.446)	(2.666)	(.926)	(-1.392)	(-1.450)	(-.152)	(-1.757)	(9.566)
45~49	1.916	.126	8.631**	18.184	-21.812	-.124	-.334	.034	.044
	(2.800)	(.790)	(2.629)	(1.090)	(-1.954)	(-1.462)	(-.570)	(.059)	(2.742)

Table 14

Regression on Absolute Differences of Birth Rates: 2002 Less 1997

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Obstetrician (Ratio)	R^2 / SEE
Total fertility rate:	335.077	-31.854	228.711	-123.355	1174.595 *	-27.288	.246
	(10.172)	(-1.458)	(1.437)	(-.237)	(2.446)	(-.419)	(174.932)
Age-specific birth rates for ages:							
15~19	8.286	6.916 **	12.102	-63.230 *	27.149	-7.203 *	.185
	(5.169)	(6.504)	(1.563)	(-2.492)	(1.162)	(-2.272)	(8.512)
20~24	21.559	1.513	36.978 **	-60.366	90.612 *	-11.240 *	.055
	(7.581)	(.802)	(2.691)	(-1.341)	(2.186)	(-1.998)	(15.103)
25~29	34.864	-1.901	3.305	-2.352	105.377 *	-1.126	.045
	(10.253)	(-.842)	(.201)	(-.044)	(2.126)	(-.167)	(18.058)
30~34	19.926	2.961	7.382	-98.779 **	57.944	1.394	.046
	(8.690)	(1.946)	(.666)	(-2.722)	(1.734)	(.307)	(12.177)
35~39	7.023	3.376 **	12.538 **	-30.975 *	-2.482	-2.329 *	.166
	(7.185)	(5.205)	(2.655)	(-2.002)	(-.174)	(-1.204)	(5.191)
40~44	3.825	.947 **	4.435	-28.231 **	8.156	-2.437	.128
	(7.268)	(2.711)	(1.744)	(-3.389)	(1.063)	(-2.340)	(2.795)
45~49	.024	.098	1.207	-3.382	5.740 **	.267	.035
	(.016)	(.100)	(1.678)	(-1.435)	(2.645)	(.908)	(.791)

Table 15

Regression on Absolute Differences of Birth Rates: 1981 Less 1976

(Sub-sample for Which 1981 Birth Rates Trended to be Less than Predicated by the Cross Sectional Model)

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Family Planning Program Man-Months (Cumulative Inputs to Prior Year) VHEN	PPHW	CODR	R^2 / SEE
Total fertility rate:	922.589	95.253 *	3235.383 **	5798.556	-5494.814	.385	-227.429	23.771	.429
	(4.820)	(2.330)	(3.441)	(1.118)	(-1.722)	(.019)	(-1.430)	(1.801)	(513.005)
Age-specific birth rates for ages:									
15~19	5.040	-.943	28.993	-5.011	60.532	.717	3.997	1.017 **	.104
	(1.523)	(-1.138)	(1.811)	(-.065)	(1.139)	(1.866)	(1.443)	(3.027)	(9.419)
20~24	19.203	13.770 **	80.248	155.025	67.719	2.642	-2.618	2.727 **	.326
	(1.931)	(5.929)	(1.535)	(1.572)	(.417)	(1.674)	(-.406)	(3.586)	(24.642)
25~29	41.023	1.758	-57.388	173.691 **	-141.166 *	2.767	-44.409	2.187	.176
	(2.136)	(.328)	(-.672)	(3.884)	(-2.410)	(1.591)	(-1.738)	(1.729)	(42.720)
30~34	63.070	6.297 **	8.326	50.911	-64.268 **	1.925	-7.788	-.598	.157
	(5.700)	(3.438)	(.193)	(1.659)	(-3.862)	(1.358)	(-.687)	(-.882)	(29.207)
35~39	16.086	5.419 **	99.334	34.751	-48.364 *	-.743	-.662	1.959 **	.239
	(2.986)	(4.515)	(3.698)	(1.690)	(-2.192)	(-1.191)	(-.149)	(3.875)	(19.388)
40~44	2.911	10.718 **	33.633 **	23.624	-34.895	-.457	.431	-.104	.493
	(1.109)	(15.040)	(2.671)	(.360)	(-.815)	(-1.515)	(.191)	(-.397)	(9.400)
45~49	1.226	.162	6.179	26.935	-16.841	-.095	-.143	-.046	.030
	(1.462)	(.916)	(1.648)	(1.324)	(-1.265)	(-.978)	(-.194)	(-.722)	(2.810)

Table 16

Regression on Absolute Differences of Birth Rates: 2002 Less 1997

(Sub-sample for Which 2002 Birth Rates Trended to be More than Predicated by the Cross Sectional Model)

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Obstetrician (Ratio)	R^2 / SEE
Total fertility rate:	440.314	29.603	258.760	-611.554	998.995	-123.293	.238
	(10.972)	(1.071)	(1.498)	(-.939)	(1.710)	(-1.992)	(152.539)
Age-specific birth rates for ages:							
15~19	9.503	7.355**	27.567*	-81.524	44.075	-9.261	.228
	(3.531)	(4.554)	(2.154)	(-2.297)	(1.318)	(-1.537)	(9.710)
20~24	28.215	5.366*	72.524**	-92.992	80.409	-19.427	.186
	(7.494)	(2.196)	(4.338)	(-1.362)	(1.364)	(-3.175)	(13.656)
25~29	44.237	2.616	43.062*	-101.095*	126.620**	1.037	.063
	(13.651)	(1.121)	(2.544)	(-2.043)	(2.738)	(.164)	(14.732)
30~34	22.770	3.883	8.454	-97.142	76.028	7.047	.062
	(6.141)	(1.890)	(.516)	(-1.682)	(1.438)	(1.097)	(12.553)
35~39	7.302	4.099**	1.597	-5.876	-12.909	-3.695	.103
	(4.616)	(3.048)	(.239)	(-.211)	(-.503)	(-.901)	(5.184)
40~44	3.300	.227	8.527**	-12.006	-6.491	-2.424	.124
	(4.720)	(.545)	(2.611)	(-1.123)	(-.597)	(-1.769)	(2.707)
45~49	-.099	.027	-.016	-.329	2.616	.274	.040
	(-1.059)	(.437)	(-.036)	(-.225)	(1.931)	(1.430)	(.478)

Table 17

Regression on Absolute Differences of Birth Rates: 1981 Less 1976

(Sub-sample for Which 1981 Birth Rates Trended to be More than Predicated by the Cross Sectional Model)

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Family Planning Program Man-Months (Cumulative Inputs to Prior Year) VHEN	PPHW	CODR	R^2 / SEE
Total fertility rate:	556.346	46.955 *	-305.721	317.447	180.119	12.574	16.315	-26.766 **	.147
	(6.467)	(1.984)	(-.763)	(.167)	(.135)	(.980)	(.225)	(-2.841)	(241.141)
Age-specific birth rates for ages:									
15~19	8.552	3.644 **	43.271 **	-119.801	9.645	-.422	-.853	.065	.221
	(2.822)	(5.848)	(3.273)	(-1.627)	(.205)	(-1.129)	(-.350)	(.334)	(7.538)
20~24	26.695	2.051	-23.260	-21.219	72.862	.122	7.593	-.734	.025
	(4.845)	(1.518)	(-.900)	(-.145)	(.796)	(.205)	(1.103)	(-1.460)	(16.705)
25~29	42.764	4.749 **	27.549	-72.995	-6.860	.052	2.198	-1.480	.059
	(6.721)	(3.383)	(.857)	(-.480)	(-.065)	(.051)	(.452)	(-2.429)	(20.936)
30~34	11.534	8.764	17.660	36.729	22.694	-.204	-2.913	-.958	.090
	(2.372)	(3.105)	(.596)	(.349)	(.299)	(-.370)	(-.823)	(-1.416)	(13.580)
35~39	6.518	3.561 *	13.720	-2.524	26.850	-.327	1.517	-.769 *	.146
	(1.167)	(2.240)	(.621)	(-.021)	(.248)	(-.300)	(.267)	(-2.320)	(8.654)
40~44	5.907	2.804 **	18.394	2.333	-61.134	.252	.208	.424 *	.489
	(1.659)	(4.759)	(1.068)	(.029)	(-.122)	(.286)	(.071)	(2.009)	(6.201)
45~49	2.578	.375	20.829 **	-.379	-27.847	-.282	-.368	.377 **	.286
	(2.232)	(.907)	(3.067)	(-.014)	(-1.453)	(-1.626)	(-.398)	(2.848)	(2.359)

Table 18

Regression on Absolute Differences of Birth Rates: 2002 Less 1997

(Sub-sample for Which 2002 Birth Rates Trended to be More than Predicated by the Cross Sectional Model)

Dependent Variable	Constant Term	Child-death Adjustment (Ratio)	Agricultural Composition (Proportion)	Male Education (Proportion)	Female Education (Proportion)	Obstetrician (Ratio)	R^2 / SEE
Total fertility rate:	251.368	-37.366	31.646	292.236	777.405	-103.174	.204
	(4.399)	(-.983)	(.097)	(.331)	(.940)	(-.441)	(205.654)
Age-specific birth rates for ages:							
15~19	8.394	5.360 **	-1.354	-50.138	3.126	-4.079	.165
	(4.678)	(4.116)	(-.162)	(-1.451)	(.100)	(-1.327)	(6.533)
20~24	18.436	2.187	4.037	-49.830	23.190	-1.868	.054
	(5.415)	(.984)	(.232)	(-1.064)	(.487)	(-.210)	(12.394)
25~29	18.038	-3.373	2.752	133.757	-34.778	-4.120	.049
	(3.237)	(-1.072)	(.120)	(1.320)	(-.415)	(-.406)	(14.619)
30~34	19.725	-.225	-2.490	-114.017 **	53.501	-6.111	.071
	(8.213)	(-.116)	(-.199)	(-2.947)	(1.487)	(-1.125)	(9.743)
35~39	6.803	3.317 **	18.290 **	-38.398 *	-3.791	-1.926	.227
	(5.570)	(4.541)	(2.640)	(-2.097)	(-.224)	(-.894)	(5.064)
40~44	4.298	2.328 **	1.185	-42.008 **	16.595	-2.314	.210
	(5.383)	(3.865)	(.299)	(-3.242)	(1.503)	(-1.485)	(2.770)
45~49	2.485	.603	8.640	-52.568 *	41.832 *	-1.009	.417
	(2.136)	(.519)	(1.426)	(-2.521)	(2.259)	(-.633)	(1.566)

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