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Japan: Where Did All the People Go? An Empirical Study on Economic and Social Impacts on Low Fertility in Japan

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JAPAN: WHERE DID ALL THE PEOPLE GO?

AN EMPIRICAL STUDY ON THE ECONOMIC AND SOCIAL IMPACTS ON LOW FERTILITY IN JAPAN

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Abstract

The focus of this project was to analyze economic and social impacts on the total fertility rate (TFR) in Japan. The Japanese government is worried that Japan's severity in population decline and ageing will cause irreversible, long-term consequences for Japan's economy, culture, and infrastructure. According to experts in demographic research, TFR is mostly responsible for trends in the population decline and population ageing in Japan. Taking data from 2010 and 2015, four models using both Ordinary Least Squares and Panel regression methods were evaluated with TFR as the dependent variable and independent variables Marriage Rate, Percentage of Households with Members Aged 65 years or older, Labor Force Participation Rate of Females, Number of Female Part Time Workers, Income Per Person, Percentage of Expenditure on Child Welfare, and Percentage of Expenditure on Social Welfare. Results indicate that income per capita has the largest impact on TFR and is highly considered by people when making fertility decisions. Results also show that Japanese government policies are largely ineffective in impacting TFR.

I. INTRODUCTION

According to the U.S. Census Bureau, it can be said that Japan has lost approximately 4.1 million people from its population since 2008 (US Census Bureau). Ever since peaking in 2008, Japan's population has been on the decline. In 2008, Japan's population declined by 20,000 people, starting a population decline domino effect that it still finds itself in today. Japan found itself deeply affected by the great global recession, its GDP falling by 12.1 percent by the beginning of 2009 (Kawai and Takagi, 2009). Then, the population declined by one-hundred-thousand people in 2010 followed by over half a million decline in 2019. Between October 2021 and October 2022, Japan had to come to terms with a record number of 644,000 decline in the population. In the U.S. Census Bureau's projection, Japan's population growth is expected to continue its downward trend through 2060 (Figure 1.1). When compared to Japan, one can see in Figure 1.2 that the United States has shown a positive growth in population and is projected to continue for at least nearly 40 years. This is the result of positive net migration into the U.S. and higher birth rates combined with lower mortality rates. On the contrary, it is due to such factors that Japan's population continues to decline. According to the World Bank, Japan does not accept nearly the same level of migrants as the U.S. (87, 584 versus 561, 580 immigrants in 2021, respectively), and its total fertility rate (TFR) is at a low 1.38 whereas it is approximately 1.7 for the United States; Japan's TFR is well below the replacement level of 2.1, which is the rate at which a population must replace itself between generations in a population with lower mortality rates (Craig, 1994).

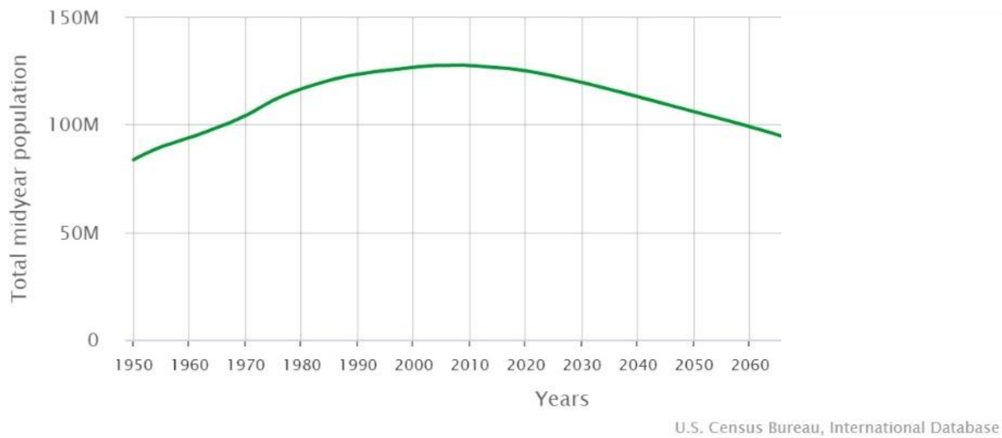

Figure 1.1 Estimated trend in Japan's total population (1950-2060)

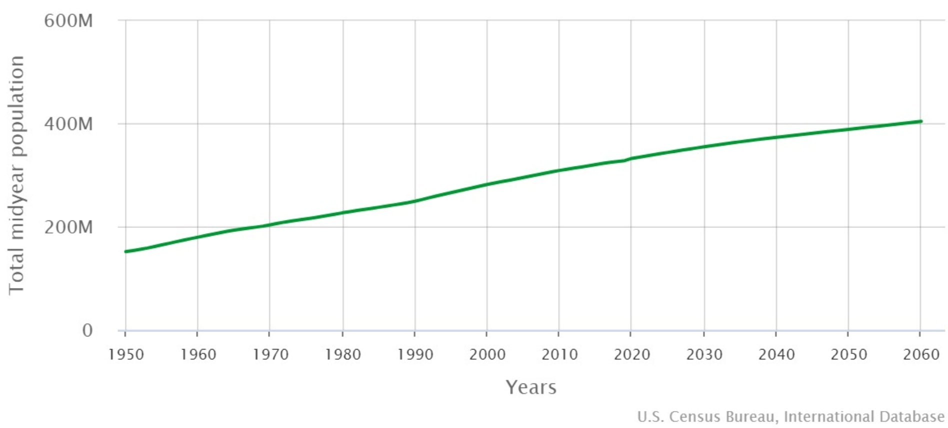

Figure 1.2. Estimated trend in United States' population (1950-2060)

Similar to how the U.S. has 50 states, Japan has 47 prefectures, and every prefecture is experiencing population decline with the exception of Okinawa. Culturally and historically, Okinawa differs from mainland Japan. Okinawans were not originally part of Japan until the Meiji period (1868-1912), and although Okinawa underwent various assimilationist policies, cultural differences may still be reflected in TFR and other factors. Moreover, an American military base has resided in Okinawa since the Pacific War (the Japanese term for World War II), which has also altered its economy and culture. Nevertheless, Figure 1.3 is a representation of the phenomenon experienced by the 46 prefectures and showcases the rate of population change of each prefecture as of October 1, 2021. Almost all prefectures in the shikoku region (second southernmost island) had 0.9% or greater decrease in its population. Moreover, Japan is a country rich in various traditions specific to each region, prefecture, and municipality. For example, there is the art of Bunraku (文楽), a traditional puppet theatre show that began during the Edo period (1603-1868). Other interesting arts include ikebana (生け花), the beautiful arrangement of flowers and plants, and tea ceremony, the ritualized art of serving tea. Sadly, if this level of decline continues, entire regions may be facing cultural extinction. The older population is heavily invested in keeping alive traditional arts, and if there are not enough in the younger generation to carry the torch of these traditions, then this puts Japanese traditional culture in jeopardy. Not only does it implicate the future of Japanese culture, but it implicates the future of entire towns. To reflect the latter problem, the term “genkai shūraku” was coined to define the towns or villages that are on the verge of disappearing due to depopulation. In addition, the age distribution of genkai shūraku is greatly skewed towards the elderly (65 years or older), which reflects Japan’s aging population (Kumagai 2020).

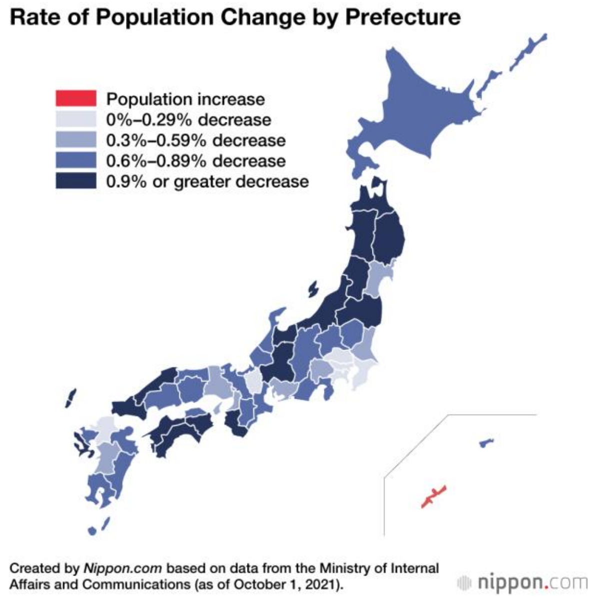

Figure 1.3. Map of Japan showing rate of population change by prefecture

Therefore, not only is Japan dealing with a declining population, but it is also dealing with an ageing population in parallel. Figures 1.4 through 1.6 are Japan's population pyramids obtained from the U.S. Census Bureau and showcase the estimated age distribution between 1990 and 2100. Japan's 1990 population pyramid is a thick, upright pyramid, which is closer to what a normal population distribution should resemble. A normal distribution would continually have a higher distribution of the population in the young to middle-aged (45 years old) generations with a smaller portion of the distribution being in the older category (65 years and over). However, the youthful population aged 14 years and below seems to be decreasing in number. An updated version of the pyramid to 2023 showcases that the trend of a small youth population has continued, but now the pyramid has flipped upside down, indicating a larger distribution of those aged 45 years and above (Figure 1.5). Lastly, Figure 6 showcases that, by 2100, a total shrinkage of Japan's population with overall population density will decrease with the greatest distribution of people in the 60–64-year-old category. Compare 2023's total population of 123.7 million to an estimated 2100's total population of 72.9 million; that is a further total population decline of *50.8 million* within the span of 77 years (Figure 1.6).

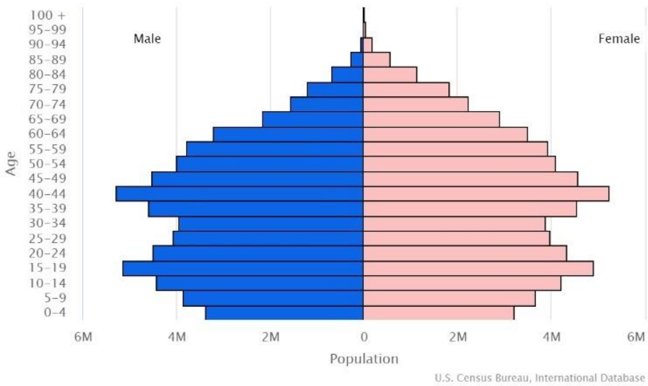

Figure 1.4. Population Pyramid, 1990

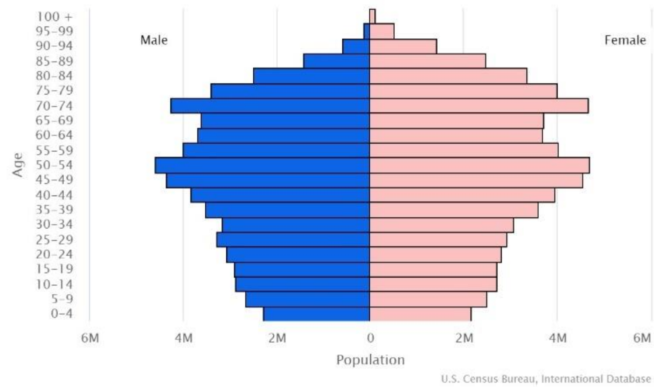

Figure 1.5. Population Pyramid, 2023

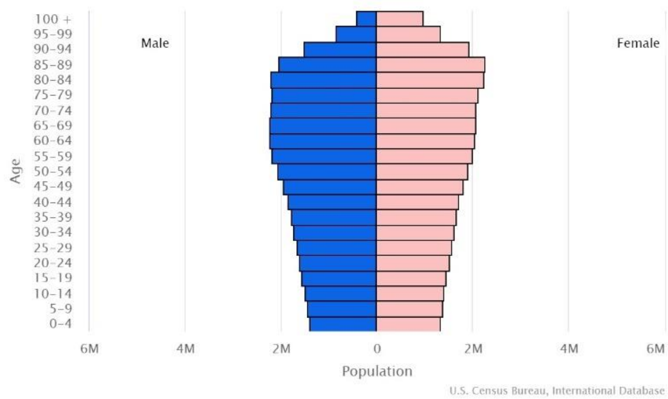

Figure 1.6. Population Pyramid, 2100

Those that have researched this topic while in Japan such as Alex Martin for the Japan Times, have the opinion that Japan is actually *overpopulated*, and its decline is therefore inevitable (Boyd and Martin, 2022). Before the population boom following industrialization in the Meiji era, Japan's population was approximately 35 million people (Tachi, 1960). During the Meiji restoration (1868-1889) in which Japan underwent a modernization process, birth rates stayed relatively the same, however mortality rates declined in light of increased treatment of tuberculosis (Tachi, 1960). The population declined during World War II yet exploded in the post-war period with two baby booms between 1947 and 1949, and in 1971 to 1974. Notwithstanding, in 1974, the TFR dropped below 2.1 and the population growth rate began to fall but was still at a positive 1.3 (Figure 1.7). Now, Japan's population finds itself in a period of annual negative growth rates since 2010. According to those of the opinion that Japan is in an era of overpopulation, it could be said that Japan entered a "population bubble," and that it is now returning to a stable population.

Figure 1.7. Population Growth for Japan

Consequences Currently Affecting Japan

Japan's infrastructure is currently sustainable only for a larger population, and already the current infrastructure is no longer maintainable as the population continues to shrink. Currently, empty villages and abandoned homes are scattered across the country. In the internal affairs ministry's Housing and Land survey of 2018, 8.49 million homes were empty, accounting for 13.6 percent of the housing market (Takaya et al, 2023). The abandoned share of the housing market is expected to rapidly grow after 2025 once the baby boomer generation, who happens to have a high home-ownership rate, is 75 years or older. Not only are homes being affected, but there are cases of many shuttered local shopping malls, with not enough people in the area to take over the businesses (Boyd and Martin, 2022). Moreover, as infrastructure begins to fall apart, the distance between humans and animal habitats begins to collapse into one another. There have been bear encounters in Hokkaido along with deer, monkeys, and wild boars making appearances everywhere throughout civilized parts of Japan.

Public transportation, local public finance, and the healthcare system are already suffering. Recently, JR West (a transportation line) released its expenses to the public, and all were in the red. Maintaining rail lines is increasingly becoming more difficult as less people pay for transportation. The same situation applies to local public finance in which there are fewer people funding local government. Additionally, the healthcare system is under pressure to support a heavily aging population.

One of the main concerns of Japanese parliament is the increasing dependency of those aged 65+ on the working age population for the pension system. In 2020, the age dependency ratio, defined as the ratio of dependents to the working age population, for Japan was 50.9 and the United States' ratio was 25.6. (Figure 1.8). Part of each worker's earnings go towards the pension system, similar to Social Security in the United States, in which retirees can pull from and rely on for their living expenses as they go into dissaving (Coulmas, 2007). The demographic transition in Japan into an older population has caused much friction between the older generation and the working generation. In surveys conducted by the Japan Broadcasting System (NHK) in 2003, it was found that the younger generation had expressed feelings of unfairness toward the fact that current retirees get to live in almost "luxury" off their hard-earned money (Coulmas, 2007). In contrast, the current working generation will ultimately have less money in the pension system to live off due to the future smaller labor force. Not only would the pension system be in danger of less funds, but the government will be faced with declining revenues and would need to find a way to increase funds through higher tax rates in order to maintain existing infrastructure (Coleman & Rowthorn, 2011).

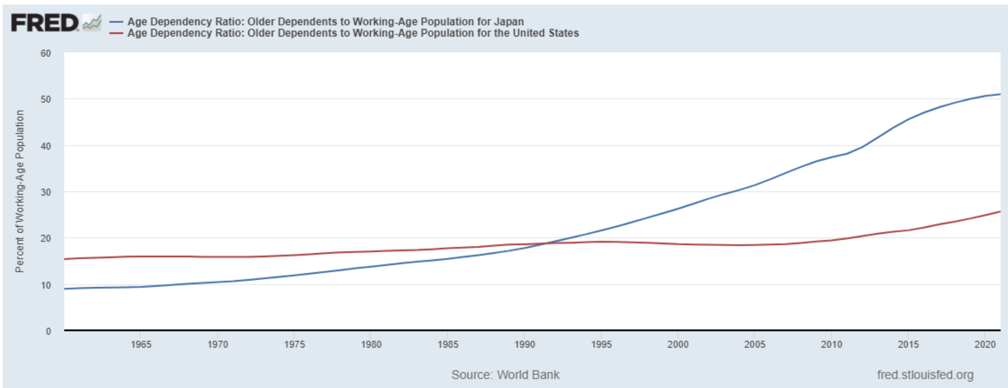

Figure 1.8. Age Dependency Ratio for Japan and the United States, 1960 to 2020

The Total Fertility Rate (TFR)

Japan, 1965: the fertility rate, which is the expected number of children a woman will give birth to in her lifetime, was at a replacement rate of 2.1 children per woman. In 1966, there was a drastic decrease to 1.6 children per woman followed by a bounce back to a flourishing 2.2 children per woman in 1967 (Figure 1.9). Anyone who may be curious as to the reason behind the seemingly random half-percentage point decrease in fertility rate in 1966 should know that this event is certainly not random, nor is it a coincidence, rather it is due to the “curse of the fire-horse.”

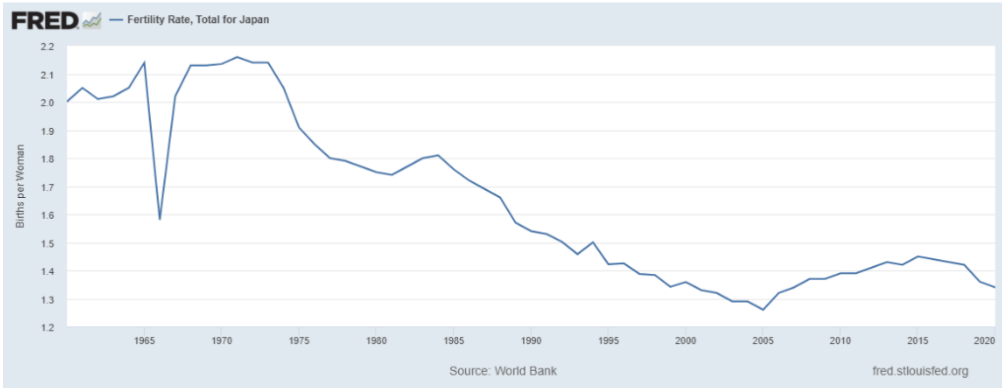

Figure 1.9. Total Fertility rate in Japan, 1960 to 2020

In Chinese astrology, people born in the year 1966 are said to be born in the year of the "Hinoe-Uma (fire-horse)," which occurs every 60 years (Suzuki and Kashiwase, 2019). In Japan, however, women specifically who are born in the year of the fire-horse are said to be particularly head-strong. Be aware, however, that this head-strongness could very well lead the woman to having a bad personality and killing her husband—according to Japanese superstition.

Although a superstition, Japanese parents believed this would affect their children's future prospects in the "marriage market" (Suzuki and Kashiwase, 2019). Approximately half of marriages in the 1960s were arranged, therefore anxious superstitious parents were plentiful. In addition, superstitions seemed more popular in rural areas rather than urban areas, so fertility rate declines observed in urban areas were less so than rural areas. In addition to seeing changes in fertility, shifts in contraceptive prevalence can be observed. There was a jump in contraceptive prevalence from 45% of married women 15-49 years old in 1963 to 56% of married women in 1965 before decreasing to 53% in 1967 (World Bank). This could also indicate that women were preventing pregnancy via increasing intake of contraceptives in fear of conceiving a fire-horse child.

The fire-horse is coming up again in 2026. Whether this superstition will impact Japan in a “macro-population scale” the same way it did in 1966 is remained to be seen (Olson, 2016). Currently, the fertility rate of Japan sits at 1.3 births per woman, so any shocks on fertility rate outside of the current decline could cause a great catastrophe. However, arranged marriages are less popular today, with arranged marriages making up only 5% of all marriages in 2010 (Suzuki and Kashiwase, 2019). With more couples marrying for love more than ever, the supposed curse of the fire-horse may not affect the fertility rate as some may be led to believe.

The Japanese government has been worrying at large over the falling fertility rates for decades now, and just recently, the prime minister made a foreboding statement declaring that Japan is “on the brink of not being able to function as a society” due to this issue (Wright, 2023). Now, it is not just a brief phenomenon occurring due to superstition, but it is a long-winded, persistent problem regarding the population due to other factors that the government has been unable to pin down, as previous efforts have not done much to stave off the falling birth rates.

To aid the Japanese government in targeting the areas which impact TFR the most, the goal of this paper is to find how certain social and economic factors impact the fertility rates in Japan. Findings from this paper could lead to further conversations and possible public policy changes to help decrease the impact of this problem.

II. LITERATURE REVIEW

Population Decline and Ageing

Research on the issue of population decline is plentiful. According to Coleman and Rowthorn (2011), population decline arises from the combination of low birth rates, high death rates, and net migration, but in the "modern world," low birth rates are key. They argue that population ageing and population decline do not cause one another, but they occur in parallel with each other with birth rates as the common denominator. Even more substantial, the continuation of "sub-replacement fertility" for many years without migration makes the population older for approximately two generations before the population structure returns to a "new, older but stable age-distribution" (Coleman & Rowthorn, 2011). However, left unchecked the population size would continue downward at an eventually constant rate, heading toward "extinction." Japan fits this description because, at the moment, Japan barely experiences positive net migration when compared to European countries, which heavily rely on immigration to keep population growing. For example, as depicted in Figure 2.1, the United Kingdom received approximately 1.3 million immigrants in 2017 even though its population is half the size of Japan's, as opposed to Japan only receiving 357,800. Japan also falls into the category of high number of deaths with decreasing numbers of births; Japan recorded 811,604 births and approximately 1.8 million deaths in 2021 (Parker, 2022). These factors together push population ageing and population decline to be more rapid.

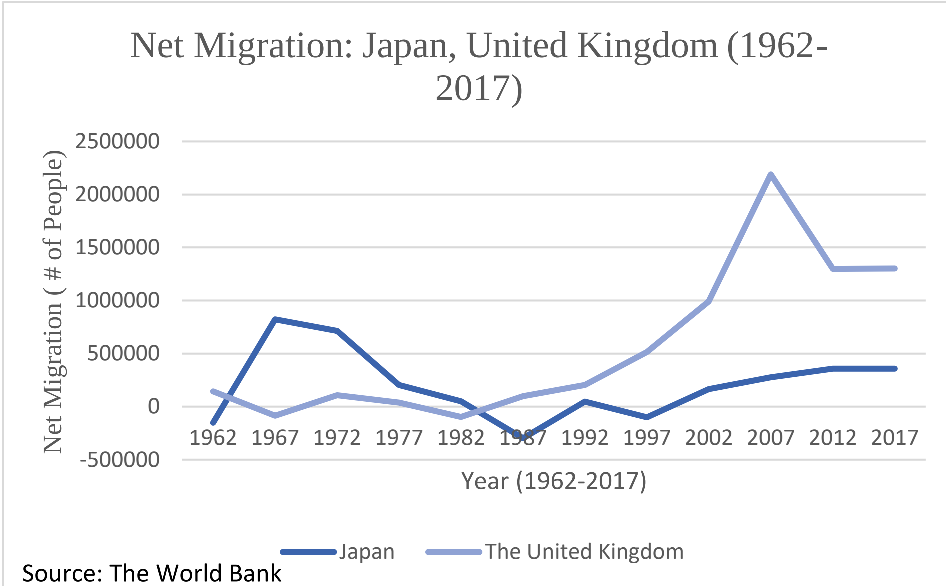

Figure 2.1. Net migration in Japan vs. the United Kingdom

Furthermore, by using an Overlapping Generations Model (OG Model), Muto et al. (2016) analyzed the economic consequences of demographic transitions and fiscal policy in Japan. The OG Model in this study created time paths that showcased how GNP would be affected over time. Ultimately, it was found that low fertility rates contribute to the slowdown of Japan's Gross National Product (GNP) growth in three ways. First, it reduces the labor population. Second, increased number of retirees in the population will "aggravate the social security burden on labor income." This will in effect distort workers' labor supply and saving decisions as the age dependency ratio increases. Lastly, since retirees have higher marginal propensity to consume than workers, the low fertility rate ultimately increases the proportion of dis-savers in households, negatively impacts the national savings rate, and prevents capital accumulation (Muto, Oda, & Sudo, 2016). The first- and third-ways impact GNP decline through reduction in the labor force and savers. The second way, however, impacts GNP decline by affecting average working hours and the workers' saving rate.

The first way (reduction of labor population) is majorly problematic for Japan because Japan's pension system relies heavily on the current workforce. In this program part of each worker's earnings go towards the pension system in which retirees can pull from and rely on for their living expenses as they go into dissaving (Coulmas, 2007). Coulmas (2007) showcased in his book about the demographic transition in Japan that this has caused much friction between the older generation and the working generation. In surveys conducted by the Japan Broadcasting System (NHK) in 2003, it was found that the younger generation had expressed feelings of unfairness toward the fact that current retirees get to live in almost "luxury" off their hard-earned money (Coulmas, 2007). In contrast, the current working generation will ultimately have less money in the pension system to live off due to the future smaller labor force. Not only would the pension system be in danger of less funds, but the government will be faced with declining revenues and would need to find a way to increase funds through higher tax rates in order to maintain existing infrastructure (Coleman & Rowthorn, 2011). Moreover, lower tax revenues will allow for government debt to accumulate over time (Muto, Oda, & Sudo, 2016).

Insofar, it seems that the real danger of population decline and population ageing stems from the cause behind both— declining fertility rates. As experts have pointed out, fertility rates are one of the main causes behind highly consequential issues, this is indicative in the importance of finding how certain factors impact TFR.

Impacts on Fertility

Female Education and Marriage

According to Shirahase (2000), educational background is important with regard to reaching the life stage of marriage in Japan. This author investigates the relationship between the decline in fertility rates and the educational background of women through the lens of social stratification. The author stresses, while finding a negative correlation between higher education and fertility rate as the dependent variable, that higher education's impact on TFR is not as significant as age is on fertility rate. Shirahase (2000) also argues that, within Japan, the "systematically and hierarchically ordered timetable based on age" weakens the socioeconomic factors impacting fertility rates, i.e., educational background and occupation. Furthermore, the lack in flexibility in such a timetable results in choices over contradictory options a woman must make, which discourages her from wanting children in the future (e.g. whether to marry or not, whether to continue to work or stop, or whether to give birth to a child or not). The author also noted that the more women's choices regarding marriage and childbirth are bound to a specific timetable, the more young women will distance themselves from the idea of marriage. In Japan, babies are rarely born out of wedlock, therefore marriage was identified as a "precondition" for deciding to have children (Shirahase, 2000).

Social Welfare

In a paper that compared France (currently with 1.85 TFR) with Japan (1.36 TFR), Boling (2008) reviewed policies aimed at reducing difficulty of child rearing and observed how similarities or differences might have accounted for the fertility rates of both countries. When compared with France, the ease at which child-care facilities operate differs. For example, Japan's kindergartens are partially paid by government and user fees, and it is only part-day (Boling, 2008). However, France's kindergartens operate on a full day and are fully funded by the public school system. As for family allowances, in 2004, from birth to age 3, families receive 10,000 yen (61 euros) per child in Japan a month compared to 121 euros in France (for two children, then an additional 155 euros per child until the age of 20). Boling (2008) notes that, although Japan's policies toward easing child-raising burdens on working mothers have expanded and improved over time, the impact on TFR has been small. This suggests that there are more impacts on total fertility rate other than child-care services.

According to Lee and Lee (2014), the failure of childcare centers to mitigate the conflict between women's work and child raising duties has discouraged women from having more children. The purpose of this work was to examine the relationship between childcare availability, female labor force participation rate, and the fertility rate in Japan for the time frame 1971-2009. In a Granger causality analysis, the empirical results informed that the availability of childcare affects the child-bearing decision of females aged 20-29 years old in the long run, however the availability of childcare does not have a short run Granger causal effect on the childbearing decisions.

III. METHODOLOGY

The Data

This study differs from others in that it broadens the scope of impacts on TFR, uses more current data and thus studies a more current generation of Japanese culture. This study pulls data from the years 2010 and 2015 from the Population Census taken every five years, The Vital Statistics Survey of Japan, and the System of Social and Demographic Statistics. Given that the data is derived from government-sourced statistics, the data is highly trustworthy. The datasets were clean and there were no missing data points. However, because the Japanese government does not conduct the Population Census annually and because data for the surveys mentioned are not updated, the years 2010 and 2015 were the most current years in which data was most easily obtainable. Once current data is released, then it would be beneficial to conduct a more relevant study that might show even larger impacts on TFR. Nonetheless, as of 2015, both the variables that are theorized to have an impact on TFR and TFR as the dependent variable are listed in the table below (Figure 3.1).

Dependent Variable	
Fertility	Total fertility rates (TFR) by each prefecture Data source: The Vital Statistics Survey of Japan, e-stat

Independent Variables	
Marriage	Marriage rates per 1000 population in Japan by prefecture Data source: The Vital Statistics Survey of Japan, e-stat
Pct65	Percentage of households with members 65 years or older by prefecture Data source: System of Social and Demographic Statistics, [Population and Households], e-stat
LFPF	Labor force participation rate of females by prefecture Data source: System of Social and Demographic Statistics, [Labor], e-stat
logPT	Number of female part time workers by prefecture, w/ log taken Data source: System of Social and Demographic Statistics, [Labor], e-stat
ChildWelfareExp	Percentage of welfare expenditure for children by prefecture Data source: System of Social and Demographic Statistics, [Administrative base], e-stat
logIncomePerPerson	Prefectural income per person with 2005 base (thousand yen) by prefecture, w/ log taken Data source: System of Social and Demographic Statistics, [Economic base], e-stat
Social Welfare Exp	Percentage of social welfare expenditure by prefecture Data source: System of Social and Demographic Statistics, [Administrative base], e-stat

Figure 3.1. Description of all variables in this study

Empirical Models

Four models are employed in this research project: Model 1 is a random effects panel regression and model 2 is an Ordinary Least Squares regression, both regressing Marriage Rate (marriage), Labor Force Participation Rate of Females (LFPF), the log of the Number of Female Part Time Workers (lnPT), Percent Expenditure on Child Welfare (ChildWelfareExp), the log of Income Per Person (lnIncomePerPerson), and Percent Expenditure on Social Welfare (SocialWelfareExp) on TFR (Fertility). Models 3 and 4 are almost exact copies of models 1 and 2, respectively, however marriage is replaced by Percentage of Households with members 65 years and older (Pct65).

Model 1. Random Effects Panel Regression w/Marriage

$$Fertility_{it} = \beta_0 + \beta_1 Marriage_{it} + \beta_2 LFPF_{it} + \beta_3 \ln{(PT)}_{it} + \beta_4 ChildWelfareExp_{it} + \beta_5 \ln{(IncomePerPerson)}_{it} + \beta_6 SocialWelfareExp_{it} + w_{it}$$

Model 2. OLS Method w/ Marriage

$$Fertility_{i} = \beta_0 + \beta_1 Marriage_{i} + \beta_2 LFPF_{i} + \beta_3 \ln{(PT)}_{i} + \beta_4 ChildWelfareExp_{i} + \beta_5 \ln{(IncomePerPerson)}_{i} + \beta_6 SocialWelfareExp_{i} + u_{i}$$

Model 3. Random Effects Panel Regression w/ Pct65

$$Fertility_{it} = \beta_0 + \beta_1 Pct65_{it} + \beta_2 LFPF_{it} + \beta_3 \ln{(PT)}_{it} + \beta_4 ChildWelfareExp_{it} + \beta_5 \ln{(IncomePerPerson)}_{it} + \beta_6 SocialWelfareExp_{it} + w_{it}$$

Model 4. OLS Method w/ Pct65

$$Fertility_{i} = \beta_0 + \beta_1 Pct65_{i} + \beta_2 LFPF_{i} + \beta_3 \ln{(PT)}_{i} + \beta_4 ChildWelfareExp_{i} + \beta_5 \ln{(IncomePerPerson)}_{i} + \beta_6 SocialWelfareExp_{i} + u_{i}$$

In both panel regressions, *i* represents the prefectures in Japan, in which there are 94 in this sample collected over the span of t=2 years, 2010 and 2015. The β_0 term is the intercept of the model. Time-invariant effects across each prefecture could impact the results, but rather than using a fixed effects model in which degrees of freedom would be exorbitantly taken, the model was more useful as a random effects model with more degrees of freedom remaining. The General Least Squares (GLS) method was employed to take care of any heteroskedastic variance within the model. The term $w_{it} = u_i + \varepsilon_i$, combines the random effects of the model in which ε_i is the disturbance term of each prefecture which happens randomly over time, and u_i is the random error term of each prefecture. To account for possible fixed effects of time in the years 2010 and 2015, the Ordinary Least Squares (OLS) method was applied for both years (model 3 & model 4).

Because variables capturing both marriage and ageing population are important in this research, two separate models were created in order to avoid perfect multicollinearity. The Variance Inflation Factor (VIF) showed that Marriage rates and percentage of households with members 65 years or older (Pct65) had high multicollinearity.[*] The same is true for the linear regression models, hence there being two more models using OLS method.

Logs were taken of part time workers (PT) and income per person in order to scale them down so that the results would not be skewed by the unbalanced equation. In the case of this data set, fertility rate only ranges from 1.12 to 1.96, therefore numbers too large would impact the results greatly.

[*] Econometric tests can be found in Appendix B

Hypotheses

Building upon previous literature on TFR and population decline and ageing, the independent variables shown in Figure 3.2 are hypothesized to have differing impacts, positive or negative, on TFR.

Independent Variable	Expected Impact on TFR
Marriage Rate	Positive (+)
% of Households with Members Aged 65 years or older	Negative (-)
Labor Force Participation Rate, Female	Negative (-)
Part Time Workers, Female	Negative (-)
Child Welfare Expenditure	Positive (+)
Income Per Person	Negative (-)
Social Welfare Expenditure	Positive (+)

Figure 3.2. Expected signs of regression output

Holding all else constant, the marriage rate in each prefecture should have a positive impact on fertility. In Japanese society, it is especially rare to have children out of wedlock. In comparison to most OECD countries, Japan's proportion of births out of wedlock is much smaller (Figure 3.3). In 2020, for example, the OECD average for proportion of babies born out of wedlock was 42% versus Japan's proportion being around 2-3% (OECD family database, 2020). Given these findings, in Japan specifically, marriage is an important factor in the decision-making process behind births. In addition, Shirahase (2000) made it clear that marriage is a prerequisite if one wishes to have children in the future. Therefore, an increase in marriage rate should lead to an increase in fertility rate and should hold true for each prefecture.

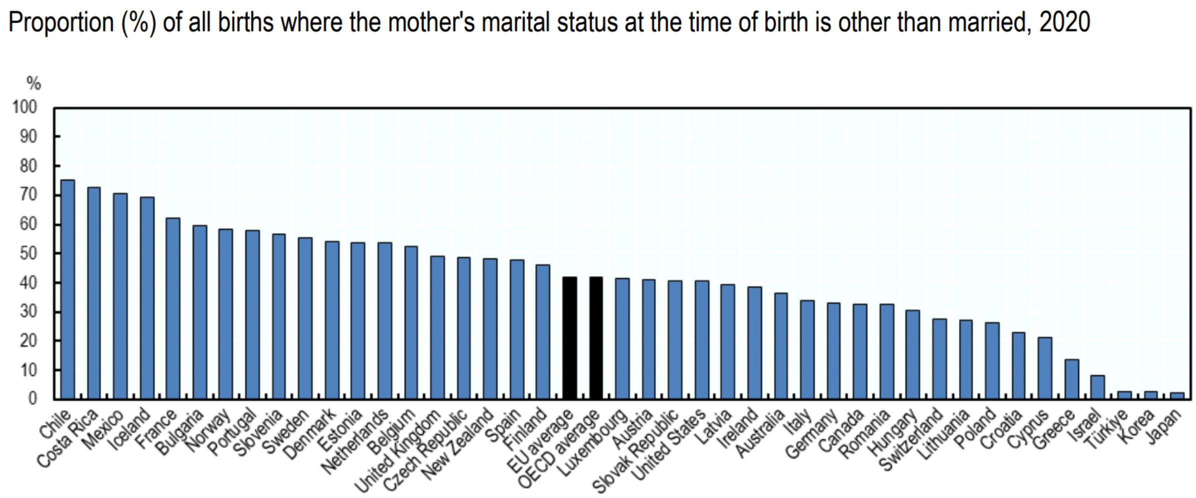

Figure 3.3. Share of births outside of marriage of OECD countries in 2020
Source: OECD Family Database

As Japan's ageing population continues to grow, working adults may be too burdened by financially supporting the social welfare of those aged 65 years or older. This could be seen in a number of ways, however one of the most common would be rising taxes on the working class Not only that, but the pressures of younger family members taking care of their elders in households can be too consuming and may weigh negatively on fertility decisions. In Japanese society, the elderly is treated with utmost respect as thanks for raising their children, which takes roots in Confucianism. Unlike in western families from countries such as the United States where it can be normal for the elderly to be put in care centers, Japanese families normally take care of their elderly at home. However, this can come at a cost to the caregivers, as caring for the aged can deplete financial resources or time, leading to less resources and/or time for any potential children (Oi, 2015). Therefore, an increase in households with members aged 65 years or older should have a negative impact on fertility rates.

As women enter the workforce and become financially independent, this could delay their decision to get married. As observed in the United States, when more women entered the labor force throughout the latter 20th century through the millennial generation, women increasingly decided they would rather continue to achieve goals in their career or find financial stability through higher salaries (Stahl, 2020). It is expected that this kind of attitude towards childrearing could be applied to Japanese women as the female labor force participation rate increases. In addition to career goals and the need for higher salaries, in Japan specifically many societal pressures are placed on mothers. As a society that is usually seen as a collective, there are many social "rules" that mothers feel pressured to follow, and the shame or judging culture surrounding this results in guilt if they are seen not to be doing a good enough job. A mother can be seen as a bad example by those around her if she hires a babysitter, takes time off from her workplace to care for her child, or if she would like to spend time on herself (Boling, 2008). Women might prefer to forgo childbirth in hopes they escape those pressures while saving their money at the same time, therefore it is hypothesized that TFR should be impacted negatively by more women entering the labor force.

Many women in Japan are involved in part-time work, with 631,000 female part-time workers in Tokyo prefecture in 2015, an increase of approximately 175,000 since 2010. In 2020, 52 percent of total employed females were in part-time work (Figure 3.4). In the case of "part-time work" in Japan, the working hours can be similar to a full-time work week, 40 hours a week, but with less pay (Boling, 2008). Moreover, married women are not encouraged to have full-time jobs especially due to the tax credit system, which rewards families if the wife does not make above ¥1.3 million. This policy continues to establish men as the main breadwinners in Japanese working society. Women involved in part-time work therefore cannot create as stable a living as those with full-time pay. It is thus suspected that an increase in part-time work will lead to a decrease in TFR due to less financial resources and time to raise children.

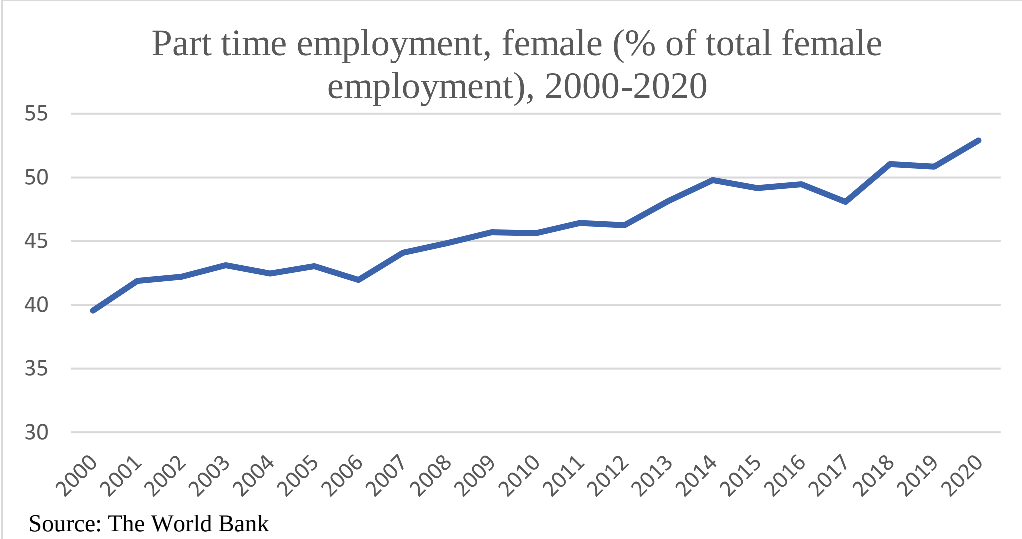

Figure 3.4. Part time employment as a percentage of total female employment

Patterns of lower fertility rates among higher income households continue to be observed in richer countries such as Japan. Due to various opportunity costs, higher costs in living, and greater expectations for a child's future, raising a child in richer countries becomes an expensive endeavor. It is therefore hypothesized that higher income per person should impact TFR negatively.

Both government expenditure on social and child welfare should have a positive impact on TFR. Although child welfare is specifically geared towards children whereas social expenditure is focused on all individuals, a broad, stable foundation may lead to an increase in TFR because those individuals have better access to the resources to have children. If fiscal policy surrounding child welfare is sufficient enough, then it will make it easier for women to have children in the future due to positively changing attitudes about the difficulties of childrearing.

While longitudinal data might be better suited to determine correlations of endogenous economic and social impacts on exogenous TFR, these statistics provided by the Japanese government are only collected on a cross-sectional basis. Suzuki (2013), in their analysis on declining fertility rates and population decline and ageing in East Asia, notes that conducting research using the Complete Fertility Rate (CFR) would be more beneficial than measuring TFR because the latter “suffers from tempo distortion and the parity composition effect.” An idea to consider for further research into this subject would be to collect longitudinal data to track the specific fertility decisions of women in the same cohort as TFR varies throughout time.

Variable	Overall (n=92)	2010 (n=47)	2015 (n=47)
Fertility Rate			
Mean	1.5	1.47	1.53
Min - Max	1.12 - 1.96	1.12 - 1.87	1.24 - 1.96
SD	0.134	0.133	0.131
Marriage Rate			
Mean	4.91	5.12	4.7
Min - Max	3.5 - 7.1	4.0 - 7.1	3.5 - 6.6
SD	0.591	0.584	0.531
Percentage of Households with Members 65 years or older			
Mean	43.1	41.5	44.8
Min - Max	28.8 - 55.8	28.8 - 53.1	30.9 - 55.8
SD	5.62	5.51	5.27
Number of Part Time Workers, Female			
Mean	108,859	97,913	119,805
Min - Max	14,410 - 631,000	14,410 - 455,870	15,780 - 631,000
SD	120,320.7	105,537.9	133,737.7
Labor Force Participation Rate, Female			
Mean	47.96	47.76	48.16
Min - Max	41.4 - 53.0	41.4 - 52.2	42.6 - 53.0
SD	2.36	2.3	2.43
Child Welfare Expenditure			
Mean	2.93	2.81	3.04
Min - Max	1.41 - 4.93	1.87 - 4.93	1.41 - 4.8
SD	0.645	0.573	0.697
Income Per Person (thousand yen)			
Mean	2,775	2,688	2,862
Min - Max	2,022 - 5,530	2,022 - 4,453	2,191 - 5,530
SD	454.9	387.7	502.7
Social Welfare Expenditure			
Mean	4.31	3.94	4.68
Min - Max	2.25 -7.37	2.7 - 5.54	2.25 - 7.37
SD	0.923	0.682	0.988

Figure 3.5. Descriptive statistics of all variables in data set studied in this research

IV. RESULTS

Models 1 & 2*

Using the 95% confidence interval, the regression outputs of model 1 and model 2 indicate that income per person has the largest impact on TFR (p-value<0.01). In the random effects panel regression model, a percentage increase of a person's income impacts TFR negatively by 0.43 percentage points. This suggests that a person takes their income into a large part of their consideration when deciding to have children in Japan. The results are both large and significant in model 2 as well, with income per person having a larger negative effect by approximately half a percentage point in 2010 (-0.528, p-value<0.01). By the end of 2010, Japan's economy had in fact shrunk, with GDP shrinking by 1.1 percent, and Japan had just lost its position to China as the fastest growing economy in the world (Kajimoto and Kihara, 2011). Moreover, not too far off from the 2008 recession, Japan's economy had not fully recovered by this point. Between 2010 and 2015, the median income per person by prefecture increased by 180,000 Yen, equal to approximately 1,345 USD in today's currency. Tokyo prefecture, the wealthiest prefecture in both years, experienced an increase of almost one million Yen, 7,472 in USD. Lower income per person in 2010 could justify a negative impact on fertility as households had less financial resources to have the desire for children.

Marriage rate also had a large, significant, positive impact on TFR across both models (p-value<0.01). In the panel regression incorporating both 2010 and 2015, an increase in marriage rate of 1 percentage point would have had a positive effect on TFR by 0.115 percentage points. In model 2 however, both years separately showed an increased effect on TFR, with marriage

* Results are in Appendix A

rate impacting TFR slightly more than 2010 by around 0.13 percent. These results show that marriage before having children in Japan becomes an important factor in a household's fertility decisions. However, one might think that an even larger impact on fertility decisions would be observed due to the low number of babies born out of wedlock in Japan as shown by the OECD chart in Figure 3.3. Although, delays in the average marriage age could also impact these results. Marriage rates decreased overall between 2010 and 2015, the median declining from 5.0 to 4.7. Though marriage rates still have a large impact on fertility decisions as shown by both model outputs, it might not be as large an impact as marriage rates continue to decline throughout Japan.

Contrary to what was hypothesized, the female labor force participation rate had a positive rather than negative, highly significant impact on TFR (p-value<0.01). Although not necessarily as large an impact as marriage rate and income per person, it is worth noting that the values of the coefficients in both 2010 and 2015 are equivalent (0.022). The LFPF is notoriously lower than labor force participation rate for males, with only a median 47.9 percent of females being in the labor force compared to a median 69.5 percent of males in the labor force (model 1). These results may indicate that this considerable gap in labor force participation between males and females across Japan leads to increased TFR as more women enter the labor force. There could also be cultural and social factors in the workplace that are unaccounted for. In Japan, it is apparent that many women leave the workforce after they get married or have children because of pressures described in the previous section, and this negative relationship between work and child/marriage life only occurs after women leave the workforce. During their time in the labor force, women, specifically those in higher paid jobs at larger firms, may get married and/or have children, but then exit due to their individual reasons having to do with poor fit between their jobs and homelife (Gunn, 2016). Large impacts may not be captured in these models due to this aspect of work culture in Japan. Moreover, there may be underlying cultural factors that impact these results and can be researched further in a future study.

As expected, a percentage increase in the number of female part time workers leads to a decrease in TFR by 0.067 percentage points in model 1 (p-value<0.01). There is no large difference in the coefficient results between model 1 and model 2 except only slightly more of a negative impact on TFR by 0.072 in 2010. This coincides with the hypothesis that women restricted to part time work may choose not to have children. The Economic Base section of the System of Social and Demographics Statistics in Japan show that most hourly part time wages for women in 2010 and 2015 were almost minimum wage, with some being below minimum wage, according to Federal standards in the U.S., with a median 945 Yen overall, 1036 Yen today, which is 7.74 USD in real terms. Such wages may not provide sustainable living for both a woman and her child, thus women engaged in part time work may postpone childrearing and/or marriage either by choice or because they have limited time and resources.

Surprisingly, neither government expenditure on child welfare nor social welfare showed significant impacts on TFR in either model, thus the null hypothesis was not rejected (p-value>0.1). It was hypothesized that sufficient government spending on welfare could stimulate a positive impact on TFR, especially due to improved stability for households that would not have children otherwise. These results could indicate that government spending on welfare have been insufficient to the point that it is ineffective in increasing TFR rather than showing negative or positive effects.

Models 3 & 4

The magnitudes and signs of the coefficients in the results of models 3 and 4 are very similar to the results for models 1 and 2. Regardless, the main variable of interest in models 3 and 4 is the percentage of households with members aged 65 and above (Pct65). Coinciding with the hypothesis, a percentage increase in Pct65 impacts negatively the TFR, however the magnitude and significance differs across both models and years. By 2015, it seems the effects of population ageing on TFR became increasingly significant (p-value<0.01). These results indicate that households' fertility decisions are now being impacted by the ageing population directly. As the aged population continues to outnumber those younger than 65 years, the strain on the caregivers, who are usually the family members in these situations, may force them to delay marriage or childrearing due to already tight resources being spent on aged dependents. Although not yet a very large issue, a pattern seems to have emerged in which the impact on TFR could become greater as the ageing population grows.

V. CONCLUSION

The purpose of this research was to find how economic and social factors impact total fertility rate (TFR) in Japan in a time where population is declining at an alarming rate combined with an ageing population. Given that it is a current issue of importance in both Japan and the world, this type of research is imperative to policy making for both the Japanese government and other countries that struggle with similar circumstances. Japan is not the only country that is beginning to suffer the consequences of declining fertility rates. Although Japan has cultural issues very specific to its decline in TFR, factors such as income are universal. As shown by the results, a higher income has very large, negative impact on TFR. This can mean that higher salary jobs have some kind of risk factor in relation to childrearing. Working at those kinds of jobs that have very long work hours while having children may be too difficult as seen in the low labor force participation rates of women.

Dealing with the declining TFR can lead to positive changes in Japanese society for women. If the Japanese government implements effective policies enforcing better social welfare policies for mothers, fathers, and children, then perhaps the fertility rates will be positively impacted. However, many women feel the pressures of their own culture, and those pressures play into their life decisions surrounding work and home life. It must be said that both Japanese culture and Japanese government policy makers need to worth together in order to help raise TFR throughout the struggling prefectures of Japan. Although population decline may be inevitable, it may not end in such a horrifying way if Japan can figure a way to make having children easier, more affordable, or less risky by supporting women in the labor force.

The results found in the econometric modelling of this paper can be improved upon once updated data is published by the Japanese government. As culture tends to change throughout the changing generations, data showing recent trends in TFR and other factors measured in the population census could show patterns in today's Japanese culture and current policies that affect TFR. Generally, Japanese culture as become somewhat more relaxed in its traditional values surrounding marriage, work, and equality among marginalized groups, however it can be said that there is still room to grow in all facets. Working hours are still too long, there is a large gender gap in the workforce, and childcare policies do not make it easier for women to care for their children among a judgmental society. Although there is social progress, the progress is slow. This is why an entire decade of data to analyze could be greatly helpful in observing patterns and projecting a certain future, culturally and demographically, for Japan.

Lastly, a qualitative study could also be an impactful addition to this research in which specific reasons for low TFR can be brought out in surveys on happiness, attitudes about work, attitudes about marriage, etc. The more impacts on TFR are studied, the more likely it is that solutions to this serious issue can be found, and the more countries in danger of the same circumstances can be aided.

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%20and%20Communities.

APPENDIX

A. Results

	Dependent variable:		
	fertility		
	panel	*OLS*	
	linear	2010	2015
	(1)	(2)	(3)
Marriage	0.115***	0.137***	0.163***
	(0.027)	(0.043)	(0.038)
LFPF	0.022***	0.022***	0.022***
	(0.004)	(0.007)	(0.006)
logPT	-0.067***	-0.072**	-0.067**
	(0.019)	(0.028)	(0.025)
ChildWelfareExp	0.017	0.002	0.009
	(0.021)	(0.032)	(0.027)
logIncomePerPerson	-0.432***	-0.528***	-0.475***
	(0.088)	(0.138)	(0.116)
SocialWelfareExp	0.008	-0.008	0.001
	(0.017)	(0.029)	(0.021)
Constant	6.962***	8.352***	7.492***
	(1.199)	(1.893)	(1.556)
Observations	94	47	47
R^2	0.556	0.567	0.645
Adjusted R^2	0.525	0.501	0.591
Residual Std. Error (df = 40)		0.094	0.084
F Statistic (df = 6; 40)	108.892***	8.713***	12.094***
Note:			*p<0.1**p<0.05***p<0.01

Models 1 and 2 panel and OLS regression outputs with marriage rate. Outputs 2 and 3 are 2010 and 2015, respectively. In model 1, 55.6 percent of the variation in TFR across two years can be explained by the independent variables in this study, excluding Pct65. F>4.0 for all three outputs, therefore at least one independent variable in each model rejects the null hypothesis in which there is no significant impact on TFR. In the 2010 output, 56.7 percent of the variation in TFR can be explained by the independent variables, whereas in 2015, 64.5 percent of the variation in TFR can be explained by the independent variables. The independent variables are more useful to the OLS model in 2015 than in 2010 due to a larger Adjusted R-squared.

	Dependent variable:		
	fertility		
	panel	*OLS*	
	linear	2010	2015
	(1)	(2)	(3)
Pct65	-0.006*	-0.008	-0.013***
	(0.003)	(0.005)	(0.005)
LFPF	0.023***	0.024***	0.025***
	(0.005)	(0.008)	(0.007)
logPT	-0.049**	-0.043	-0.066**
	(0.021)	(0.029)	(0.029)
ChildWelfareExp	0.038*	0.027	0.028
	(0.022)	(0.035)	(0.030)
logIncomePerPerson	-0.342***	-0.436***	-0.363***
	(0.093)	(0.146)	(0.122)
SocialWelfareExp	0.003	-0.017	-0.007
	(0.018)	(0.033)	(0.024)
Constant	6.137***	7.558***	7.002***
	(1.306)	(2.135)	(1.742)
Observations	94	47	47
R^2	0.481	0.486	0.566
Adjusted R^2	0.446	0.409	0.501
Residual Std. Error (df = 40)		0.102	0.092
F Statistic (df = 6; 40)	80.740***	6.300***	8.692***
Note:	*p<0.01**p<0.05***p<0.01		

Models 3 and 4 panel and OLS regression outputs with percent of households with members 65 years and older. In model 1, 48.1 percent of the variation can be explained by the independent variables in this study, excluding marriage rate. F>4.0 for all three outputs, therefore at least one independent variable in each model rejects the null hypothesis in which there is no significant impact on TFR. In the 2010 output, 48.6 percent of the variation in TFR can be explained by the independent variables, whereas in 2015, 56.6 percent of the variation in TFR can be explained by the independent variables. The independent variables are more useful to the OLS model in 2015 than in 2010 due to a larger Adjusted R-squared.

B. Econometric Testing

Variance Inflation Factor (VIF) Test

```
> vif(model1)
         Marriage              LFPF             logPT    ChildWelfareExp logIncomePerPerson
         2.627021          1.252930          3.244478          2.011511           1.741979
  SocialWelfareExp
         2.485173
> vif(model2)
            Pct65              LFPF             logPT    ChildWelfareExp logIncomePerPerson
         2.891424          1.366467          3.255084          1.966968           1.632215
  SocialWelfareExp
         2.430233
> vif(model3a)
            Pct65              LFPF             logPT    ChildWelfareExp logIncomePerPerson
         3.775556          1.369647          3.030528          1.759264           1.672944
  SocialWelfareExp
         2.249469
> vif(model3b)
            Pct65              LFPF             logPT    ChildWelfareExp logIncomePerPerson
         3.429872          1.446109          3.625315          2.329771           1.760836
  SocialWelfareExp
         2.907904
> vif(model4a)
         Marriage              LFPF             logPT    ChildWelfareExp logIncomePerPerson
         3.374084          1.260783          3.318442          1.788015           1.763332
  SocialWelfareExp
         2.080879
> vif(model4b)
         Marriage              LFPF             logPT    ChildWelfareExp logIncomePerPerson
         2.731738          1.312785          3.328485          2.391725           1.947179
  SocialWelfareExp
         2.928590
```

Breusch-Godfrey test for serial correlation:

```
> bgtest(model1)

        Breusch-Godfrey test for serial correlation of order up to 1

data:  model1
LM test = 0.051565, df = 1, p-value = 0.8204

> bgtest(model2)

        Breusch-Godfrey test for serial correlation of order up to 1

data:  model2
LM test = 0.0020679, df = 1, p-value = 0.9637
```

Breusch-Pagan Test for Heteroskedasticity

```
        studentized Breusch-Pagan test

data:  model1
BP = 5.063, df = 6, p-value = 0.5358

> bptest(model2)

        studentized Breusch-Pagan test

data:  model2
BP = 9.5327, df = 6, p-value = 0.1458

> bptest(model3a)

        studentized Breusch-Pagan test

data:  model3a
BP = 5.6572, df = 6, p-value = 0.4627

> bptest(model3b)

        studentized Breusch-Pagan test

data:  model3b
BP = 5.067, df = 6, p-value = 0.5353

> bptest(model4a)

        studentized Breusch-Pagan test

data:  model4a
BP = 2.7958, df = 6, p-value = 0.834

> bptest(model4b)

        studentized Breusch-Pagan test

data:  model4b
BP = 2.1432, df = 6, p-value = 0.9061
```

C. Data

Year	*Prefecture*	*TFR*	*Marriage*	*LFPF*	*PT*	*Pct65*	*SocialWelfareExp*	*IncomePerPerson*	*ChildWelfareExp*
2010	Hokkaido	1.26	5.2	45.2	193,760	36.58	3.72	2,462	1.97
2010	Aomori-ken	1.38	4.3	48.3	33,650	45.75	3.81	2,322	3.05
2010	Iwate-ken	1.46	4.3	48.4	36,330	48.14	3.63	2,266	2.56
2010	Miyagi-ken	1.3	5.1	46.0	56,460	37.88	3.77	2,438	2.83
2010	Akita-ken	1.31	4	45.6	33,420	53.11	3.66	2,280	2.11
2010	Yamagata-ken	1.48	4.4	49.3	27,110	52.93	3.08	2,366	2.96
2010	Fukushima-ken	1.52	4.7	47.3	49,070	45.56	3.58	2,532	2.66
2010	Ibaraki-ken	1.44	5.1	47.6	78,320	40.11	4.18	2,979	3.18
2010	Tochigi-ken	1.44	5.4	49.3	98,010	39.12	3.91	3,055	3.31
2010	Gumma-ken	1.46	4.9	48.9	61,640	40.62	4.97	2,845	3.84
2010	Saitama-ken	1.32	5.5	47.8	299,590	34.30	5.06	2,818	3.73
2010	Chiba-ken	1.34	5.7	46.4	217,500	34.85	5.39	2,868	2.61
2010	Tokyo-to	1.12	7.1	46.0	455,870	28.79	4.08	4,453	3.25
2010	Kanagawa-ken	1.31	6.1	45.0	317,580	31.57	5.54	2,917	2.72
2010	Niigata-ken	1.43	4.7	49.1	85,360	47.59	2.86	2,608	1.87

2010	Toyama-ken	1.42	4.6	51.0	32,720	47.81	2.72	3,054	2.69
2010	Ishikawa-ken	1.44	5	52.1	46,920	40.25	4.31	2,783	2.78
2010	Fukui-ken	1.61	4.7	52.2	21,190	46.77	2.70	2,873	2.63
2010	Yamanashi-ken	1.46	5	48.8	29,200	42.67	3.45	2,787	2.51
2010	Nagano-ken	1.53	4.9	51.6	76,100	46.30	4.01	2,639	2.48
2010	Gifu-ken	1.48	4.9	50.0	74,740	44.39	3.84	2,650	2.60
2010	Shizuoka-ken	1.54	5.5	51.2	158,840	41.76	4.32	3,122	2.45
2010	Aichi-ken	1.52	6.2	50.0	280,600	33.85	4.40	3,117	2.70
2010	Mie-ken	1.51	5.2	48.4	66,220	41.41	4.24	2,955	3.23
2010	Shiga-ken	1.54	5.5	48.3	46,870	36.77	4.08	3,232	3.45
2010	Kyoto-fu	1.28	5.3	47.1	81,000	36.16	5.19	2,896	2.61
2010	Osaka-fu	1.33	5.9	43.9	356,060	35.19	3.93	2,913	2.19
2010	Hyogo-ken	1.41	5.4	44.3	211,230	38.23	4.13	2,734	2.30
2010	Nara-ken	1.29	4.7	41.4	47,130	41.82	4.10	2,489	3.21
2010	Wakayama-ken	1.47	4.8	44.8	28,740	46.10	4.39	2,631	2.25
2010	Tottori-ken	1.54	4.8	51.1	14,410	46.84	3.36	2,259	3.40
2010	Shimane-ken	1.68	4.6	49.1	18,550	50.45	2.90	2,292	2.18
2010	Okayama-ken	1.5	5.1	47.4	57,800	41.24	3.60	2,613	2.24
2010	Hiroshima-ken	1.55	5.4	47.5	114,470	37.45	4.03	2,893	3.16

2010	Yamaguchi-ken	1.56	4.8	45.3	59,060	44.23	3.66	2,854	2.12
2010	Tokushima-ken	1.42	4.6	45.6	18,730	44.32	2.95	2,758	2.45
2010	Kagawa-ken	1.57	5	47.9	28,580	41.69	4.12	2,721	2.46
2010	Ehime-ken	1.5	4.9	46.1	53,520	41.90	3.97	2,492	2.34
2010	Kochi-ken	1.42	4.4	46.7	14,470	44.37	3.59	2,307	2.67
2010	Fukuoka-ken	1.44	5.8	46.4	309,400	35.23	4.67	2,741	3.58
2010	Saga-ken	1.61	5	50.5	28,840	45.46	3.53	2,480	3.46
2010	Nagasaki-ken	1.61	4.7	46.5	53,540	42.86	3.98	2,346	2.74
2010	Kumamoto-ken	1.62	5	48.5	65,270	43.08	3.85	2,338	3.31
2010	Oita-ken	1.56	5.1	46.8	31,340	42.42	3.90	2,533	2.67
2010	Miyazaki-ken	1.68	5.2	49.6	37,560	41.00	2.76	2,226	2.57
2010	Kagoshima-ken	1.62	5.1	47.1	54,840	40.48	4.17	2,398	3.20
2010	Okinawa-ken	1.87	6.4	47.3	40,290	30.59	5.14	2,022	4.93
2015	Hokkaido	1.31	4.8	44.6	265,250	40.98	4.87	2,608	2.05
2015	Aomori-ken	1.43	4.2	48.6	46,840	49.68	4.73	2,536	3.36
2015	Iwate-ken	1.49	4.1	49.6	46,490	50.10	2.71	2,666	1.78
2015	Miyagi-ken	1.36	4.9	46.6	77,240	40.35	3.15	2,915	2.53
2015	Akita-ken	1.35	3.5	46.2	35,070	55.82	4.32	2,490	2.35

2015	Yamagata-ken	1.48	4	50.6	31,310	54.66	3.61	2,625	3.21
2015	Fukushima-ken	1.58	4.7	48.0	62,800	47.91	2.25	2,830	1.41
2015	Ibaraki-ken	1.48	4.7	48.1	104,030	43.99	5.40	3,072	3.31
2015	Tochigi-ken	1.49	4.9	49.0	82,060	43.34	4.72	3,361	3.86
2015	Gumma-ken	1.49	4.6	49.8	71,210	44.45	4.80	3,144	4.18
2015	Saitama-ken	1.39	4.9	47.8	344,930	39.09	6.66	2,938	3.76
2015	Chiba-ken	1.38	4.9	46.5	288,000	39.47	5.69	2,974	3.16
2015	Tokyo-to	1.24	6.6	44.3	631,000	30.85	5.32	5,530	3.54
2015	Kanagawa-ken	1.39	5.4	44.9	405,090	35.58	7.37	3,109	3.94
2015	Niigata-ken	1.44	4.1	49.8	106,340	50.80	3.58	2,768	1.94
2015	Toyama-ken	1.51	4.3	51.4	42,980	51.46	3.54	3,231	2.57
2015	Ishikawa-ken	1.54	4.5	51.8	52,650	43.94	4.37	2,870	2.80
2015	Fukui-ken	1.63	4.5	53.0	38,670	50.06	3.71	3,202	2.75
2015	Yamanashi-ken	1.51	4.7	50.0	35,510	46.12	3.79	2,807	2.37
2015	Nagano-ken	1.58	4.6	52.1	71,630	49.10	4.83	2,851	2.37
2015	Gifu-ken	1.56	4.4	50.9	96,770	48.09	4.91	2,737	2.49
2015	Shizuoka-ken	1.54	4.9	51.2	159,890	45.78	4.99	3,299	2.91
2015	Aichi-ken	1.57	5.6	49.7	419,350	37.35	5.72	3,702	3.26

2015	Mie-ken	1.56	4.8	48.7	103,050	44.41	5.11	2,944	3.34
2015	Shiga-ken	1.61	4.9	49.1	62,240	40.41	4.72	3,105	3.49
2015	Kyoto-fu	1.35	4.9	46.9	107,500	40.07	5.75	2,900	3.20
2015	Osaka-fu	1.39	5.4	43.7	407,900	39.10	6.13	3,076	3.37
2015	Hyogo-ken	1.48	4.8	44.4	276,030	42.16	5.66	2,852	3.18
2015	Nara-ken	1.38	4.2	42.6	53,850	46.73	4.85	2,484	2.96
2015	Wakayama-ken	1.54	4.5	46.0	34,510	49.50	4.53	2,754	2.64
2015	Tottori-ken	1.65	4.7	51.2	15,780	49.22	4.57	2,334	3.56
2015	Shimane-ken	1.78	4.3	50.5	24,910	52.12	3.40	2,592	2.29
2015	Okayama-ken	1.54	4.9	48.3	69,170	44.01	4.33	2,756	2.56
2015	Hiroshima-ken	1.6	4.9	47.7	122,380	41.13	5.35	3,044	3.37
2015	Yamaguchi-ken	1.6	4.2	45.5	68,740	47.68	4.13	2,855	2.61
2015	Tokushima-ken	1.53	4.3	46.6	22,130	47.54	3.28	2,988	2.44
2015	Kagawa-ken	1.63	4.8	47.8	40,070	45.38	4.58	2,911	2.89
2015	Ehime-ken	1.53	4.4	47.2	48,780	45.50	4.85	2,520	2.55
2015	Kochi-ken	1.51	4.2	46.6	22,290	48.08	4.20	2,520	2.83
2015	Fukuoka-ken	1.52	5.5	46.2	250,210	38.55	4.62	2,760	4.76
2015	Saga-ken	1.64	4.5	51.6	35,080	48.00	4.83	2,539	3.21
2015	Nagasaki-ken	1.67	4.5	47.7	54,500	46.34	5.55	2,428	3.51

2015	Kumamoto-ken	1.68	4.6	49.2	87,660	45.74	4.97	2,424	3.61
2015	Oita-ken	1.59	4.6	47.5	42,970	45.58	4.80	2,607	2.91
2015	Miyazaki-ken	1.71	4.6	49.9	39,210	44.42	3.76	2,318	3.46
2015	Kagoshima-ken	1.7	4.7	47.9	72,220	43.07	5.04	2,365	3.59
2015	Okinawa-ken	1.96	6.1	46.3	54,530	32.76	5.98	2,191	4.80

D. R Script

```
install.packages("plm")
library(plm)
summary(working_march_28)
Newdata<-pdata.frame(working_march_28, index=c("Year", "obs"))

Newdata$logPT=log(Newdata$PT)
Newdata$IncomePerPersonTotal=(Newdata$IncomePerPerson)*1000
Newdata$logIncomePerPerson=log(Newdata$IncomePerPersonTotal)

data2010<-subset(working_march_28, working_march_28$Year==2010)
data2015<-subset(working_march_28, working_march_28$Year==2015)
data2010$logPT=log(data2010$PT)
data2015$logPT=log(data2015$PT)
data2010$IncomePerPersonTotal=(data2010$IncomePerPerson)*1000
data2010$logIncomePerPerson=log(data2010$IncomePerPersonTotal)
data2015$IncomePerPersonTotal=(data2015$IncomePerPerson)*1000
data2015$logIncomePerPerson=log(data2015$IncomePerPersonTotal)

rm(model1,model2,model3)
rm(Model1, model10,model11,model12,model13,model14,model15)
rm(model16,model17,model18,model19,model20,model21,model22,model23,model24,model25,
model26,model27,model28,model29,model30,model31)

#RE Models
model1<-
plm(fertility~Marriage+LFPF+logPT+ChildWelfareExp+logIncomePerPerson+SocialWelfareEx
p, data=Newdata, model="random", random.method="walhus")
summary(model1)
```

```
model2<-
plm(fertility~Pct65+LFPF+logPT+ChildWelfareExp+logIncomePerPerson+SocialWelfareExp,
data=Newdata, model="random", random.method="walhus")

summary(model2)


#Linear Models

rm(model4, model4a, model4b, model5, model5a,model5b)


model3a<-
lm(fertility~Pct65+LFPF+logPT+ChildWelfareExp+logIncomePerPerson+SocialWelfareExp,
data=data2010)

summary(model3a)

model3b<-
lm(fertility~Pct65+LFPF+logPT+ChildWelfareExp+logIncomePerPerson+SocialWelfareExp,
data=data2015)

summary(model3b)


model4a<-
lm(fertility~Marriage+LFPF+logPT+ChildWelfareExp+logIncomePerPerson+SocialWelfareExp
, data=data2010)

summary(model4a)

model4b<-
lm(fertility~Marriage+LFPF+logPT+ChildWelfareExp+logIncomePerPerson+SocialWelfareExp
, data=data2015)

summary(model4b)


library(stargazer)

stargazer(model2,model3a,model3b, type="html", out="Pct65FertilityRE.html")

stargazer(model1, model4a,model4b, type="html",out="MarriageFertilityRE.html")


#Playing again

library(plm)
```

```
model5<-
plm(fertility~Marriage+LFPF+logPT+ChildWelfareExp+logIncomePerPerson+SocialWelfareEx
p+ChildWelfareInst, data=Newdata, modell="random", random.method="walhus")

summary(model5)


#Descriptive Statistics


summary(data2015$fertility)

sd(data2015$fertility)


summary(data2010$Marriage)

summary(data2015$Marriage)

sd(data2010$Marriage)

sd(data2015$Marriage)


summary(data2010$Pct65)

summary(data2015$Pct65)

sd(data2010$Pct65)

sd(data2015$Pct65)


summary(data2010$logPT)

summary(data2015$logPT)

sd(data2010$logPT)

sd(data2015$logPT)


summary(data2010$LFPF)

summary(data2015$LFPF)

sd(data2010$LFPF)

sd(data2015$LFPF)
```

```
summary(data2010$ChildWelfareExp)
summary(data2015$ChildWelfareExp)
sd(data2010$ChildWelfareExp)
sd(data2015$ChildWelfareExp)

summary(data2010$logIncomePerPerson)
summary(data2015$logIncomePerPerson)
sd(data2010$logIncomePerPerson)
sd(data2015$logIncomePerPerson)

summary(data2010$SocialWelfareExp)
summary(data2015$SocialWelfareExp)
sd(data2010$SocialWelfareExp)
sd(data2015$SocialWelfareExp)

summary(Newdata$fertility)
sd(Newdata$fertility)

summary(Newdata$Marriage)
sd(Newdata$Marriage)

summary(Newdata$Pct65)
sd(Newdata$Pct65)

summary(Newdata$logPT)
sd(Newdata$logPT)

summary(Newdata$LFPF)
sd(Newdata$LFPF)
```

```
summary(Newdata$logIncomePerPerson)
sd(Newdata$logIncomePerPerson)

summary(Newdata$SocialWelfareExp)
sd(Newdata$SocialWelfareExp)

summary(data2010$PT)
summary(data2015$PT)
sd(data2010$PT)
sd(data2015$PT)
summary(Newdata$PT)
sd(Newdata$PT)

summary(data2010$IncomePerPerson)
summary(data2015$IncomePerPerson)
sd(data2010$IncomePerPerson)
sd(data2015$IncomePerPerson)
summary(Newdata$IncomePerPerson)
sd(Newdata$IncomePerPerson)

hist(Newdata$fertility)
hist(Newdata$IncomePerPerson)

library(plm)
model20<-plm(fertility~Pct65+LFPF+logPT+ChildWelfareExp+logIncomePerPerson,
data=Newdata, model="random", random.method="walhus")
install.packages("AICcmodavg")
summary(model20)

#Econometric Testing
```

```
library(AICcmodavg)
models<-list(model2, model20)
mod.names<-c('fertility.social','fertility.nosocial')
aictab(cand.set = models, modnames = mod.names)
install.packages("rlang")
install.packages("skedastic")
library(skedastic)
white(model1, interactions=TRUE)
library(lmtest)
bptest(model1)
bptest(model2)
bptest(model3a)
bptest(model3b)
bptest(model4a)
bptest(model4b)

resettest(model1, power=2:4)
install.packages("zoo")
install.packages("stats")

library(zoo)
library(stats)
library(lmtest)
resettest(model1)
library(lmtest)
dwtest(model1)
summary(Newdata)
bgtest(model1)
bgtest(model2)
```

```
library(car)
vif(model1)
vif(model2)
vif(model3a)
vif(model3b)
vif(model4a)
vif(model4b)
```