

Demographic Transition in Postwar Japan: A Time-Series Analysis

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ABSTRACT

This paper examines the pattern of both fertility and mortality change in postwar Japan and attempts to analyze macrolevel time-series data to identify the factors inducing such demographic transformations. The computed results show that while the decline of mortality is linked very closely to the rising level of real GNP per capita, the course of fertility is a considerably more complicated matter. A time-series econometric analysis based upon data pertaining to period parity progression affected by a different combination of socioeconomic and demographic variables.

I. Introduction

Japan was the first country outside the West to accomplish not only modern economic growth but also demographic transition (Minami, 1986; Hodge and Ogawa, 1991). Japan's fertility decline was both the earliest to occur in the postwar period and the greatest in magnitude among the world's industrialized nations (OECD, 1988). In addition, its mortality improved dramatically over the last four decades. At present, Japanese life expectancy at birth is the highest in the world. As a result of such rapid demographic shifts, the population of Japan has been aging at an extremely fast pace, and is projected to become the world's oldest population in the early part of the next century (Ogawa, 1989).

In the first half of this paper, we will examine the pattern of both fertility and mortality changes in Japan since the close of World War II. In the latter half, we will attempt to identify the factors contributing to such demographic transformations.

II. Fertility Change

In contrast to the case of the United States or that of European countries, Japan's postwar baby boom was extremely short; it lasted only three years, from 1947 to 1949. Following that short postwar baby boom, Japan's fertility dropped markedly, as shown in Figure 1. During the period 1947-1957, the total fertility rate (TFR) declined by more than half from 4.54 to 2.04 children per woman. There were only minor fluctuations around the replacement level of fertility until the 1973 first oil crisis, except for 1966, the Year of the Fire Horse, which occurs once every 60 years. According to this long-standing superstition, a female born in the Year of the Fire Horse is destined to both an unhappy life and killing her husband if she marries (Kaku, 1972). Immediately after the first oil crisis, TFR started to fall again, and dropped to 1.54 in 1990.

In line with these changes in TFR, the birth cohort size varied considerably over time, as displayed in Figure 1. During the baby boom period, there were, on the average, approximately 2.7 million births per

Figure 1. Trends in the Total Fertility Rate and Number of Births



year, but the number of births had decreased to 1.6 million by 1957. In the early 1970s, however, despite the low fertility rate, it increased to more than 2 million, as an "echo" effect of the baby boom cohorts. Since then, it has again been on a downward trend, recording 1.2 in 1990, or less than one half of the annual total births recorded during the baby boom period.

Family size goals and actual family size achievements have become increasingly homogeneous in Japan over the last few decades, stabilizing at two to three children, as documented in Table 1 (Hodge and Ogawa, 1991). In the process of such homogenization, the advantages of having children have been declining with the passage of time (Ogawa and Retherford, 1993). Data collected from various rounds of the nationally representative KAP survey conducted by the Mainichi Newspapers (hereafter, the Mainichi KAP survey) indicate that the proportion of married Japanese of childbearing age who expected to depend upon their own children as a source of old-age security declined almost continuously from 65 percent in 1950 to 18 percent in 1990 (Ogawa and Retherford, 1992). The tempo of such reduction was fast in the 1950s and 1960s, and was precipitated by the establishment of a universal pension system in 1961. In 1990, only 1.3 percent of married women aged less than 50 thought that their children had a productive utility (Population Problems Research Council, 1990). In contrast to the diminished utility of having children, the cost of childbearing has been rising over time, primarily resulting from expanded educational enrollment for higher learning (Hodge and Ogawa, 1991).

As a consequence of the declined utility and the increased cost of having children, the average number of children born to a married couple fell rapidly. Reduced marital fertility was the main source of Japan's fertility reduction during 1950-1975. This is confirmed by the results of decomposition of TFR for every quinquennial period in postwar Japan, as presented in Table 2.

The decline of marital fertility was facilitated by a wide prevalence of abortions (Oakley, 1978) and an increased use of contraception (Hodge and Ogawa, 1991). As can be seen by inspecting Table 3, the abortion ratio (1000 x the number of reported abortions / the number of live births) was well above 500 during the period 1955-1961. It should

Table 1. Cohort Marital Fertility and Fertility Preference, 1963-1990

(unit: number of children)

Year and Age	Children Ever Born	Desired Family Size
1963		
25-29	1.28	2.41
30-34	2.08	2.58
35-39	2.57	2.71
40-44	3.07	2.79
45-49	3.47	2.88
1971		
25-29	1.42	2.61
30-34	1.98	2.68
35-39	2.14	2.70
40-44	2.28	2.84
45-49	2.77	3.07
1981		
25-29	1.42	2.49
30-34	2.01	2.52
35-39	2.14	2.58
40-44	2.22	2.58
45-49	2.26	2.57
1990		
25-29	1.24	2.51
30-34	1.88	2.62
35-39	2.21	2.74
40-44	2.12	2.73
45-49	2.20	2.67

Source: Compiled from various rounds of the Mainichi KAP survey.

Table 2. Decomposition of TFR for Japan, 1950-1990

(unit: percent)

Time Period	Marital Composition	Marital Fertility
1950-1955	18.3	81.7
1955-1960	4.8	95.2
1960-1965	48.2	51.8
1965-1970	74.3	25.7
1970-1975	-3.2	103.2
1975-1980	108.1	-8.1
1980-1985	2887.8	-2787.8
1985-1990	99.5	0.5

Table 3. Trends in Ever-Use of Contraception for Currently Married Women Aged 16-49, and in Total Abortion Rates and Abortion Ratios for All Women

Year	Overall Use Rate ^{a)}	Total Abortion Rate ^{b)}	Abortion Ratio
1950	30.9	---	209.20
1952	41.7	---	401.96
1955	56.0	1.753	676.11
1957	59.6	1.600	716.35
1959	65.4	1.502	675.76
1961	70.4	1.366	651.41
1963	68.1	1.213	575.52
1965	72.4	1.041	462.38
1967	75.8	0.894	386.17
1969	78.8	0.855	393.93
1971	81.3	0.834	369.66
1973	84.3	0.767	334.87
1975	86.0	0.725	353.20
1977	85.7	0.698	365.36
1979	87.7	0.668	373.60
1981	83.3	0.655	390.05
1984	83.0	0.637	381.88
1986	86.0	0.593	381.72
1988	78.7	0.556	369.97
1990	82.5	0.527	373.81

a) Percent currently or previously using among married women aged 15-49.

b) Women aged 15-49.

SOURCES: The data on contraceptive use come from the various rounds of the Mainichi National Family Planning Surveys (Population Research Council, 1990). The total abortion rates (analogous to total fertility rates) and abortion ratios are based on vital statistics and census data and official statistics on abortions based on physician reports to the government (Ministry of Health, Statistical Report on Eugenic Protection, (various years).

be noted, however, that the use of contraception became increasingly important in the 1960s and 1970s, thus indicating the substitution of contraceptives for induced abortions. Though not shown in Table 3, the proportion of married women currently practicing contraception increased from 42 percent in 1961 to 60 percent in 1975 (Ogawa and Retherford, 1991). Since the latter half of the 1970s, the corresponding figures have been virtually unchanged.

As presented in Table 2, beginning from the mid-1970s, delay of marriage has been playing a principal role in accounting for the decline of fertility. The proportion of women married in the age group 25-29 fell from 79.1 percent in 1975 to 59.6 percent in 1990. Accordingly, the singulate mean age at first marriage for Japanese women rose from 24.5 to 26.9 years old during the same time period. It should be stressed that although Japan has traditionally been a universal marriage society, the idea of remaining single without considering marriage is rapidly spreading among the nation's young people. As presented in Table 4, data gathered from a nationwide survey on family life and organization conducted in 1988 (hereafter, the 1988 family survey) show that three-quarters of the female respondents in their 20s supported this idea. A statistical analysis of this data set has revealed that the proportion of the respondents who support this newly-emerging concept is substantially higher among those who are women, at relatively younger ages, with higher education, and living in urban areas (Ogawa and Retherford, 1993). It is important to observe, however, that virtually none of the women at ages 20-39 who were single at the time of the survey wished to remain single throughout their lifetime. These results appear to suggest that although the pattern of universal marriage still persists in contemporary Japan, there may be a further delay in marriage in the foreseeable future.

It should also be added that both out-of-wedlock childbearing and the incidence of divorce have been relatively minor in Japan, thus having generated no significant impact on fertility change. Less than one percent of births since 1967 have occurred outside marriages, as opposed to over 20 percent in the United States in recent years, and the divorce rate has been less than a third of that of the United States since 1960 (Preston and Kono, 1988).

These fertility changes in postwar Japan can also be analyzed on the

Table 4. Attitudes of Japanese Men and Women Toward
a "New Single Life " Concept, by Age, 1988

Age	Attitude Toward a "New Single Life"	
	Agree(%)	Disagree (%)
		<u>Male</u>
All Ages	46.0	54.0
20-29	52.4	47.6
30-39	65.1	34.9
40-49	47.4	52.6
50-59	35.1	64.9
60+	34.8	65.2
		<u>Female</u>
All Ages	57.9	42.1
20-29	74.5	25.5
30-39	67.1	32.9
40-49	66.3	33.7
50-59	46.1	53.9
60+	33.6	66.4

basis of a time series of period parity progression ratios (PPPRs). Feeney and Saito (1985) estimated, by applying an indirect estimation procedure to both census and marriage registration data, the period progression to first marriage for Japanese women over the period 1870-1980. In his subsequent work, Feeney (1986) computed, by following a similar method, a series of period parity progression measures for Japan for the years 1950-1982. These estimates have recently been updated to the year 1990, but using the same computational procedure. (Ogawa and Retherford, 1993).

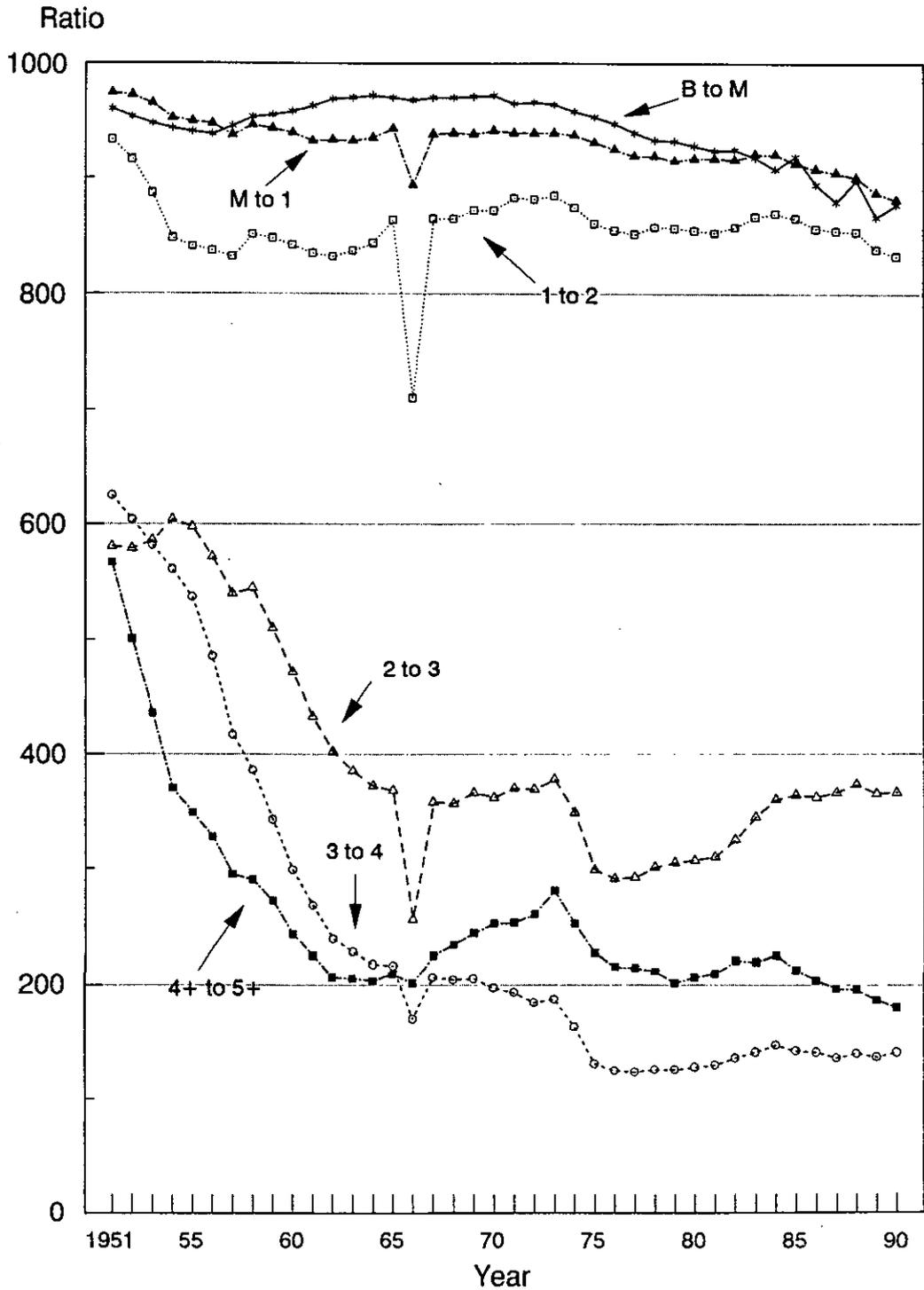
The computed results are depicted in Figure 2. Several points of interest emerge from this graph. First of all, the estimated values of period progression from birth of woman to first marriage were relatively stable from 1951 to around 1970, but they have been on the downward trend since the early 1970s. These results are consistent with Japanese women's changing values pertaining to marriages, as discussed earlier. It is important to note that if the recent marriage market situation persists, approximately 12 percent of Japanese women will remain single throughout their lifetime. This may foretell a gradual change in the universal marriage pattern in Japan.

Secondly, the computed period progression ratio from first marriage to first birth declined considerably in the early 1950s, but it remained fairly constant up to the mid-1970s. Since then, however, it has been decreasing again, thus recording 882 in 1990. This implies that if the present pattern prevails, the proportion of Japanese women without children will be 12 percent, which is a substantial increase, as compared with 3 percent in 1951.

Thirdly, the period progression from first to second birth remained virtually unchanged throughout the period under question, except for the early 1950s and the most recent two years. When the result for 1951 is compared with that for 1990, the proportion of married couples having only one child increased from 6.5 percent [= $0.974 \times (1 - 0.933)$] to 14.7 percent [= $0.882 \times (1 - 0.833)$], a result worth noting.

Fourthly, the PPPRs for higher parities changed to a marked extent over the last four decades. It is important to observe, however, that although the period progression from fourth or higher to fifth or higher birth almost continuously declined over time, the PPPRs for parities 2

Figure 2. Parity Progression Ratios for Japan,
1951-1990



Source: Ogawa, Naohiro, and Robert D. Retherford, "Resumption of Fertility Decline in Japan," unpublished manuscript.

and 3 fell pronouncedly from the early 1950s to the mid-1970s, after which they were on an upward trend over the last 15 years. The precise mechanism by which the PPPRs for parities 2 and 3 upsurged slightly in the recent years, however, is not entirely clear.

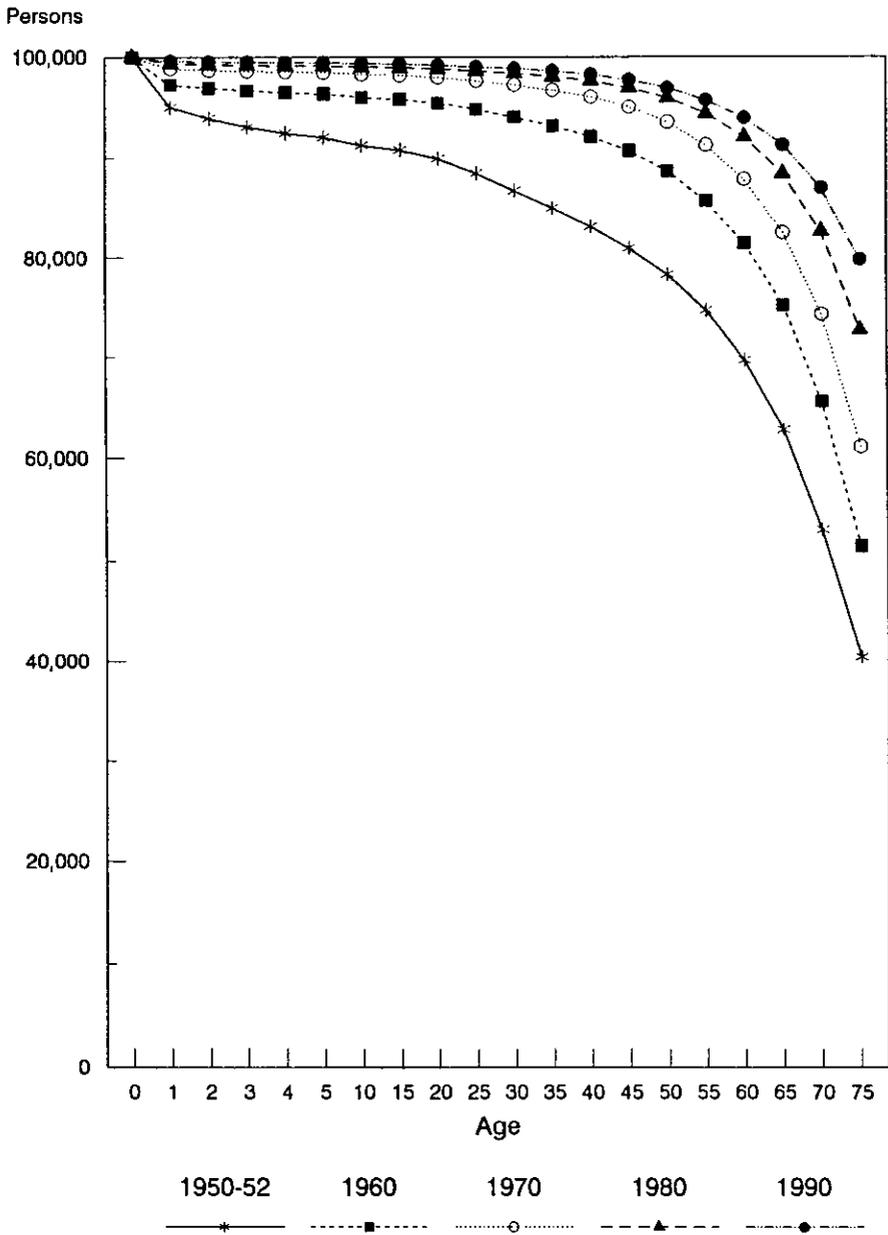
Fifthly, these intertemporal changes in the period progression ratios for Japanese women are in full agreement with the results obtained from our earlier decomposition analysis of TFR over the period 1950-1990. More specifically, the total marital fertility rate (TMFR) calculated from the period parity progression ratios dropped from 3.17 in 1951 to 2.01 in 1975, while the period parity progression ratio TFR decreased from 3.05 to 1.92 during the same time period. Since 1975, the difference between these two fertility measures, which represents a postponement of marriages, has been expanding substantially, being as large as 0.23 in 1990, i.e., 1.92 for TMFR and 1.69 for TFR. Whether or not the marriages postponed are subsequently made up remains to be seen in the years to come.

III. Mortality Change

As fertility fell during the postwar period, mortality also declined (Riley, 1990). Over the period 1948-1990, life expectancy at birth rose from 59.4 to 81.8 years for females, as depicted in Figure 3. During the same time period, the corresponding values for males increased from 55.6 to 75.9 years. At present, both Japanese men and women enjoy the world's highest life expectancy. It is worth remarking, however, that the annual increment in life expectancy has been decreasing to a considerable degree over the last two decades or so. More importantly, infant mortality has been falling continuously throughout the period under review, and has been below 10 since the mid-1970s, as indicated in Figure 3.

Because of such low infant mortality, improved survivorship at older ages has been contributing considerably to the protraction of life expectancy in recent years (Ogawa, 1986; Feeney, 1990). Figure 4 reveals this shift in the demographic sources of mortality reduction in postwar Japan. In 1947, life expectancy at age 65 was 10.2 years for males and 12.2 years for females, but rose to 13.7 years for the former and 16.6

Figure 4. Pattern of Female Survivorship in Selected Years



Source: Ministry of Health and Welfare, Minister's Secretariat,
 Statistics and Information Department, 17th Life Tables, 1992.

years for the latter in 1975, and the corresponding values for 1990 were 16.2 and 19.9 years, respectively.

Japan has now entered the fourth stage of the epidemiologic transition, the stage in which the onset of degenerative diseases is delayed (Olshansky and Ault, 1986). At present, three degenerative diseases, i.e., cancer, heart disease, and cerebrovascular disease, are the major sources of mortality. It should be noted that unlike most developed countries where heart disease is the number-one killer, cancer has been the leading cause of death since 1981 in Japan.

If the risk of dying from the three principal killers could be totally eliminated as a result of medical technological progress, life expectancy at birth would exceed 85 years for males and 90 years for females. In the recent past, Feeney (1990) has estimated, by extrapolating into the future the linear trend of the past 25 years for those aged 45 and over whose survivorship has improved with pronounced rapidity, that the expectation of life at birth will be 81.0 years for males and 88.0 years for females during 2000-2004. The other recent mortality study (Longevity Study Group, 1989) has estimated that in the year 2010, Japanese life expectancy at birth will be 78.9 years for males and 86.0 years for females. The same study has also suggested the possibility that it will be 79.8 years for males and 86.5 years for females in the year 2025.

The feasibility of these estimated levels of life expectancy is dependent upon a host of factors. These factors include the future government policy direction of health care programs, dietary changes, housing conditions, and smoking habits. In the 1980s, the government made a series of efforts to curb the escalating costs of health care services under the social insurance system (Social Insurance Agency, 1991).

Due to a consequence of diversified dietary pattern, the intake of salt has been declining, which has, in turn, reduced the incidence of stomach cancer and cerebrovascular disease (Martin, 1989). Furthermore, as a result of fast economic growth, the quality of housing has been improving, particularly with respect to temperature control at home, which has apparently contributed to the reduction of cerebrovascular disease. Although the percentage of Japanese males at ages 20 and over

who smoke fell from 70 percent in 1980 to 61 percent in 1990, the percentage of adult females who smoke oscillated between 13 and 15 percent (Japan Tobacco Corporation, 1990). It will take considerable time before the change in smoking habits affects the incidence of lung cancer.

IV. Statistical Analysis

In this section, we attempt to identify the factors influencing these demographic transformations in postwar Japan. In view of the fact that a system of structural equations dealing with both fertility and mortality changes has been recently estimated on the basis of time-series data elsewhere (See Chapter I of Hodge and Ogawa, 1991), we confine ourselves to estimating equations pertaining to both the PPPR-based TFR and life expectancy at birth for females. Moreover, although the modeling exercise undertaken by Hodge and Ogawa (1991) covers the period 1951-1982, our estimation efforts are based upon time-series data over the period 1951-1990. Before proceeding to the statistical results, let us briefly discuss Japan's postwar socioeconomic development which has accompanied such rapid demographic shifts.

A. Socioeconomic Development

The Japanese economy was in shambles at the end of World War II, but its economic growth performance has been phenomenal during the past four decades. During the 1960s, Japan's real GNP grew at an impressive rate of about 11 percent per annum; this rapid economic growth was brought about by such factors as the use of abundant high-quality labor, the borrowing of advanced technology from developed countries, and the favorable international trade market (Oshima, 1986). However, since the oil crisis of 1973 which triggered a series of programs aimed at the restructuring of the Japanese economy, its economic growth performance has been much less impressive than that for the 1960s. In the face of this major change in its growth performance, the average annual growth rate of real GNP for the 1980s dropped to 4.2 percent--still higher than the figures for many other industrialized nations. Data gathered by the World Bank

(1992) show that Japan's GNP per capita increased from US\$458 in 1960 to US\$25,430 in 1990.

Over the period 1950-1990, the proportion of those residing in urban areas more than doubled, from 37 to 77 percent. The female enrollment rate at junior colleges and universities grew at a spectacular rate. It was 5 percent in 1955, but rose to 37 percent in 1990 which was slightly higher than the corresponding figure for males.

In addition to these fast socioeconomic changes, the participation of women in paid employment has been increasingly activated. The proportion of women at ages 20-39 who were working as paid employees grew from 26.2 percent in 1960 to 51.9 percent in 1990. This pronounced increase is considered as one of the most drastic changes in female labor force participation in the recorded experiences of industrialized countries (Shimada and Higuchi, 1985; Osawa, 1988).

B. Fertility Equations

To examine the effect of a few proximate determinants upon the fertility change over the period 1951-1990, the TFR computed from the period parity progression ratios (TFR_{pppr}) is used as a dependent variable, while the following four explanatory variables are introduced: the mean age at first marriage for women (AFM), the proportion of married women aged less than 50 who were using contraceptives (CONTRA), the ratio of induced abortions to live births (ABORT) and a dummy variable representing the Year of the Fire Horse (YEAR66). To allow for the conception period, both AFM and CONTRA are lagged one year.

Although we have estimated the equation by ordinary least squares (OLS), the Durbin-Watson statistic (0.856) allows us to reject the null hypothesis of zero autocorrelation in the error terms associated with the OLS regression. For this reason, we have re-estimated the equation, using the Cochrane-Orcutt procedure, the results of which are shown as below:

$$(1) \text{ TFR}_{\text{pppr}} = 8.4652 - 0.2276 \text{ AFM}_{-1} - 0.0123 \text{ CONTRA}_{-1}$$
$$(14.31) \quad (-8.51) \quad (-7.13)$$

$$\begin{array}{r}
 - 0.00036 \text{ ABORT} - 0.3814 \text{ YEAR66} \\
 (-3.92) \qquad \qquad (-10.55)
 \end{array}$$

$$\text{Adjusted } R^2 = 0.978; \text{ D-W} = 1.793; \text{ N} = 39$$

where the t-statistics of the coefficients are reported in parentheses beneath their estimated values. Each estimated coefficient is statistically significant and has a correct sign; the mean age at first marriage for women, the percentage of married women using contraceptives, induced abortions, and the Year of the Fire Horse have all contributed to a decrease in TFR_{pppr} .

Now, we will introduce a few socioeconomic variables into Equation (1) in order to examine their effects upon TFR_{pppr} . The explanatory variables added include (i) GNP per capita measured in 1985 constant prices (GNPPC), (ii) the proportion of women of the relevant age who enrolled in junior colleges or universities (EDUC), and (iii) the percentage of women aged 20-39 working as paid employees (EMP). These additional variables are expected to affect TFR_{pppr} directly or indirectly through the proximate determinants included in the equation. We eschew any further discussion of these additional explanatory variables entering the equation, because it is self-evident how these variables in the equation would either increase or decrease the fertility rate. It should be noted, however, that due to the limited availability of time-series data on women's paid employment, we have estimated the equation on the basis of data over the period 1960-1990. It should also be noted that because of the time between a conception and a birth, we have lagged all of these additional socioeconomic variables. The OLS results are as follows:

$$\begin{array}{r}
 (2) \text{ } TFR_{pppr} = 5.1493 - 0.0650 \text{ AFM}_{-1} - 0.0057 \text{ CONTRA}_{-1} \\
 (7.46) \quad (-1.54) \qquad \quad (-1.74)
 \end{array}$$

$$\begin{array}{r}
 - 0.00088 \text{ ABORT} - 0.2215 \text{ YEAR66} \\
 (-3.28) \qquad \qquad (-3.79)
 \end{array}$$

$$\begin{array}{rcc}
+ 0.00019 \text{ GNPPC}_{-1} & - 0.0195 \text{ EDUC}_{-1} & - 0.0192 \text{ EMP}_{-1} \\
(2.85) & (-4.79) & (-2.46)
\end{array}$$

$$\text{Adjusted } R^2 = 0.966; \text{ D-W} = 1.872; \text{ N} = 30$$

All of the estimated coefficients have correct signs, but the coefficients for both the mean age at first marriage and the contraceptive prevalence rate are statistically insignificant. This implies that the effects of the socioeconomic variables upon TFR_{pppr} through these two proximate determinants are substantial. In addition, the estimated results for the socioeconomic variables confirm to a *priori* expectations; GNPPC, which represents the income effect, contributed to an increase in the fertility rate, while EDUC and EMP, both of which represent a woman's opportunity costs, depressed TFR_{pppr} . In particular, the result for EMP is consistent with the fertility theory of the new home economics approach. Ogawa and Mason (1986), for instance, have demonstrated that an alternative specification of the Butz-Ward model, which uses as one of the key explanatory variables the proportion of paid employees in the currently married female population to explain fertility, tracks the course of TFR quite satisfactorily over the period 1964-1984. Also, Osawa (1988) has undertaken a similar study to show the applicability of the Butz-Ward model to postwar Japan.

Theory points to the possibility of the replacement effect of infant mortality upon fertility. For this reason, we have estimated another equation, by introducing the infant mortality rate (lagged by one year) into Equation (2). The estimated results show that the coefficient for infant mortality was statistically insignificant (t-statistic = - 0.990), and that the coefficients for all the remaining variables were only marginally affected. Thus, these results suggest that because the infant mortality rate over the sample period (1961-1990) has been low, its replacement effect has been weak over the last three decades in Japan.

We have also estimated a number of other fertility equations, each of which has employed a different period progression ratio as a dependent variable. As regards the period progression from birth to first marriage (BM), the estimation has been made for the sample period 1971-1990. This restriction of the sample period has been adopted primarily because no

marked change in BM could be observed before the early 1970s, as displayed in Figure 2. In addition, most Japanese women get married in their 20s, so that for this equation, we have decided to use the proportion of women at age 20-29 holding paid jobs (EMP2029). Furthermore, because the three socioeconomic explanatory variables are highly correlated with each other during the period 1971-1990, we have dropped GNPPC from the equation. The fitted results based upon the Cochrane-Orcutt procedure are:

$$(3) \text{ BM} = 1222.7 - 3.1782 \text{ EDUC} - 3.9395 \text{ EMP2029}$$

$$(62.9) \quad (-5.08) \quad (-10.9)$$

$$\text{Adjusted } R^2 = 0.932; \text{ D-W} = 2.510; \text{ N} = 20$$

As expected, both young women's educational enrollment into tertiary education and their participation in paid employment have significantly contributed to reducing BM over the last two decades. It should be warned, however, that the causal relationship may be two-way; women's education and their participation in paid employment may be affected by the timing of their marriages. In a country like Japan where the age at first marriage was high even in the early 1970s, it may be safe to assume that EDUC affects BM. In the case of EMP2029 in relation to BM, however, the endogeneity problem tends to be serious. Although we have attempted to identify a few instrumental variables to solve this problem, no powerful instruments have been found. For this reason, caution should be exercised in interpreting these statistical results.

Table 5 presents the results for various components of $\text{TMFR}_{\text{pppr}}$ over the period 1961-1990. In each equation, we have used the same explanatory variables as those included in Equation (2), and to cope with the problem of autocorrelation, each equation has been estimated on the basis of the Cochrane-Orcutt procedure.

A close examination of the results reported in Table 5 reveals that the number of determinants increases with parities. In particular, the socioeconomic variables are a significant role in depressing higher order births. This result is not surprising because the completed family size has fallen considerably with Japan's postwar development, as discussed in

Table 5. Regression Results for Various Components of PPPR-Based Total Marital Fertility Rate, Japan, 1961-1990

Explanatory Variables	Progression Ratios				
	Marriage to First Birth	First to Second	Second to Third	Third to Fourth	Fourth or Higher to Fifth or Higher
Constant	1417.6 (8.49)	1551.5 (5.99)	1071.6 (2.53)	813.90 (3.35)	1028.9 (6.13)
AFM ₋₁	-16.286 (-2.01)	-23.989 (-1.88)	-26.725 (-1.14)	-21.882 (-1.53)	-2.9706 (-0.28)
CONTRA ₋₁	0.0608 (0.14)	0.3713 (0.51)	-0.6141 (-0.38)	-0.5154 (-0.48)	-3.0221 (-3.67)
ABORT	-0.00849 (-1.93)	-0.1633 (-2.34)	0.1400 (1.01)	0.0777 (0.88)	-0.4169 (-3.67)
YEAR66	-31.892 (-3.91)	-125.83 (-9.67)	-120.23 (-4.48)	-45.256 (-2.55)	64.016 (4.42)
GNPPC ₋₁	-0.0069 (-0.59)	0.0244 (1.30)	0.0943 (2.62)	0.0252 (1.13)	0.1359 (8.08)
EDUC ₋₁	-0.5578 (-0.67)	-2.3609 (-1.79)	-9.5256 (-3.97)	-6.4094 (-4.53)	-6.2681 (-6.28)
EMP ₋₁	-0.8224 (-0.68)	-8.519 (-0.44)	0.4586 (0.11)	0.8519 (0.33)	-12.554 (-6.34)
Adjusted R ²	0.958	0.969	0.913	0.965	0.914
D-W	1.670	1.644	1.545	1.690	1.986
N	30	30	30	30	30

Note: t-values in parentheses.

the earlier section.

The mean age at first marriage is an important explanatory variable in accounting for the variance in progression from marriage to first birth. This result seems to suggest that there exists the so-called catch-up effect of the delayed timing of marriage. Both CONTRA and ABORT have entered the equation for the period parity progression ratio from fourth or higher to fifth or higher birth. These results indicate that although many Japanese women in higher parities practice contraception, those who become pregnant are likely to terminate pregnancies with induced abortions.

The Year of the Fire Horse (YEAR66) is the only explanatory variable that has entered all the equations. It is worth noting, however, that the estimated coefficient for this variable is a positive sign. As depicted in Figure 2, the effect of this cultural factor upon progression from fourth or higher to fifth or higher birth is almost negligible. It may be hypothesized that higher-parity women do not care about the superstition because they are highly motivated to achieve their larger family size target. It is rather puzzling that the abortion ratio is a determinant for progression from first to second birth. To disentangle this statistical puzzle, we need time-series data for the parity-specific abortion ratio. In fact, we should have used the parity-specific use of contraception to assess the effect of CONTRA upon the period parity progression ratios. Unfortunately, such data are not readily available.

C. Mortality Equations

Now, let us turn our attention to an analysis of mortality. We have estimated the following two mortality-related equations: one on life expectancy at birth for Japanese women (LIFE) and the other on the infant mortality rate (IMR). Following the earlier work by Hodge and Ogawa (1991), we have employed GNPPC as an explanatory variable for these two equations. The sample period used for estimating these equations begins from 1951 and end in 1990. In view of the fact that the universal medical care programs were instituted in 1961, for the three-quarters of this sample period, GNPPC can be considered as a proxy for the government financial resources allocated for the public support system. A prelimi-

nary analysis has indicated that there is a nonlinear relationship between LIFE and GNPPC. A similar pattern has also been observed between IMR and GNPPC. Taking into consideration these bivariate relationships, the logarithmic value of each variable has been utilized for estimation. Moreover, owing to autocorrelation of the disturbances, both equations have been estimated by the Cochrane-Orcutt procedure. The fitted regression results are:

$$(4) \ln \text{ LIFE} = 3.648 + 0.0929 \ln \text{ GNPPC}$$

$$(111.7) \quad (20.4)$$

$$\text{Adjusted } R^2 = 0.988; \text{ D-W} = 1.772; \text{ N} = 40,$$

$$(5) \ln \text{ IMR} = 9.9576 - 1.0260 \ln \text{ GNPPC}$$

$$(22.0) \quad (-16.2)$$

$$\text{Adjusted } R^2 = 0.994; \text{ D-W} = 2.424; \text{ N} = 40$$

where \ln denotes the natural logarithm. The estimated results are not only consistent with the theoretical expectations, but also statistically significant. In each equation, the coefficient for GNPPC represents the elasticity of a change in GNPPC with respect to the dependent variable. It can be easily observed that the computed elasticity is substantial in Equation (5); a 10-percent increase in real GNP per capita induces almost the same amount of relative change in the infant mortality rate. In contrast, the calculated elasticity is relatively small in Equation (4); a 10-percent rise in GNPPC leads to only a 0.9-percent improvement of life expectancy at birth for women.

These estimated results agree to the view that although infant mortality declines rapidly with economic development, the marginal gain in the extension of life among the elderly is relatively small as a country develops (Ogawa, 1990).

It is often argued that women's education plays an important role in reducing infant mortality. To test the validity of this argument, we

have re-estimated Equation (5) with EDUC incorporated as an additional explanatory variable. The estimated coefficient for this additional variable has proved to be statistically insignificant.

V. Concluding Remarks

In the present paper, we have outlined Japan's postwar demographic transition and the socioeconomic factors associated with it. Japan's remarkable economic recovery in the aftermath of World War II is often considered the cause of its rapid demographic transition (Oshima, 1986). We have seen that the decline in mortality is indeed linked very closely to the rising level of real GNP per capita. The course of fertility is a different and much more complicated matter, however. Our PPPR-based analysis has shown that not only the socioeconomic variables but also the demographic factors have played a significant role in reducing the fertility rate, and that each parity progression ratio has been affected by a different combination of these variables. It should be emphasized, however, that the present study suffers from numerous time-series data limitations. When these required data become available in the future, this study should be revised and further elaborated.

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