THE EFFECTS OF LOWER-THERAN-REPLACEMENT FERTILITY AND AGING SOCIETIES ON GDP PER CAPITA IN DEVELOPED NATIONS: A REGRESSION ANALYSIS OF JAPAN, FRANCE, AND ITALY

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ABSTRACT

With the exception of the United States, fertility rates across the developed world have been below the replacement level of 2.1 children per woman since the 1970s. This phenomenon, coupled with increasing life spans, has caused the populations of developed countries to age considerably. With fewer children born, it is expected that the next ten to fifteen years will witness population declines and the beginning of labor shortages and declines in labor output in the developed world as the cohort of those aged 15-64 begins to shrink. Such consequences will cause Western governments great struggle in financing the pensions and health needs of a growing elderly population, and it is expected that real GDP and GDP per capita of developed nations will incur negative growth as a result.

This thesis analyzes regressions on Japan, France, and Italy and attempts to support the hypothesis that declining fertility rates in those countries will have a negative effect on GDP per capita. The regression models also incorporate other social, demographic, and economic variables, based on available literature, to predict GDP per capita. Results indicated that identical regression models could not be used for all developed nations, but fertility rate was positively correlated with GDP per capita.
To Charles Vehorn,
who encouraged me with a smile, advice, and good conversation along the way

and

To Hamid Faruqee,
whose research on demographic change I enjoyed reading immensely
and whose e-mails made me laugh
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INTRODUCTION: WHY DEMOGRAPHIC CHANGE IS IMPORTANT

It seems possible that a society in which the proportion of young people is diminishing will become dangerously unprogressive, falling behind other communities not only in technical efficiency and economic welfare, but in intellectual and artistic achievement as well.

—Extract from the Report of the Royal Commission on Population, United Kingdom, 1949

Everywhere in the developed world people, on average, are getting older. With each successive generation, women around the world are having fewer children while life spans, on average, steadily increase. This phenomenon has been most pronounced in the highly industrial and developed nations of the world, which have seen their combined populations fall from 32.2% of the world population in 1950 to 20.6% in 1995 to a projected 12.4% in 2050.1 The United Nations predicts that deaths will exceed births by 73 million in developed nations between 2005 and 2050. However, levels of immigration exceeding 98 million people from less developed areas to developed countries could more than offset potential population declines in developed areas.2

Demographic change is altering the appearance of the human population in all respects. Its effect upon the world, and developed nations in particular, has serious social, economic, and political repercussions that are just beginning to fully emerge. Furthermore, there are no prescribed means to counteract the long-term social and economic effects of financing the retirement benefits of a growing elderly population with taxes from a stagnating or decreasing labor force. Political wrangling in developed countries over tax increases, cuts in retirement benefits,
further eligibility restrictions for retirement benefits, and incentives to maintain and increase labor output and productivity in the coming decades will be long and difficult.

THE WORLD AS WE KNOW IT

The human population is currently growing approximately 1.3%, or a net gain of approximately 84 million people, every year. This growth rate is less than the 1965-1970 recorded peak of 2.1%, but the number of people on earth is at an all time high of approximately 6.5 billion and growing. However, worldwide fertility rates are steadily declining, and the United Nations Population Fund projects that the global population will peak in 2050 at approximately 8.9 billion. By 2050, 75% of all countries in less developed parts of the world are expected to experience fertility rates below the level necessary to maintain a steady or growing population, or lower than an average of 2.1 children per woman. In March 2003 the average worldwide fertility rate fell to 2.8 children per woman, due largely to the fact that China, Japan, nearly all of Europe, Russia, and many parts of South and Southeast Asia have fertility rates below the replacement level of 2.1.

There are several reasons why women in developed countries are choosing to have fewer children. Perhaps the biggest reason is women increasingly have more choice and control over their fertility with advances in women’s rights and birth control. There is also a global trend illustrating that the higher level of education a woman attains, the fewer children she will have on average. As incomes around the world rise and
developing nations create a sustainable middle class, we might expect to see this trend continue. Many women also postpone having children until they feel they are established in their careers. The average age of marriage in developed countries is 27 (women are generally 1 to two years younger than men at the time of marriage), despite the fact that, on average, a woman’s peak fertility occurs in her late twenties. Figure 1 shows that fertility rates in developed countries have been on the decline for decades and, with the exception of the United States, are expected to remain below two children per woman.

Figure 1. Past and Projected Fertility Rates in Developed Countries, 1950-2050

![Graph showing fertility rates](source.png)

Different countries have dealt with their respective population growth rates in different ways. China, for example, combated extreme population growth by imposing a one-child-per-couple fertility limit in 1979 that met fierce resistance and caused orphanages in a society in which families prefer boys to fill up with unwanted baby girls. On the other hand, governments in Italy, Japan, and Singapore are encouraging higher birth rates with such tactics as monetary incentives and even ship cruises for singles. Australian Treasurer Peter Costello has made having children a matter of civic duty and introduced a measure in 2004 that guaranteed Australian women approximately $3000 for every child they bear. "You should have one for the father, one for the mother and one for the country. If you want to fix the ageing demographic, that's what you do," Costello urged in May 2004. Many less developed nations, such as Indonesia, have utilized intensive family planning programs to promote contraception and smaller families in order to alleviate poverty and reduce unemployment.

ECONOMIC PROJECTIONS

The central hypothesis of this study postulates that lower than replacement fertility rates (and negative growth in those fertility rates) and their concomitant social, economic, and demographic consequences in developed nations will cause GDP and, more importantly, GDP per capita to fall. Developed nations have labor forces that already incorporate the vast majority of working aged citizens, are highly industrially advanced, and no longer have the capacity for double digit economic growth that many developing nations are experiencing. Australia, for example, has a current fertility rate of
about 1.75 and will experience over the next 40 years what has been occurring in Japan for some time: declining aggregate labor force participation. Figure 2 illustrates projected GDP per capita growth in Australia during the next 45 years.

**Figure 2. Projected GDP Per Capita Growth in Australia, 2006-2045**

Assumes labor productivity growth of 1.75% per year.

Australia’s population is expected to rise by 5.7 million (on account of longer life spans) over the next 40 years. However, two-thirds of this increase will be accounted for by people aged 65 and over, while the number of children aged 0-14 is projected to fall by about 240,000. Australian officials project aggregate labor force participation to fall from its current rate of 63.5% of the population to 55.5% by 2045. Consequently,
growth in real GDP and real GDP per capita is projected to slow over the coming decades because of reduced birth rates and the resulting decline in labor force participation.

Several countries with lower than replacement fertility rates will experience the peak of what Natalie Jackson (2003) refers to as the ‘demographic gift’ around 2008. This occurs when a maximum proportion of the population is within the working ages of 15 to 65 (including working baby boomers). This cohort is productive, numerous enough to support the elderly through payroll taxes and government transfers, and, due to low fertility rates, has few children to care and pay for. However, as this cohort ages, those aged 15-64 will steadily decline as a proportion of the overall population.6

In February 2006, the Economist reported that the number of workers in the European Union between ages 50 and 64 will increase by 25% over the next two decades while those ages 20-29 will decrease by 20%.7 There is not only a concern that the workplace will soon lose a great many younger people, there is fear that many companies will experience a torrential loss in expertise as waves of baby boomers begin retiring over the next fifteen to twenty years. Companies like General Motors have already had to undergo serious changes in their mechanics and infrastructure as a result of generous health benefits and retirement plans to a swelling mass of long-lived retirees. In recent years, this former titan of a company (and largest US employer for decades until displaced by Wal-Mart) has experienced billions of dollars of losses, thousands of layoffs, cuts in health benefits, and the relegation of GM bonds to junk status. GM’s generous retirement payments and health plan outlays to retirees and their families have
crippled the company and made the building and selling of cars seem like a secondary business venture.

The Brookings Institution and Congressional Budget Office project that by 2015 nearly $1.8 trillion, or about half of the US federal budget, will be spent on pension and health care programs for the elderly. The portion of the federal budget that is spent on the elderly increased from 29% in 1990 to 35% in 2000 and, as projected, will continue to rise. John Rother, a policy analyst for the American Association of Retired People, was quoted in the February 2, 2005 edition of The Washington Post reported as saying

> Europe and Japan have already entered the demographic crunch that American policymakers fear. And although economic growth in those countries has slowed, standards of living have remained high. If the US economy could better harness the strength of an elderly workforce, through job creation and volunteerism, some of the anticipated economic impact of a growing pool of retirees could be mitigated.8

Social Security eligibility at age 62 and below around the developed world has encouraged people to leave the workforce several years earlier than, on average, they once did. At the same time, these retirees are living several years longer than just three of four decades ago and, consequently, must be supported with federal outlays for many more years than before. Between 1970 and the late 1990s, the average retirement age in France fell from 64 to 59. In West Germany during the same period it fell from 63 to 61. Only the UK (which has held steady at age 62) and the US (which as actually increased to 65) have had enough retirement disincentives to maintain some older workers. Several years ago the French and German governments reacted to high unemployment by slashing work hours, promoting early retirement, and increasing the number of holidays. The two countries are paying for this now with high federal outlays to the elderly.
Additionally, workers in France and the Netherlands are further encouraged to retire earlier because at the age of 61 they lose 80% of their pension wealth for each year of postponed retirement.9 The National Bureau of Economic Research reported in April 2006 that

Mathematical simulations for each country [Italy, Belgium, Denmark, Netherlands, France, United Kingdom, Germany, Spain, Canada, Sweden, Japan, and the United States] show that, on average across all 12 countries, a reform that delays first eligibility for benefits by three years would likely reduce the proportion of men aged 56 to 65 who are out of the labor force by between 23 and 36 percent.10

As its population of ages, Japan’s public retirement benefits are expected to rise from approximately 11% of GDP in 2000 to 20-25% of GDP in 2050. Developed countries with aging populations and zero or negative population growth may expect such economic repercussions as long-term flat or negative growth in GDP, declining rates of savings and investment, falling demand for new infrastructure (highways, housing, etc.), durable goods (cars, refrigerators, etc.) and capital goods (plants, mills, etc.), and shrinking consumer markets with declining domestic profits.11

Regarding Japan, Martin Muhleisen and Hamid Faruqee (2001) wrote that the “inflow of young adults as a share of the adult population (age 15 and older) has declined significantly over the past 40 years.” Japan’s workforce can be expected to decline for much of the 21st century in the face of an expected increase in life expectancy to well over 81 years. This change in the workforce demographic is expected to lead to shrinking economic output over time and severely limited increases in economic welfare. While it is possible for rising capital intensity, increases in productivity, and higher labor participation rates among the young and the elderly to mitigate economic decline, IMF
simulations portend that the level of real GDP in Japan “will fall by a cumulative 20% over the next century compared with a baseline simulation with a stationary population.” More importantly, in per capita terms,

GDP is expected to drop by about 5%...primarily because the percentage decline in effective labor is larger than the fall in number of workers, given the aging of the workforce and the differences in labor productivity and labor supply across age groups implicit in Japanese age-earnings profiles.\(^\text{12}\)

Figure 3 shows that Japan’s real GDP and GDP per capita are expected to experience negative growth through 2150 as effective labor falls. Effective labor can be described as the amount of labor that is largely between the ages of 15 and 50. Labor studies have shown that average work productivity falls precipitously after age 50 and is
nearly nonexistent after age 70. Because populations are aging, we have witnessed that a growing percentage of the workforce is over the age of 50.

This analysis concentrates on already largely developed parts of the world. Such a limitation is a necessary because many underdeveloped areas of the world, while experiencing declining fertility rates, still have large percentages of their populations that are unincorporated into modern industry and the labor force (and thus still have huge potential for growth in labor participation. For example, China has had lower than replacement fertility but 8-11% growth in GDP for the past 15 years). Figure 4 illustrates that population increases in developed countries are decreasing and expected to become negative between 2000 and 2010. Immigration can help mitigate some of this effect.

**Figure 4. Past and Projected Population Changes in Developed Countries With Regard to Immigration, 1950-2050**


One of the chief concerns of population stabilization and decline in developed
countries is the dramatic increase in public health expenditures and decrease in aggregate saving associated with an aging population, as described by the life-cycle hypothesis.\textsuperscript{13} Fertility rates in developed countries have fallen below the minimum replacement rate of 2.1 children per woman, causing the populations of these countries to age (the United States, among developed countries, is a lone exception, at about 2.1 because of higher levels of immigration).

Nearly all developed countries can expect to reach a point within the next 20 years when fewer people will be entering the workforce than are leaving it because of death or retirement. In 1989 Auerbach, Kotlikoff, Hagemann, and Nicoletti illustrated in a model that the rates of national saving, real wage rates, and current accounts in Germany, Japan, Sweden, and the US appeared sensitive to increases in dependency ratios caused by significant percentage growth in the cohort of those aged 65 and above.\textsuperscript{14} The share of the elderly as a percentage of the population in developed countries is undoubtedly growing, while the share of those between 0 and 65 years of age (including the all-important working cohort of 15-64) is in slow, steady decline. It is widely believed by economists that the economies and incomes of developed countries will, consequently, begin to shrink.

The decline in fertility rates in developed countries is often attributed to three economic factors: a decrease in the salary gap between men and women, difficulties in reconciling work with child rearing, and social security systems generous enough to increase the financial independence of the elderly. There is a broad consensus among
economists that a shrinking and aging population is associated with lower employment and output and will limit increases in economic welfare. Increasing capital intensity, productivity increases, and higher labor force participation rates could mitigate the negative impact on per capita incomes, but the ultimate economic impact is expected to be negative nonetheless.

The effects of aging have been somewhat offset by a continuing trend of higher female labor force participation in the workforce, but this effect can only continue until women are fully integrated. In the United States, there are currently more women than men applying to and attending undergraduate and graduate degree institutions. If this fact is any indication, the day when women’s involvement in the workforce is maximized cannot be far away.

The demographic trends of most developed countries imply that the level of real GDP will fall dramatically over the next century if and when their populations begin to fall. The populations of developed countries are still growing at a decreasing rate because of immigration from developing nations and longer life spans have been offsetting lower fertility rates to some degree. In per capita terms, GDP in Japan is expected to drop by about 5% relative to a stable population, largely because the percentage decline in effective labor is larger than the fall in the number of workers (given an aging workforce and the differences in labor productivity and labor supply across age groups). Figure 5 shows that average life expectancy throughout the world has been increasing since 1700 and will continue increasing through 2050. The figure
also illustrates that average world fertility rate has been falling since 1800 and will fall below 2.1 around 2050.

**Figure 5. Past and Projected Global Life Expectancy and Fertility Rates, 1700-2050**

![Graph showing past and projected global life expectancy and fertility rates, 1700-2050.]


**POPULATION PROJECTIONS**

The United Nations projects that fertility rates in developed countries will recover somewhat during the next 50 years, although they are expected to remain at or below 2 children per woman. There is little dispute, given current worldwide fertility trends, among the World Bank, United States Census Bureau, and International Institute for Applied Systems Analysis (IIASA) as to what the approximate global population will be in 2050. Estimates range from 8.8 billion to 9 billion.  

According to the IMF, population projections can be in error for three basic reasons. First, the base year population estimate may be inaccurate. Second,
inaccurately projected trends in fertility, mortality, and migration will produce poor projections. Third, unforeseen events, such as war, famine, and the spread of disease may cause demographic consequences. Figure 6 shows that as time progresses farther into the future, population projections become more unreliable. In 2010, it is expected that between 10% or 11% of the world’s population will be aged 60 or above, but by 2050 projections range from 14% to 29%.

**Figure 6. Uncertainty in Population Projections. Forecast of People Aged 60 and Above as Percentage of World Population, 2000-2050**


1Shaded area represents IIASA mean projection plus and minus two standard deviations.
In short, nothing can be certain when it comes to demographic projections, but experts are confident that current demographic trends portend a fairly stable world population by 2050, a decrease in the proportion of those aged 0-14 and those primarily involved in the labor force (aged 15-64), and a large increase in the proportion of those aged 65 and above. It is also important to note that the median age of the world’s population has grown from 28.6 in 1950 to 38.7 in 2005 and is projected to reach 46.4 in 2050.19

SAVING RATES AND GOVERNMENT TRANSFERS

In the long run, developed countries can also expect investment and aggregate saving levels to decline with GDP. The fall in investment could reflect a desire to shed capital in the face of declining labor and output in the economy, although the rate of investment as a share of GDP may be unchanged. The life-cycle hypothesis assumes that individuals consume a constant percentage of the present value of their life income, according to preferences, tastes, and income, but consumption as a fraction of income varies with age.20 Young and old individuals have a larger marginal propensity to consume than those who are middle aged (and probably working, with higher personal saving rates). Young and old individuals also tend to borrow against future income or run down their savings in the absence of work and with a limited income (Ruby 2003). It is difficult to determine whether private saving will decline as populations in developed countries begin to fall because there are myriad factors controlling tastes and preferences.
The decline in the inflow of young adults (who tend to consume at higher relative rates) and a growing proportion of the elderly (who tend to save less because they have reduced incomes after retirement) with increased longevity may act to raise or lower private saving rates. Japan’s saving rate was 13% in 1996, but it is expected to fall dramatically in the next century as the population ages. As the life-cycle theory tells us, elderly people save less as a percentage of their income than those in the work force.\textsuperscript{21}

It is widely believed that, while private saving rates are difficult to predict, public saving rates will most likely fall with an aging and shrinking population. Tax rates in many developed countries are already quite high (ranging from 25-50\% of personal income) in order to pay for socialized health care, pensions, and a wide array of social programs and safety nets. While several developed countries currently enjoy surpluses in their public pension systems, future pension claims will more than offset them. An aging population will only exacerbate the difficulty in maintaining public health care and pension expenditures. Even if private saving rates remain positive, the fall in public saving rates is expected to offset any positive private saving and create a negative aggregate saving balance (Feroli 2003, Brooks 2005, Bettendorf and Knaap 2002).

Developed countries have limited options in dealing with the saving problem. Japan enacted legislation in 1994 to cut lifetime pension benefits by about 20\% for future retirees and increase the age of eligibility from 60 to 65 for earnings-related pension payments.\textsuperscript{22} Though a person in the United States is eligible for reduced social security benefits at age 62, the US has already begun incrementally increasing eligibility for full
benefits for those born from 1938 and 1960 from age 65 to 67. The US will most likely be forced to lower social security benefits, raise payroll taxes, or employ a combination of these measures in order to maintain outlays to those who have contributed decades of tax payments to the federal government.

Slow debt consolidation and gradual social security reform will undoubtedly lower living standards in developed countries with aging populations because they imply higher social security contribution rates and indirect tax increases necessary to finance growing government transfer and interest payments. As stated above, the real policy questions have to do with concentrating more on increasing taxes for social benefits, reducing transfer payments, or increasing eligibility ages for such payments. Developed countries have been steadily increasing the percentages of consumption, income, and payroll taxes since 1960 (Razin 2001, Faruqee 2001, Auerbach 1989). Public investment cuts, measures to broaden the income tax base, increases in consumption taxes, and reductions in social security and pension benefits are likely to be the key parts of a long-term solution to financing an aging population.

In the United States, aging has been more gradual than in other developed countries like Japan, France, Germany, Australia, and the United Kingdom. This phenomenon is due largely to higher levels of immigration to the United States. After lingering at 1% or 1.5%, the US national saving rate dipped below zero during the last three quarters of 2005. On the other hand, models of national saving have shown that Japanese national saving will drop rapidly during the beginning of the
21st century and begin rising again around 2010. German national saving is expected to decline more gradually only after rising slightly between 2000 and 2010.

One of my sources, Hamid Faruqee of the International Monetary Fund, responded to an e-mail inquiry of mine with the following statement:

The importance of demographic change is hard to understate. Population aging is, as you mentioned, a global phenomenon that will be with us for awhile—although different countries are at different points in this transition.

The developed world is just beginning to see the effects of this transition, the fact that developed countries are at different stages of this transition is important to my regression results in this study. Western Europe’s GDP growth is stagnating, and members of the baby boom generation in developed countries begin to turn 60 in 2006. The United States has experienced rancorous internal debates as to whether privatized retirement accounts should be created within the Social Security Administration as a means for younger people to rely on their own earnings for social security benefits rather than the earnings of the workforce at the time of their retirement. This is a separate issue from the much larger problem of a huge looming Medicare deficit. Decades of low fertility rates in developed countries are beginning to show their potential for great negative economic effects.

Some economists believe that fertility rates in developed countries will begin to increase between 2010 and 2030 and declines in real GDP and GDP per capita will begin to turn around between 2025 and 2060. These are only projections, however, that cannot account for the social and demographic trends that will actually occur. It is impossible to
know whether women will, on average, begin to bear more children in 20 years when fertility trends have only been in decline since the 1950s. Many governments of developed countries have implemented incentives for their citizens to bear more children, but they have provided lackluster results thus far. It is my goal to use demographic and economic trends of the past 45 years to attempt to prognosticate the future growth of GDP per capita in Japan, France, and Italy. Figure 7 illustrates a decline of those aged 0-14 as a percentage of the world population since 1800 and an increase in those aged 65 and above as a percentage of the world population since 1900. The largest changes in both cohorts are expected to occur between 2000 and 2050.

![Figure 7. Past and Projected Changes in World Age Demographics, 1700-2050](image)


**REGRESSION ANALYSIS**

There are a number of countries eligible for study in this analysis. All of Western
Europe, Australia, Japan, Singapore, and the United States are developed nations that have suffered extreme declines in fertility rates during the past forty years. However, the United States is probably the worst of the group to study for reasons already explained.

It is the central hypothesis of this researcher that successive decades of lower-than-replacement fertility rates in developed countries will lead to declines in GDP per capita. Given that the chief hypothesis of this analysis stems from the steep decline in fertility rates across developed countries, it is a given that the particular fertility rate among the countries of concern is the primary independent variable in the regressions in this analysis. According to the great amount of literature available, there are several other variables that may be employed to study the effects of fertility rates on GDP per capita in the developed world. However, many of these variables have limited data available. This study is a time-series analysis, and it was imperative that the variables had data for as many years as possible in order to establish varying trends among the countries under scrutiny.

The few data sets that offer information on the variables used in this study provide data only as far back as 1960. The vast majority of the data used in this analysis is derived from two comprehensive sources. The first is the World Bank World Development Indicators (WDI) 2005. WDI is the World Bank’s premier annual compilation of data about development. The 2005 WDI includes more than 800 indicators in 83 tables organized into the following six sections: world view, people, environment, economy, states and markets, and global links. Data is available for 152
economies with populations of more than 1 million and 14 country groups. WDI 2005 may be found at http://www.worldbank.org/data/wdi2005/index.html.

The second main data source, found at http://titania.sourceoecd.org/vl=3219347/cl=13/nw=1/rpsv/home.htm¹, is the Index of Statistical Variables as part of the Organization for Economic Cooperation and Development’s SourceOECD. This data provides information for many countries on a large number of variables dating back to 1960.

The WDI and SourceOECD data has both strengths and weaknesses. It encompasses an enormous amount of information regarding literally hundreds of social, economic, and geographic variables and attempts to be comprehensive over 4 decades and 152 economies. Indeed, the full data contains far more variables than this study requires. However, the two sources have much more missing data than I originally presumed. Whereas some variables contain 45 observations (representing data from each year from 1960 to 2004), other variables, several of which I believed, based on the literature available, would be important to this study, have as few as 4 or 5 observations. The latter variables could not be used as no noticeable trend could be established or imputed.

In order to properly examine the effects of variables of interest on the growth of GDP per capita in developed countries, I believed it important that all countries involved

¹ I was able to access all WDI and SourceOECD data through Georgetown University’s Lauinger library research association.
in the study were examined with the same model. At first glance, it seemed that the data for different variables among developed countries had similar trends. For example, one could easily see that average life expectancy in developed countries from 1960 to 2004 was getting longer and, on average, had a positive change from year to year. While the absolute variable data differed among developed countries, it seemed as if the similar increasing or decreasing trends of those variables were enough to warrant identical regression models to study each one. However, the intended model chosen for this analysis does not hold for all industrial countries, and variation among variables in each country was captured in different ways. The original theory that every country could be examined similarly did not hold. Therefore, each country had to be properly examined with a unique regression model.

I must conclude that while my variable data seems to indicate similar trends among developed countries, the annual changes in each variable throughout the time series were dissimilar enough between the countries under scrutiny to produce unique models and different coefficient results. Naturally, different developed countries have positive variable trends that increase at different rates and negative variable trends that decrease in the same fashion. I surmise this fact to be the source of my surprise at the regression results.

The one independent variable that could not be eliminated from any regression in this study was fertility rate, as the entire outcome of this analysis was predicated on the long-term economic effects of lower-than-replacement fertility in developed countries.
OLS Regression analysis of variables in describing the growth of GDP per capita in France, Japan, and Italy provided the best results for this study and will be examined in the following pages. Japan and Italy were of particular interest because they have the lowest current fertility rates of 1.29 children per woman. I greatly desired to use Germany in this study as well, as its fertility rate has been well below the replacement rate since the early 1970s and stood at 1.34 in 2004. However, there was a great deal of missing data for the variables I deemed necessary to study for Germany, and it was therefore difficult to establish and analyze the essential variable trends this analysis requires.

Because the long-term analysis of trends was paramount to the success of this study, it was necessary to eliminate any variable that did not have appropriate data dating back to approximately 1960. I made an exception with the variable measuring the adjusted net savings of human and natural capital because the saving rate is the central theme of my theoretical lifetime consumption model. Therefore, regressions employing this variable have approximately 34 observations, dating to the early 1970s, instead of 44 or 45. When this variable was statistically significant or not highly correlated with any other variables, I felt its inclusion was worth a necessary loss in observations.

It was difficult to ascertain the best way to measure the variables used in this study, and several ways were employed to determine which was most proper. Some of the variables and their absolute changes from year to year were quite large relative to others. I determined that the large degrees of annual variation among variables was best
accounted by measuring them as an annual percentage change. This method ensured that variable ranges were as similar as possible as a means to providing as accurate a regression as could be created. I also found that this form of measurement mitigated multicollinearity among the variables involved to the best degree.

The reader will notice that many of the names of the variables used in this analysis begin with the prefix ‘NEW’. This prefix was developed as a result of many hours spent modifying the method of variable measurement as a means to ameliorate problems encountered with variable multicollinearity and high resultant coefficient P values. All variables with the prefix ‘NEW’ earned their new moniker after I altered their measurement values from annual absolute numbers to annual percentage changes. Three exceptions to this exist due to the following: first, GDP per capita (GDPPERCAP) was already measured as an annual percentage change; second, population growth (POPGROWTH) was also already measured as an annual percentage change; and third, fertility rate (FERTILITYRATE) was measured as an annual average rather than the annual change in that average.

FERTILITYRATE was measured differently than the other variables because the annual change in the average fertility rate, often 0.05 or less, was extremely small relative to the annual changes in the other variables. By allowing FERTILITYRATE to remain its absolute average, rather than the change in that average, I was able to make the range of all variables as similar as possible.

Finally, before actual regression analysis is scrutinized, it is important to
note that not only did the various countries require unique regression models as part of this study, but the signs of some variable coefficient proved to be contrary to what my hypothesis and current literature would predict. For instance, much of the literature states that as the cohort of those aged 65 and above grows as a percentage of the population, GDP per capita will be effected negatively as a long term trend. This study found that assertion not always to be the case.

The variables involved in this study were the following:

**Dependent Variable:**

*GDPPERCAP*: Annual percentage change in GDP per capita.

**Independent Variables:**

*FERTILITYRATE*: Annual average fertility rate. This variable was expected to have a positive effect on GDPPERCAP.

*NEWADJSAVINGSNET*: Annual percentage change in net national savings of natural and human capital as a percentage of GNI. This variable was expected to have a positive effect on GDPPERCAP.

*NEWTOTALLABOR*: Annual percentage change in total labor force as measured the following way: \(((\text{Current Total} - \text{Previous Year Total}) / \text{Previous Year Total}) \times 100\). This variable was expected to have a positive effect on GDPPERCAP.

*NEWLIFEEXPECTANCY*: Annual change in life expectancy in years. This variable was expected to have a negative effect on GDPPERCAP.
NEWPOP1564: Annual percentage change in those aged 15-64 (primary working population) as a percentage of the entire population. This variable was expected to have a positive effect on GDPPERCAP.

NEWPOP65: Annual percentage change in those aged 65 and above (primary retired population) as a percentage of the entire population. This variable was expected to have a negative effect on GDPPERCAP.

NEWTAXREVENUE: Annual percentage change in total tax revenue collected by the government as a percentage of GDP. This variable was expected to have a negative effect on GDPPERCAP.

POPGROWTH: Annual percentage change in total population. This variable was expected to have a positive effect on GDPPERCAP.

NEWUNEMPLOYMENT: Annual percentage change in total unemployment as a percentage of the total labor force. This variable was expected to have a negative effect on GDPPERCAP.

NEWPUBLICHEALTHEXPENS: Annual change in public health expenditure as a percentage of GDP. For public health expenditures as a percentage of GDP rise, I expected to see progressive increases in payroll and social taxes and thus a negative effect on GDPPERCAP.

The expected model was based on similar models and variables of interest in the literature I reviewed for this analysis and was to look like the following:
GDPPERCAP = \beta_0 + \beta_1 FERTILITYRATE + \beta_2 NEWADJSAVINGSNET + \\
\beta_3 NEWTOTALLABOR + \beta_4 NEWLIFEEXPECTANCY + \beta_5 NEWPOP1564 + \\
\beta_6 NEWPOP65 + \beta_7 NEWTAXREVENUE + \beta_8 POPGROWTH + \\
\beta_9 NEWUNEMPLOYMENT + \beta_{10} NEWPUBLICHEALTHEXPENS + \varepsilon_i

Using an OLS regression model, this study was narrowed to examine the economic consequences of lower-than-replacement fertility rates and their concomitant effects on the change in GDP per capita in Japan, France, and Italy. In the long term, GDP per capita growth is expected to be negative, and the following pages provide an examination of those regressions.

Japan

At 1.29 children per woman, Japan is tied with Italy for the lowest national fertility rate in the world. Japan’s population is just beginning to shrink, and the life expectancy of its citizens averaged 81.8 years in 2004. Productivity growth in the Japan has been small in recent years, but, despite a shrinking labor force, there is hope it can be boosted with further investment in information technology and automation. Nearly 20% of Japan’s population is over age 65, higher than any nation in the world. Regression analysis on Japan required the elimination of several variables due to multicollinearity and some extremely insignificant t statistics.

On the following page, Table 1 lists a brief overview of independent variable correlation results with the dependent variable, GDPPERCAP, for Japan.
Table 1. Correlations For All Independent Variables Against GDPPERCAP For Japan

<table>
<thead>
<tr>
<th>Variable</th>
<th>GDPPERCAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>FERTILITYRATE</td>
<td>0.61</td>
</tr>
<tr>
<td>NEWPUBLICHEALTHEXPENS</td>
<td>-0.24</td>
</tr>
<tr>
<td>NEWTOTALLABOR</td>
<td>0.56</td>
</tr>
<tr>
<td>NEWLIFEEXPECTANCY</td>
<td>0.22</td>
</tr>
<tr>
<td>NEWPPOP1564</td>
<td>0.61</td>
</tr>
<tr>
<td>NEWPPOP65</td>
<td>-0.62</td>
</tr>
<tr>
<td>POPGROWTH</td>
<td>0.33</td>
</tr>
<tr>
<td>NEWTAXREVENUE</td>
<td>0.36</td>
</tr>
<tr>
<td>NEWUNEMPLOYMENT</td>
<td>-0.53</td>
</tr>
<tr>
<td>NEWADJSAVINGSNET</td>
<td>0.53</td>
</tr>
</tbody>
</table>

With the exception of NEWLIFEEXPECTANCY and NEWTAXREVENUE, all independent variables were correlated in accordance with expectations. It is hypothesized that as life spans increase and the elderly population grows as a percentage of the total population, GDP per capita would be affected negatively because the growing elderly cohort will have to be supported by a shrinking labor force. Similarly, I hypothesized that as government tax revenues as a percentage of GDP increased (the data shows it increased from 18.3% in 1965 to 25.8% in 2004), GDP per capita would decrease as a result of people having to pay higher percentages of their incomes to the Japanese government. Again, the correlation results indicate otherwise, and I can only guess as to why such an outcome has occurred.

The variable measuring population growth was highly correlated with one variable or another in every regression analysis for every country tested. In this case, it
had a correlation of 0.80 with the variable measuring fertility rate and so was expunged immediately from the model. Unexpectedly, the variable measuring the growth of the cohort aged 65 and above had a correlation of 0.90 with the variable measuring fertility and was also expunged. This seemed a great loss to the model as the literature attests that the growth of this cohort as a percentage of the population is a huge factor in the economic decline of developed countries. Lastly, the NEWPOP1564 was expunged from the model because it continually had a P value of approximately 0.98. I deemed this value far too insignificant to include the variable in the model. The final model resulted from the elimination of highly correlated independent variables and those highly statistically insignificant as part of the regression result. Table 2 lists the regression results for Japan on the following page.
Table 2. Japan Regression Results  
Standard Errors in Parentheses

| Variable                        | Coefficient Estimate | Pr > |t|  |
|---------------------------------|----------------------|------|---|
| Intercept                       | -0.7989 (-1.98)      | 0.6890 |
| FERTILITYRATE                   | 2.4179 (-1.24)       | 0.0606 |
| NEWPUBLICHEALTHEXPENS           | -4.7473 (-2.01)      | 0.0253 |
| NEWTAXREVENUE                   | 0.5916 (-0.46)       | 0.2134 |
| NEWUNEMPLOYMENT                 | -1.9006 (-1.3)       | 0.1554 |
| NEWADJSAVINGSNET                | 0.2894 (-0.42)       | 0.4965 |

R-Square: 0.6272  
Adj R-Sq: 0.5606  
F Value: 9.42  
Pr > F: < .0001

Number of Observations Read: 45  
Number of Observations Used: 34

The resultant regression coefficients may be interpreted in the following way:

1) Holding other independent variables constant, a one-tenth of a percentage point increase in the fertility rate is expected to cause an increase in the change of GDP per capita in Japan by 0.24 percentage points. This variable was statistically significant at the 94% level.
2) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in public health expenditure as a percentage of GDP is expected to cause a decrease in the change of GDP per capita in Japan by 0.47 percentage points. This variable was statistically significant at the 97.5% level.

3) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in total tax revenue as a percentage of GDP is expected to cause an increase in the change of GDP per capita in Japan by 0.06 percentage points. This variable was not statistically significant at the 90% level or higher.

4) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in total unemployment as a percentage of the total labor force is expected to cause a decrease in the change of GDP per capita in Japan by 0.19 percentage points. This variable was not statistically significant at the 90% level or higher.

5) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in net adjusted savings of natural resources and human capital as a percentage of GNI is expected to cause an increase in the change of GDP per capita in Japan by 0.029 percentage points. This variable was not statistically significant at the 90% level or higher.

Unfortunately, neither variable representing the proportions of those aged 15-64 and 65 and above could be used in Japan’s regression analysis. I felt it important to include these demographic variables as often as possible, but, as the reader will see, they proved
somewhat unreliable as predictors of the annual change in GDP per capita. This fact is in keeping with the idiosyncratic nature of these regressions among developed countries experiencing very low fertility rates.

**France**

The fertility rate in France first fell below 2.1 in 1975, when the World Bank recorded it at 1.925. France stands apart from many of its industrialized contemporaries in that its fertility rate has been on the rise since 1994, when it reached a nadir of 1.65 children per woman. While still below the replacement rate of 2.1, France’s fertility rate increased to between 1.85 and 1.89 in 2004. Similar to all other industrial nations, the average life span in France has been consistently on the rise since 1960 and stood at just over 79 years of age in 2004.

The percentage of France’s population aged 15 to 64 has increased from 61% in 1960 and stabilized at 65% in 1985. This cohort is expected to begin decreasing as a percentage of the total population during the next 10 to 15 years. The cohort of those aged 65 and above as a percentage of France’s total population has steadily increased from 11.6% in 1960 to 16.1% in 2004 and is expected to continue increasing as fertility rates remain low and life spans remain high.

Of particular interest to me during my analysis of France were the effects that rising public health expenditures as a percentage of GDP (2.4% in 1960 to 7.8% in 2004) and rising government tax revenues as a percentage of GDP would have on the dependent variable. In comparison to more capitalistic tendencies in United States and Japan,
European countries are known for their relatively generous social programs and outlays. Such insurance programs (unemployment, social security, health care, etc.) require a great amount of federal funding and a tax rate of 35-50% of personal income, so it was no surprise to see that France’s 2004 tax revenue was 43.7% of GDP (compared to tax revenues of 25.5% of GDP in the US and 25.8% of GDP in Japan), up from 34.5% in 1965. The correlation results of all independent variables against GDPPERCAP are listed in Table 3.

### Table 3. Correlations For All Independent Variables Against GDPPERCAP For France

<table>
<thead>
<tr>
<th>Variable</th>
<th>GDPPERCAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>FERTILITYRATE</td>
<td>0.70</td>
</tr>
<tr>
<td>NEWPUBLICHEALTHEXPENS</td>
<td>-0.006</td>
</tr>
<tr>
<td>NEWTOTALLABOR</td>
<td>0.36</td>
</tr>
<tr>
<td>NEWLIFEEXPECTANCY</td>
<td>0.08</td>
</tr>
<tr>
<td>NEWPOP1564</td>
<td>-0.17</td>
</tr>
<tr>
<td>NEWPOP65</td>
<td>0.21</td>
</tr>
<tr>
<td>POPGROWTH</td>
<td>0.59</td>
</tr>
<tr>
<td>NEWTAXREVENUE</td>
<td>-0.17</td>
</tr>
<tr>
<td>NEWUNEMPLOYMENT</td>
<td>-0.42</td>
</tr>
<tr>
<td>NEWADJSAVINGSNET</td>
<td>0.55</td>
</tr>
</tbody>
</table>

NEWLIFEEXPECTANCY, NEWPOP1564, and NEWPOP65 had correlations with opposite signs than I expected. Increases in life spans and the cohort of those aged 65 and above were expected to affect the dependent variable negatively, while increases in the labor force (the cohort aged 15-64) were expected to affect the dependent variable positively. Furthermore, the variable representing public health expenditures had only a
slightly negative correlation with the dependent variable. The regression results for France are below in Table 4.

### Table 4. France Regression Results

| Variable                        | Coefficient Estimate | Pr > |t| |
|--------------------------------|----------------------|------|---|
| Intercept                      | -4.9761              | 0.0053 |     |
| FERTILITY RATE                 | 3.3859               | 0.0024 |     |
| NEW PUBLIC HEALTH EXPENSES     | -1.6825              | 0.3362 |     |
| NEW TOTAL LABOR                | 0.8330               | 0.2034 |     |
| NEW LIFE EXPECTANCY            | 1.7163               | 0.0493 |     |
| NEW POP 15-64                  | 1.5070               | 0.1988 |     |
| NEW TAX REVENUE                | 0.1876               | 0.5047 |     |
| NEW UN EMPLOYMENT              | -0.6088              | 0.0470 |     |
| NEW ADJ SAVINGS NET            | 0.6881               | 0.0005 |     |

R-Square: 0.7503  
Adj R-Sq: 0.6704  
F Value: 9.39  
Pr > F: <.0001  
Number of Observations Read: 45  
Number of Observations Used: 34
POPGROWTH was eliminated from the model because it had a correlation of 0.84 with FERTILITYRATE. Similarly, NEWPOP65 was eliminated because it had a correlation with NEWPOP1564 of –0.92. The resultant regression coefficients may be interpreted in the following way:

1) Holding other independent variables constant, a one-tenth increase in the fertility rate is expected to cause an increase in the change of GDP per capita in France by 0.34 percentage points. This outcome supports the original hypothesis. This variable was statistically significant at the 99% level.

2) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in public health expenditure as a percentage of GDP is expected to cause a decrease in the change of GDP per capita in France by 0.17 percentage points. This variable was not statistically significant at the 90% level or above.

3) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in total labor force as a percentage of the French population is expected to cause an increase in the change of GDP per capita in France by 0.08 percentage points. This variable was not statistically significant at the 90% level or above.

4) Holding other independent variables constant, a one-tenth of a point increase in the change in life expectancy is expected to cause an increase in the change of GDP per capita in France by 0.17 percentage points. This outcome is contrary to
what the literature predicts and what I expected in my results. This variable was statistically significant at the 95% level.

5) Holding other independent variables constant, a one-tenth of a percentage point increase in the change of the French population between the ages of 15 and 64 is expected to cause an increase in the change of GDP per capita in France by 0.15 percentage points. This variable was not statistically significant at the 90% level or above.

6) Holding other independent variables constant, one-tenth of a percentage point growth in the change in total tax revenue as a percentage of GDP is expected to cause an increase in the change of GDP per capita in France by 0.02 percentage points. This variable was not statistically significant at the 90% level or above.

7) Holding other independent variables constant, one-tenth of a percentage point growth in the change in total unemployment as a percentage of the total labor force is expected to cause a decrease in the change of GDP per capita in France by 0.06 percentage points. This variable was statistically significant at the 95% level.

8) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in net adjusted savings of natural resources and human capital as a percentage of GNI is expected to cause an increase in the change of GDP per capita in France by 0.07 percentage points. This variable was statistically significant at the 99% level.
The regression results yielded two aberrations to my hypothesis. First, the results indicate that increasing life spans affect GDP per capita positively. This result is contrary to all literature I reviewed in my efforts to support the hypothesis that longer life spans in developed countries will affect GDP per capita negatively. Second, the results predict that increasing government tax revenues as a percentage of GDP will affect GDP per capita positively. Intuition tells us that higher taxes lead to lower personal net incomes. However, intuition might also tell us that as taxes increase over time so too do personal gross incomes. Perhaps higher average incomes account for the fact that higher tax revenues as a percentage of GDP do not cause decreases in GDP per capita. It is also important to note that NEWTAXREVENUE is not statistically significant in the regression results for France, so its impact on GDPPERCAP may be ignored.

**Italy**

As previously mentioned, Italy’s fertility rate was approximately 1.29 in 2004, and the nation has experienced lower than replacement fertility rates since 1977. Although the fertility rate has generally trended downward since 1960, its low point to date, as reported by the World Bank, was 1.18 in 1995. The average life expectancy in Italy has also risen from just over 69 years of age in 1960 to just under 80 years of age in 2004. Like France, Italy’s tax revenue as a percentage of GDP is over 40%, and I expected the gradual rise in that variable during the past 45 years to affect the dependent variable negatively. Unfortunately, I was only able to gather data on Italy’s public health expenditures back to 1988, so that important variable could not be
used in Italy’s regression model because having only 16 observations for the entire regression was unacceptable.

The percentage of Italy’s population aged 15 to 64 has been relatively stable since 1960, varying from 65% to 68%. While I had originally expected to see a gradual trend downward with this variable, future populations projections for Western Europe indicate that this variable will indeed begin to fall during the next ten to fifteen years. The percentage of Italy’s population aged 65 and above has dramatically increased, from 9.3% in 1960 to 19.3% in 2004. Table 5 lists all correlations between the independent variables and the dependent variable for Italy.

| Table 5. Correlations For All Independent Variables Against GDPPERCAP For Italy |
|-----------------------------------|------------------|
| FERTILITYRATE                    | 0.55             |
| NEWPUBLICHEALTHEXPENS            | 0.15             |
| NEWTOTALLABOR                    | -0.16            |
| NEWLIFEEXPECTANCY                | 0.04             |
| NEWPOP1564                       | -0.14            |
| NEWPOP65                         | 0.03             |
| POPGROWTH                        | 0.50             |
| NEWTAXREVENUE                    | -0.28            |
| NEWUNEMPLOYMENT                  | -0.30            |
| NEWADJSAVINGSNET                 | 0.50             |

Although NEWPUBLICHEALTHEXPENS is positively correlated with the dependent variable, as indicated above, it is difficult to know if this would have been the case had data from more years been available. Additionally, NEWTOTALLABOR,
NEWLIFEEXPECTANCY, NEWPOP1564, and NEWPOP65 are correlated to GDPPERCAP with opposite signs than expected. Italy’s regression results are listed in Table 6.

| Variable                   | Coefficient Estimate | Pr > |t| |
|----------------------------|----------------------|------|--|
| Intercept                  | -1.7342 (-1.00)      | 0.0949 |
| FERTILITYRATE              | 2.0404 (-0.53)       | 0.0008 |
| NEWLIFEEXPECTANCY          | 0.7962 (-1.02)       | 0.4443 |
| NEWPOP1564                 | 2.6676 (-0.91)       | 0.0067 |
| NEWPOP65                   | 3.4943 (-1.31)       | 0.0127 |
| NEWTAXREVENUE              | -0.2834 (-0.17)      | 0.1059 |
| NEWUNEMPLOYMENT            | -0.7859 (-0.34)      | 0.0304 |
| NEWADJSAVINGSNET           | 0.9296 (-0.21)       | 0.0001 |

R-Square: 0.6596  
Adj R-Sq: 0.5679

F Value: 7.20  
Pr > F: <.0001

Number of Observations Read: 45  
Number of Observations Used: 34
The regression model for Italy also had variable coefficients that do not seem to affect the dependent variable as predicted. POPGROWTH was expunged from the model because it had a correlation with FERTILITYRATE of 0.92. Additionally, NEWTOTALLABOR was expunged from the model because initial regression results indicated that its P value was 0.88.

The resultant regression coefficients may be interpreted in the following way:

1) Holding other independent variables constant, a one-tenth increase in the fertility rate is expected to cause an increase in the change of GDP per capita in Italy by 0.2 percentage points. This outcome supports the original hypothesis. This variable is statistically significant at the 99.9% level.

2) Holding other independent variables constant, a one-tenth of a point increase in the change in life expectancy is expected to cause an increase in the change of GDP per capita in Italy by 0.08 percentage points. This outcome is contrary to what the literature predicts and what I expected in my results. This variable is not statistically significant at the 90% level or above.

3) Holding other independent variables constant, a one-tenth of a percentage point increase in the change of the Italian population between the ages of 15 and 64 is expected to cause an increase in the change of GDP per capita in Italy by 0.27 percentage points. This variable is statistically significant at the 99% level.

4) Holding other independent variables constant, a one-tenth of a percentage point increase in the change of the Italian population between aged 65 and above is
expected to cause an increase in the change of GDP per capita in Italy by 0.35 percentage points. This outcome is contrary to what the literature predicts and what I expected in my results. This variable is statistically significant at the 98% level.

5) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in total tax revenue as a percentage of GDP is expected to cause a decrease in the change of GDP per capita in Italy by 0.03 percentage points. This variable is statistically significant at the 90% level.

6) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in total unemployment as a percentage of the total labor force is expected to cause a decrease in the change of GDP per capita in Italy by 0.08 percentage points. This variable is statistically significant at the 97% level.

7) Holding other independent variables constant, a one-tenth of a percentage point increase in the change in net adjusted savings of natural resources and human capital as a percentage of GNI is expected to cause an increase in the change of GDP per capita in Italy by 0.09 percentage points. This variable is statistically significant at the 99.9% level.

The regression results yielded two aberrations from my variable hypotheses.

First, NEWLIFEEXPECTANCY was shown to have a positive effect on GDPPERCAP when other variables were held constant. Second, and more disturbing, NEWPOP65 demonstrates a large positive effect on GDPPERCAP when all literature suggests that the
increase of this variable is one of the chief reasons why labor force participation is in
decline and public outlays are increasing amid low fertility rates. NEWPOP65 is also
highly significant in the results for Italy and so its effect on GDPPERCAP cannot be
ignored.

CONCLUSION

This study was an attempt to analyze independent regression models of
industrialized nations. The literature supporting the life cycle theory of savings and
spending patterns and that examines the effects of low fertility rates on GDP per capita
often lumps industrialized nations together or studies its effect on the entire world in a
single analysis. I believed that individual analysis might show developed nations
experiencing the same basic trends in such data associated with savings, health care
spending, taxing, age demographics, life expectancy, and, most importantly, fertility rates
might be studied in identical or similar regression models with similar results. While it
seemed that similar trends were observed among these many variables between several
different industrial nations, my results proved otherwise.

Initially, I examined variable trends in Japan, France, Italy, Australia, Germany,
the United Kingdom, and the United States. While this study only examines the first
three countries in any detail, resultant regression models of the other countries further
proved that developed countries with low fertility rates cannot be examined in the same
way. The largest coefficient differences came from the variables measuring the annual
percentage change in total labor force (NEWTOTALLABOR), the population cohort of those aged 65 and above (NEWPOP65), and tax revenue (NEWTAXREVENUE).

Such differences in signs were not expected and might be explained in one of four ways. First, it is possible that additional or different variables were more appropriate for this study than were actually employed. Second, those variables used in the regression analysis may have been inappropriately measured and utilized for the purposes of this study. Third, each developed country involved in this analysis may have idiosyncratic factors within them that may or may not be accounted for by the model (and may be in the error term). Fourth, the fact that predicted negative effects on GDP and GDP per capita have largely been determined by forecasting the effects of future, uncertain trends in several social, economic, and demographic variables reminds us that we can only guess the future effects of different variable on GDP per capita based on the inconclusive (and often incomplete) data at hand.

The policy implications of lower-than-replacement fertility rates in developed countries are many and have already largely been mentioned. In addition to changes that must take place with tax levels and pension eligibility requirements, the labor forces of developed countries might be grown with more liberal immigration laws. The United States Congress is currently embroiled in such a debate and other developed countries, such as France, have been accused of both restricting immigration and treating immigrants like second-class citizens. It seems that government incentives to increase fertility rates are not having their desired effects, and, in addition to an increasing number
of immigrants to maintain growth in the work force, it seems likely that the government will have to force delays in retirement through changes to workers’ pension benefits. The key to maintaining labor output, in lieu of technological advances in productivity, is to ensure the size of the labor force grows at a proportionate rate or greater than retirees and the elderly population.

Below, with the addition of regression results from Australia and the United Kingdom, Table 7 lists a condensed version of the regression results of the primary countries involved in this study for further comparison:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Japan</th>
<th>France</th>
<th>Italy</th>
<th>Australia</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>FERTILITYRATE</td>
<td>2.418</td>
<td>3.386</td>
<td>2.040</td>
<td>1.77</td>
<td>2.07</td>
</tr>
<tr>
<td>NEWPUBLICHEALTHEXPENS</td>
<td>-4.747</td>
<td>-1.683</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>NEWTOTALLABOR</td>
<td>N/A</td>
<td>0.833</td>
<td>N/A</td>
<td>-1.26</td>
<td>N/A</td>
</tr>
<tr>
<td>NEWLIFEEXPECTANCY</td>
<td>N/A</td>
<td>1.716</td>
<td>0.796</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>NEWPOP1564</td>
<td>N/A</td>
<td>1.507</td>
<td>2.668</td>
<td>2.03</td>
<td>2.50</td>
</tr>
<tr>
<td>NEWPOP65</td>
<td>N/A</td>
<td>N/A</td>
<td>3.494</td>
<td>-4.26</td>
<td>4.09</td>
</tr>
<tr>
<td>POPGROWTH</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>NETAXREVENUE</td>
<td>0.592</td>
<td>0.188</td>
<td>-0.283</td>
<td>-0.93</td>
<td>-0.34</td>
</tr>
<tr>
<td>NEWUNEMPLOYMENT</td>
<td>-1.901</td>
<td>-0.609</td>
<td>-0.786</td>
<td>-1.03</td>
<td>N/A</td>
</tr>
<tr>
<td>NEWADJSAVINGSNET</td>
<td>0.289</td>
<td>0.688</td>
<td>0.930</td>
<td>N/A</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Despite some unexpected differences in coefficient size and sign, it was pleasing to see that all coefficients measuring average fertility rate were both large and positive. It was most important to illustrate in this time-series analysis that respective increases in the fertility rate are predicted to cause growth in GDP per capita within the different
countries under scrutiny. This one result supports the primary hypothesis that this study was predicated on. All other variables in this analysis were part of a supporting cast, chosen in aggregate based on the studies of others.
6 Jackson, Natalie, and Bruce Felmingham, The Demographic Gift in Australia, University of Tasmania, March 2003, pp. 3-4.
16 Faruqee and Muhleisen, pg. 14.
18 IBID.
22 Haruhiko Kuroda, 1996.


Jackson, Natalie, and Bruce Felmingham, *The Demographic Gift in Australia*, University of Tasmania, Discussion Papers, March 2003, pp. 3-4.


