The Baby Boom Generation's Effect on Stock Returns and Bond Yields in the Canadian Market

by Suzanne M. Robertson

An Honours essay submitted to
Carleton University in fulfillment
of the requirements for the course
ECON 4908, as credit toward
the degree of Bachelor of Arts with
Honours in Economics.

Department of Economics
Carleton University

Ottawa, Ontario

July 24, 2006

Table of Contents

List of Tables

List of Figures

Abstract

This paper shows that the Baby Boom generation has an impact on the rates of return earned on Canadian equities and long term government bonds. The baby boomers are the largest cohort in Canada and therefore, have the greatest influence on the economy. Starting in the year 2007 the baby boomers will retire from the workforce and thereafter rely upon their investments and savings as a source of income. This implies that when baby boomers liquidate their assets there will be a decrease in the rates of return earned on equities and bonds as the baby bust generation is not a large enough market to keep asset returns at a constant level.

Contrary to the result of Poterba's (2001) study I find there to be a significant negative relationship between the age 40 – 64 cohort and the level of asset returns. I find that for a one percentage point increase in the proportion of the Canadian population between the ages of 40 and 64 there is a decrease in equity returns and bond yields of 713 and 65.5 basis points respectively. The inclusion of the years 1998 to 2005 in this study have helped in uncovering this relationship as this time period captures the beginning of the baby boomers retiring, the technology boom, bust and recovery, and the bull market of the last year and a half.

1.0 Introduction

This paper examines the relationship between equity prices, bond yields, and demographics, specifically addressing the question of whether the returns on Canadian equities and long term bonds are influenced by the baby boom generation. Interest in the relationship between demographics and financial assets has grown since the large increase in American and Canadian stock prices during the 1990s. Dent (1998) found that the increase in the baby boomers' demands for equities was related to the rise in share prices for the United States.[1]

At present time and through to the year 2020 the baby boomers will leave the workforce and liquidate their investments to help finance their retirement. The retirement of the baby boom generation may have an impact on the rates of return earned on financial assets. This study examines the hypothesis that the boomers' withdrawal from the financial market will lead a decline in the rates of return earned on stocks and bonds. Analysis of previous theoretical and empirical studies has helped to provide insight on the relationship between demographic changes, share prices and returns, and bond yields. I have examined the correlation between the returns on financial assets and changes in demographic structure empirically using the models developed by Davis and Li (2003).

This paper adds to the literature and empirical analyses on demographics and asset returns as past studies [e.g. Ang and Madaloni (2003), Davis and Li (2003), Bakshi and Chen (1994)] have primarily focused on the United States and European OECD

[1] The result of Dent's (1998) study is taken from Poterba (2001), p.565.

countries. Little work has been done using Canadian data. The Canadian studies that have examined the relationship between demography and financial assets have either focused on RRSPs, personal savings accumulation and the baby boom generation (Fougere 2002, Fougere & Merette, 2000), or have examined the Canadian market with the exclusion of other macroeconomic variables (Poterba, 2001). This study provides further insight to the relationship by using recent data that includes the impact of the technology bubble and the beginning of the baby boomers retirement.

In this study I examine whether the rates of return are correlated with the number of investors between the ages of 20-64, and if the withdrawal of middle aged (40-64 years old) investors from the market is going to cause an "asset meltdown".[2] Empirically Yoo (1994b) found evidence that a person's level of risk aversion increases as he or she ages. The implication of this empirical result is that the baby boomers are expected to liquidate their riskier stocks and reallocate their investments to safer financial assets such as bonds and Treasury bills (T-bills) as they age. Given that changes in demographic structure are slowly moving and foreseeable, there is only a marginal likelihood that a decrease in financial returns will occur. The Canadian equities market is efficient, and therefore it is assumed that all available information related to equities is reflected in the current share prices.[3] Therefore, the impact of a large demographic shift should be reflected in the stock prices at the time when the cohort is born, as demographic shifts are foreseeable.

[2] "Asset meltdown" is the phrase Poterba (2001) uses to describe the potential outcome of the baby boomers' withdrawal from the equities and bond markets.
[3] Bodie, Kane, Marcus, Perakas, and Zane (2005) states that the Canadian market is efficient.

There are a number of caveats to bear in mind when considering the analysis attempted in this paper. First, there has only been one baby boom in Canada, and thereby there are no other booms to compare the population statistics and effects to. The availability of data on the prices of the S&P/TSX composite index are only made available starting in 1956. Poterba (2001) said that the results of his study were to be interpreted with caution given the small number of degrees of freedom for the statistical tests, and the same holds true for this study.[4] For the purposes of this examination I have assumed that the Canadian economy is closed. While this is not true, it allows for a better analysis of the relationship between financial assets and demographics. Also, it has been shown that investors prefer to purchase equities in their respective domestic market.[5] Given the uncertainty surrounding the future prices of the S&P/TSX index I did not use a forecasting model as it increases the likelihood of an incorrect conclusion being drawn on the relationship between demographics and asset returns.

Consistent with theory I empirically find evidence that the rates of return earned on stocks and bonds are *negatively* related to the proportion of the middle aged population in Canada. A one percentage point increase in the middle aged population leads to an approximate decrease in the returns earned on stocks and bonds of 713 and 65.5 basis points respectively. The results that I find are an indication that the aging of the baby boom generation will lead to a small decrease in the returns on stocks and bonds, though not large enough to cause an "asset meltdown". Previously, Poterba (2001) found there to be little evidence in Canada of the existence of a relationship between demographics and

---

[4] Poterba,(2001). p. 565

[5] The preference of a consumer to invest in his or her respective country is known as "home bias". An explanation of this is provided in Lewis (1999).

the returns on stocks and bonds. However, Poterba (2001) did find the proportion of the Canadian population between the ages of 40-64 to have a significant *positive* relationship with the yield on bonds. The exclusion of non-demographic variables from his models was likely the reason for not finding a relationship between demographics and equities. With the inclusion of macroeconomic variables, I find there to be a significant relationship between demographics and the returns on stocks and bonds in Canada.

The format of the paper is organized as follows. In Section 2, I examine the historical and future population structure of Canada and the factors underlying it. In Section 3, I describe the macroeconomic theories of consumption and investment. I also give an interpretation of the life-cycle and permanent income hypothesis to help determine if the retirement of the baby boom generation will have an impact on the markets. In Section 4, I have conducted a literature review on studies that have researched the relationship between demographics and the returns on financial assets. In Section 5, I describe the models developed by Davis & Li (2003), the data, and the methodology used to examine the relationship between demographics and the rates of return. Section 6 follows with the empirical results of the models. In Section 7, I present the implications and contributions of the study. Section 8 concludes.

2.0 The Canadian Demographic Structure: Past, Present, and Future

To develop an understanding of the impact that the Canadian population has on the rates of return of financial assets, this section examines the past, present and forecasted future of the Canadian population. This examination provides a framework for the assessment of the trends of Canada's demographic structure and its influence on stocks and bonds market. It also gives an analysis of the future direction of the Canadian population.

2.1 Defining the Baby Boomers

A baby boom is defined as being any period of time when there is a large increase in the birth rate within temporal and geographical bounds.[6] Those who are born during this period are often referred to as baby boomers. A baby boom is commonly considered to be a sign of economic growth and stability, and typically occurs after an uplifting factor such as a war.

The term baby boom is commonly referenced as being the period that followed World War II. Those nations who participated in World War II all experienced a baby boom following the war, though each countries boom occurred at different times. The baby boom of Canada is referenced by demographers as being the generation that was born from 1947 to 1966. Those who were born after 1966 fall under the baby bust generation. In Canada, there is only record of one baby boom. Over the last century there have been

[6] Definition from www.wikedpedia.ca

eight demographic cohorts in Canada. Each of these cohorts has their own impact on society and the economy. Table 2.0 breifly describes the characteristics of each cohort.[7]

[7] Table 2.0 The Demographic Ladder has been taken from the study conducted by Vinette and Yan (2004), Canadian Individual Taxpayers, a Changing Profile. These authors have used the definitions for each cohort from the book written by David K. Foot (1996), *Boom, Bust and Echo*.

Table 2.0 The Demographic Ladder[8]

Generation Name & Year Span	General Descriptions
Golden Oldies < 1927	Members of this era are now over 78 years old. Their income comes from Old Age Security, RRSPs, and Pension Plans. This cohort accounts for approximately 3% of the Canadian population
The Blessed Ones 1928 – 1946	The Blessed Ones are given this name as they make up a small cohort that had no competition when they entered the job market. This cohort amassed great personal wealth in Canada. They are currently between the ages of 60 to 77, and make up approximately 14% of the population.
The Baby Boomers 1947 - 1966	***They are the defining demographic cohort of Canada, accounting for 30% of the population***. The Baby Boomers have a strong influence on the Canadian market, and will continue to have the biggest impact on the age structure of the Canadian population. Members of this generation are between the ages of 40 and 59, and are beginning to retire from the workforce.
First Phase: 1947 - 1956 Woodstock Generation	The members of the first phase of the Baby Boom had an economic advantage: they made it to the job market before Generation X, but their sheer numbers resulted in a lot of competition when entering the workforce.
Second Phase: 1957 - 1966 Generation X	Generation X had the misfortune of experiencing a highly competitive workforce seeing as how they were the tail end of the Baby Boom. They were also had the disadvantage of experiencing two recessions during their career formation ages.
The Baby Bust 1967 – 1979	Making up 21% of the population, the Baby Busters don't have a lot of competition within their age group for the job market. The Baby Busters are more idealistic than Generation X, and their economic prospects are better than those of Gen-X. Members of this generation are currently between the ages of 27 and 39, and are on the edge of their prime income earning years.
Echo Boom 1980 – 1995	A relatively large cohort, making up approximately 22% of the population. They are the children of the Boomers. Aged between 11 and 26 years old, they will face more labour market challenges due to peer competition. The leading third of the Echoes are either in, or are about to enter the labour force. They think, behave, and interact differently than older generations.
Millennium Busters 1996 - 2010*	They are the children of the Baby Bust cohort. The Millennium Busters represent a small cohort (10% of the population), reflecting both the small size of their parents' generation as well as their parents' low fertility rate. They will benefit from reduced peer competition when they enter the labour force. **This generation isn't closed yet; it is forecasted to go up to 2010.*

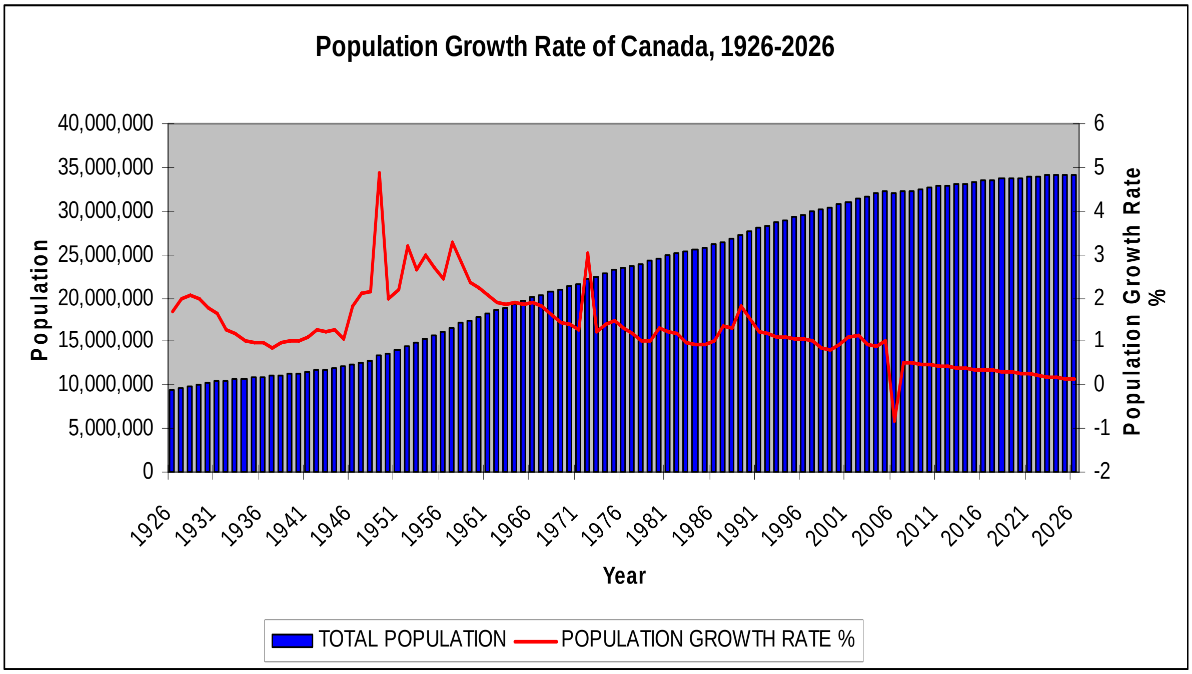
Source: Canadian Individual Taxpayers: a Changing Profile

[8] The proportion of the total population (%) that each cohort makes up has been calculated for the year ending 2005. Population data is from Statistics Canada. Some of the demographic ladder characteristics listed by Vinette and Yan (2004) have been omitted for the purposes of this study. I have changed the years for the cohorts to directly represent the work of David K. Foot (1998).

2.2 A Look at Canada's Population Trends

Following the baby boom, Canada's birth and population growth rates have steadily declined as illustrated in Figures 1 & 2. Using current demographic statistics the estimations of future growth rates are reliable, ceteris paribus.

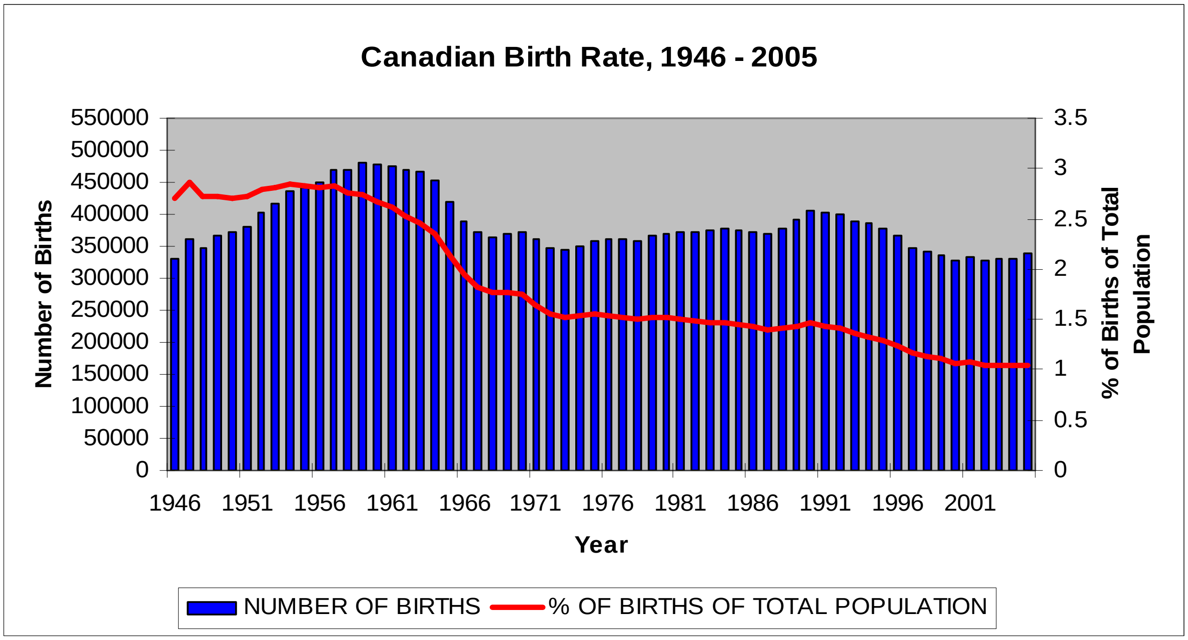
Figure 1: Population Growth Rate of Canada, 1926 - 2026[9]



Source: Statistics Canada

[9] Demographic Division, Statistics Canada. Forecasts are under the assumptions of medium variant fertility & immigration.

Figure 2: Canadian Birth Rate, 1946 – 2005

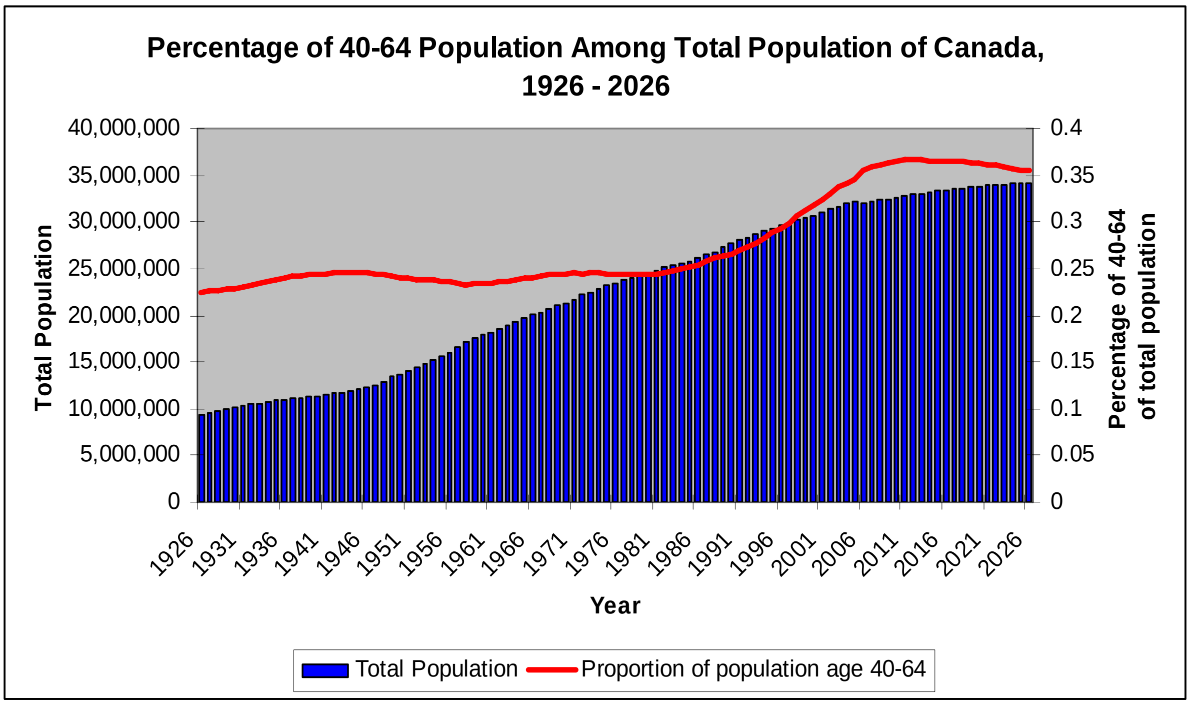


Source: Statistics Canada

It is evident from Figure 1 that following 1966 the population growth rate in Canada has steadily declined while the total population increases. The decrease in the growth rate is due to the declining number of births while the increase of total population is due to longer life expectancy and immigration. The spike of the growth rate occurs following World War II which is consistent with the increase in the birth rate. The only other rise in the growth rate is during the early seventies and late eighties presumably at the time when the boomers were beginning to have families of their own.

The effect of the baby boom is currently being seen with an increase in the number of middle aged people, and those who will become middle aged over the next ten years. The birth rate for 2005 was only 1.04 % of the total population; the number of people who will be dependent on the working population is rising and may potentially become a burden on the government and economy.[10] While the proportion of Canadians in the three age categories listed in Table 2.1 in the following section has consistently rose over the last eighty years, the ratio of those in the middle age (40-64) and elderly (65 and over) categories to the total population has increased starting in 1996, and is projected to continue rising as illustrated in the following graphs and table.

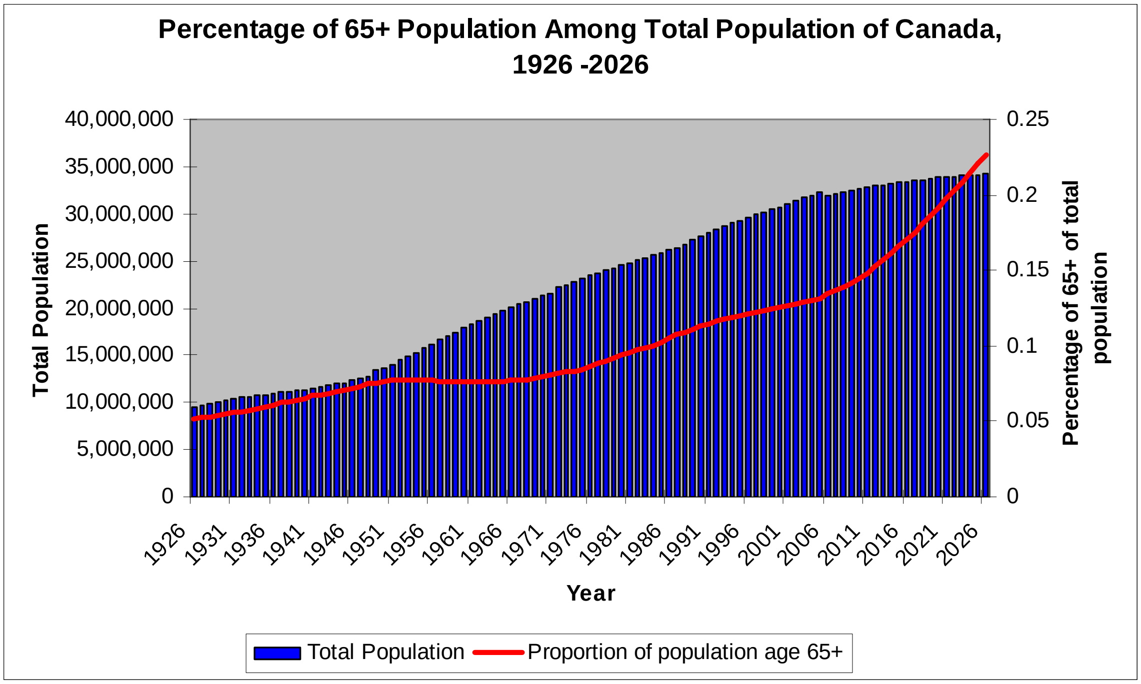
Figure 3: Percentage of 40-64 Population Among Total Population of Canada, 1926-2026



Source: Statistics Canada

[10] Number of births for 2005 from Stats Can; economic burden is being assumed as more people will be using the Canadian pension as their source of income, and there will not be enough workers in the future to help keep the pension at its current levels.

Figure 4: Percentage of 65+ Population Among Total Population of Canada, 1926-2026



Source: Statistics Canada

2.3 Dependency Ratio

To develop a better understanding of the potential burden that the boomers will place on the Canadian economy an examination of the current and forecasted elderly dependency ratio is essential. The ratio is the number of individuals aged 65 years and over to the number of individuals in who are of the working age population (aged 15 to 64).[11] Canadians who are 65 years of age and over are more likely to be economically dependent on the working age population.[12] The elderly dependency ratio has uniformly increased for ninety years. The biggest increase of 37% in the ratio for those aged 65 and over is forecasted to occur during the next twenty years (see Table 2.1 arrow). This

[11] Statistics Canada, Demography Divisions definition of the Elderly Dependency Ratio.
[12] Statistics Canada, Demography Divisions assumption.

implies that the number of people who are dependent on the working age will rise while the portion of the working age population will remain relatively constant.

Table 2.1 Canadian Age Category Population and Elderly Dependency Ratio Estimates and Projections (%)

Decade	Ages 15 - 39 / Total Population	Ages 40 - 64 / Total Population	Age 65+ / Total Population	Elderly Dependency Ratio
1926 – 1935	39.68	23.06	5.52	8.82
1936 – 1945	40.81	24.41	6.60	10.14
1946 – 1955	38.40	24.03	7.59	12.20
1956 – 1965	35.31	23.57	7.64	12.98
1966 – 1975	37.85	24.34	8.03	12.90
1976 – 1985	43.08	24.56	9.45	13.98
1986 – 1995	41.04	26.93	11.32	16.68
1996 – 2005	36.28	32.09	12.59	18.43
2006 – 2015	34.30	36.31	14.82	21.00
2016 – 2025	32.85	36.07	19.75	28.68

Source: Statistics Canada

Caution must be taken when interpreting the dependency ratio: it is a static analysis. In Canada the average age of retirement is assumed to be 65. As a result it is assumed that upon retirement an individual ceases to earn income and becomes reliable on her pensions and investments for consumption. Therefore, those who are retired presumably become dependent upon those who are of the working age for support. However, with an increase in the average age of life expectancy and better healthcare more people are choosing to remain in the workforce beyond the age of 65. On the same note some people are choosing to retire before reaching the age of 65. Therefore the dependency ratio is likely to be relatively accurate assuming that an equal number of people choose to retire before reaching the age of 65 and chose to continue working beyond the age of 65.

3.0 Macroeconomic Theories of Consumption and Investments

In this chapter I analyze the theoretical background on the relationship between demographics and financial asset returns. The following review provides the framework for understanding how an individual's investment and consumption decisions change throughout her life.

3.1 The Life Cycle – Permanent Income Hypothesis

The relationship between demographics and the prices of financial assets can be explained by the two leading macroeconomic theories of consumption: *the Life-Cycle Theory of Consumption* developed by Modigliani and Brumberg (1954) and Ando and Modigliani (1963), and the *Permanent Income Hypothesis* developed by Friedman (1957). The foundation of these two theories is that a consumer's current consumption is based on both the current value of her income, and the present value of her future expected income. These two hypotheses are derived from Fisher's (1933) inter-temporal consumption model.

The principle of Fisher's model is that a consumer lives for two periods and has access to markets which she can lend and borrow without restraint at the market interest rate. The optimization problem of the consumer is then to maximize her level of lifetime utility derived from consumption over the two periods.[13] Mathematically,

$$\max_{C_1, C_2} \; u(C_1) + \beta u(C_2) \qquad \textit{Subject to:} \quad C_1 + \frac{C_2}{1+r} = Y_1 + \frac{Y_2}{1+r} \qquad (1)$$

Where: C_1, C_2 = *level of consumption for periods 1 & 2 respectively*
Y_1, Y_2 = *level of income for periods 1 & 2 respectively*
U = *level of utility*
r = *the market interest rate*
β = $1 / 1 + \rho$ *, where* ρ *is the rate of time preference*

The budget constraint in equation 1 indicates that the present value of current consumption must be equal to the present value of future income. The first order condition of the model is given by equation 2:

$$u'(C_1) = \beta(1 + r)u'(C_2) \qquad (2)$$

Rearranged the F.O.C. yields

$$\frac{u'(C_2)}{u'(C_1)} = \frac{(1 + \rho)}{(1 + r)} \qquad (3)$$

In equation 3 if the rate of time preference ρ, equals the market interest rate r, then the condition implies that an individual tries to smooth her level of consumption across the two periods. This condition is shown in equation 4:

$$u'(C_2) = u'(C_1), \text{ implying that } C_1 = C_2. \qquad (4)$$

The implications of Fisher's model is that if the consumer has access to the market lending and borrowing rate then she will use these opportunities to "smooth out" her lifetime consumption pattern in order to maximize her level of utility.

[13] Equations for the Fisher (1933) model are taken from Professor F. Demers Econ 4201 lecture notes, Handout No. 4, February 2006.

When an individual first enters the work force she earns lower wages than she will in the future as she gains experience. Therefore, the individual will borrow during her early years (20 – 35 years of age) and lend during her later years (36 onward) in order to smooth out lifetime consumption and maximize utility. The life-cycle and permanent income hypothesis both represent the forward looking, consumption smoothing pattern of Fisher's model. The limitations of these models are the assumptions that the consumer has access to perfect markets, and has a homogeneous consumption pattern.

Hall (1978) examined an alternative explanation to the life cycle – permanent income hypothesis. He found that a consumer's lifetime pattern of consumption has the stochastic properties of a random walk. Hall empirically determined that only current consumption and (possibly) the prices of the stock market have a small degree of predictive power relative to future consumption.[14]

In a more recent study on the life-cycle hypothesis Browning and Crossley (2001) note that consumption smoothing need not be constant through time as the previous studies have assumed. Browning and Crossley's statement for the relaxation of this assumption is quoted below.

> It is important to emphasize that within the life-cycle framework, smoothing does *not* mean keeping consumption or expenditures constant – far from it. Rather, smoothing means that agents try to keep the marginal utility of money constant over time, which may involve quite variable expenditures. (p.4, italics, authors)

As described above this is the type of consumer behaviour seen in the marketplace. In order to keep her level of utility constant an individual will borrow, lend, invest, sell, and

[14] Robert E. Hall, (1978) pp.972-985.

buy various assets. This observation of consumer behaviour by Browning and Crossley supports both Halls (1978) empirical results and the life cycle – permanent income hypothesis. A consumer is assumed to be forward looking regarding her level of consumption. Empirically, it was shown that patterns of consumption follow a random walk. Part of this random walk is the consumer's attempt to maintain a constant level of utility.

3.2 Constant Relative Risk Aversion and Precautionary Savings

Contrary to the concept that an individual has access to perfect capital markets Zeldes (1989) relaxed this assumption and introduced the possibility that the individual may not have the access to markets at all. The assumption of Zeldes model is an individual has "constant-relative-risk aversion" (CRRA).[15] Therefore even if the individual can lend or borrow the possibility that she may become constrained in the future reduces the level of current consumption.

Consistent with the relaxed assumptions of the life cycle – permanent income hypothesis and with Zeldes (1989) model Caballero (1990) introduced a framework where the individual determines current and future consumption based upon her level of risk aversion. If the level of income in the future is uncertain, than the individual will reduce her level of current consumption in attempt to smooth out lifetime utility..

[15] Zeldes model is : $u(C) = (1-\gamma)^{-1} C^{(1-\gamma)}$, where γ is the measure of relative risk aversion. Formula and explanation of this model is from Professor F. Demers Econ 4201 lecture notes, Handout No. 4, February 2006.

Empirically found by Yoo (1994a), it is Caballero's model that is most common in the marketplace. As an individual becomes older she has fewer paychecks remaining before retirement; consequently, her level of risk aversion rises and current consumption is reduced. This implies that the individual will switch from investing in risky assets such as equities and switch to investing into safer assets such as bonds, RRSPs, and T-bills. These safer investments provide for a reliable source of future income.

3.3 Financial Assets and the Life Cycle Hypothesis

Using the theoretical background from the previous section it asserts that a consumer attempts to smooth her lifetime level of utility. The implication of this is that a consumer's level of savings and investments should also follow the life cycle pattern. When an individual enters the workforce (around the age of 20) she is presumed to have little income and borrow in order to help accumulate wealth. Between the ages of 20 – 39 an individual will borrow to help finance the purchases of expensive assets such as a car, or, a house as found by Mankiw and Weil (1989). During the middle aged years of 40 – 64, an individual is at her prime income earning years and thereby has more money to invest. The younger and middle aged individual has the opportunity available to her to use future expected income as compensation for any potential losses from investing. An older agent who is approaching retirement or who is retired does not have this opportunity available to her. At the retirement stage of life (ages 65 and over) an individual sets aside money and is assumed to go into the period of dissaving as a method to smooth out her lifetime level of utility. The life-cycle assumption of income earning patterns is evident for Canada as displayed in Table 3.1.

Table 3.0 Average Annual Income of Canadians sorted by age group, 1980 – 2003

Year	All Age Groups	Under 20	20 – 24	25 – 34	35 – 44	45 - 54	55 - 64	65 +
1980-1983	29,375	6,775	20,500	33,250	40,200	39,150	33,000	19,925
1984-1987	29,025	6,525	18,425	31,825	39,250	38,750	31,850	20,825
1988-1991	30,150	6,850	18,475	31,600	39,750	40,425	32,850	22,525
1992-1995	29,275	5,875	15,250	30,150	37,500	39,075	31,025	22,775
1996-1999	29,550	5,750	13,550	29,375	36,925	39,925	30,775	23,700
2000-2003	31,800	6,233	15,233	32,133	40,300	42,033	33,467	24,700

Source: Statistics Canada

Consistent with the life-cycle hypothesis, an individual between the ages of 35 – 54 is in her prime earning years. Between the ages of 20 – 34 an individual earns less and can use her expected future level of income to help smooth out consumption. Given the decrease in annual income for an individual aged 55 years and over, she will likely decrease her current level of consumption in an attempt to maintain a constant level of lifetime utility

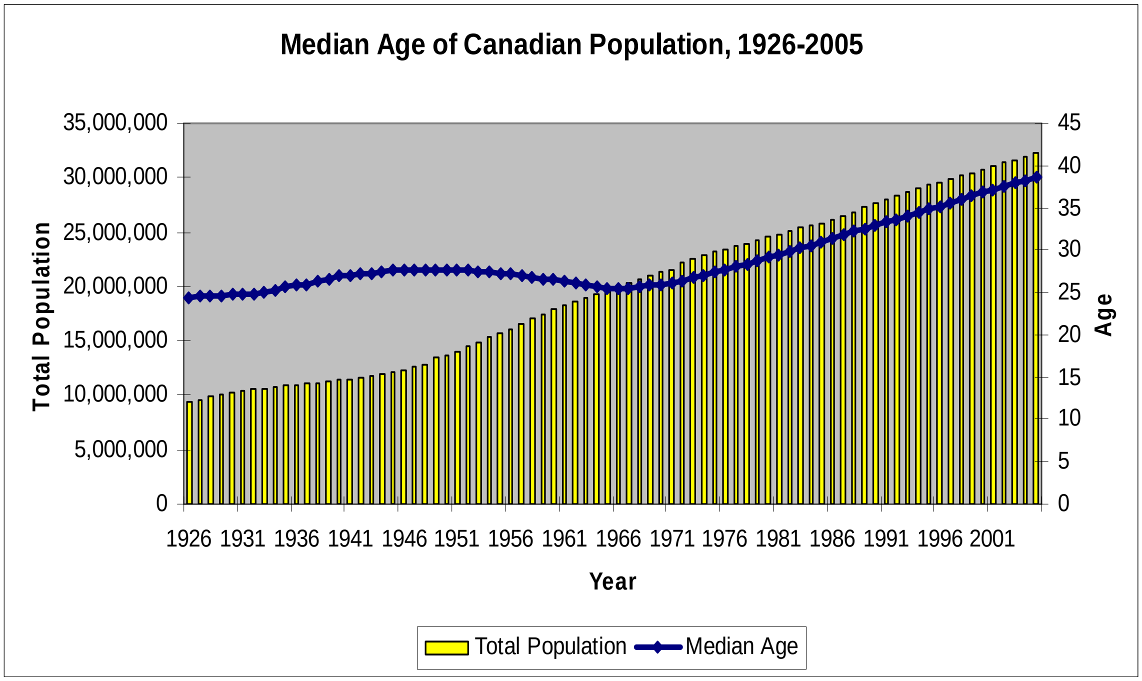
The hypothesis that at retirement an individual enters a period of dissaving is controversial at best: the average age of retirement in Canada is now younger than in the past, and the average age of life expectancy has increased over the last twenty five years (see Table 3.1). The increase in the average age of life expectancy can also be seen by the increase in the median age of Canadians as illustrated in Figure 3.

Table 3.1 Average Age of Retirement and Estimated Life Expectancy for Canadians

Years	Average Age of Retirement	Average Estimated Life Expectancy
1985 - 1987	63.77	76.63
1988 - 1990	63.10	77.30
1991 - 1993	62.40	77.90
1994 - 1996	61.93	78.20
1997 - 1999	61.03	78.80
2000 - 2002	61.43	79.57
2003 - 2005	60.50	80.00

Source: Statistics Canada

Figure 5: Median Age of the Canadian Population, 1926 – 2005



Source: Statistics Canada

The increase in the life expectancy and median age of the Canadian population is a reflection of better health care and of the baby boom cohort. These demographic changes may be an indication that an individual is choosing to remain invested in the market after retirement, assuming that she is in good health and is attempting to preserve her lifetime utility.[16] Uncertainty regarding longevity and potential ill health will also lead to precautionary savings. Another reason for choosing to remain invested for a longer period of time is that of the bequests motive.[17] Both of these factors are indications that the amount of dissaving by an individual at retirement is likely to be overestimated.

For simplicity I have assumed in this study that a consumer follows the life-cycle pattern of utility maximization. Therefore, in the early working years an individual will borrow, during the middle aged years she will invest, and upon retirement she will enter a period of dissaving.

In a study conducted by Yoo (1994a) he found that in the United States the majority of risky assets (equities) were held by middle aged individuals. The results of Yoo's study indicate that it is the baby boomers who own the majority of shares in the U.S. as they are in their prime investing/saving years. Evidence of Yoo's finding can be seen through the examination of Table 3.2. The average annual investment income earned per age cohort is displayed and the trend is that individuals from the age of 54 and over have the highest level of investment income. While the sources of investment income are not specified by Statistics Canada it can be assumed that the majority of income is from dividends and capital gains. Given that this age category has the highest level of investment income it is

[16] This is assuming that the individual will live to reach the average age of life expectancy.
[17] See Abel (2001).

potentially an indication that an individual belonging to this cohort is choosing to liquidate her assets and withdraw from the market; if this is the case then the individual is realizing higher capital gains.

Table 3.2 Average of Annual Investment Income per Age Group for Canada, 1980 - 2003

Years	All Age Groups	Under 20	20 – 24	25 – 34	35 - 44	45 - 54	55 - 64	65 +
1980 - 1983	4,775	1,150	1,400	2,225	3,725	5,325	7,250	8,375
1984 - 1987	4,575	1,875	1,500	2,100	3,250	4,700	6,475	7,800
1988 - 1991	4,525	1,425	1,550	1,850	2,825	4,375	6,625	8,125
1992 - 1995	4,175	1,075	1,500	1,825	2,575	3,625	5,625	6,900
1996 - 1999	3,300	1,150	950	1,000	1,725	3,225	4,675	5,300
2000 - 2003	3,400	1,067	1,100	1,433	2,400	3,267	3,967	5,100

Source: Statistics Canada

Consistent with the life-cycle assumption Browning and Crossley (2001) found that upon retirement an individual's level of consumption declined. The explanation offered for this is that the individual has realized that she previously misjudged her attempt to smooth consumption, and thereby scales back as a method to smooth consumption over the remaining years of her life.[18]

[18] Browning and Crossley (2001) p. 16.

The use of these assumptions in this study will allow for a better examination of the relationship between demographics and the returns earned on stocks and bonds in the Canadian market. I have selected a model for this study that also helps to provide insight to the future changes that may occur in the Canadian market upon the retirement of the baby boom generation.

4.0 Literature Review

In this section I have reviewed some of the previous literature and empirical studies on the topic relating the returns of financial assets to a nation's population. The following reviews explain the motive and the framework of the study.

4.1 The First Study on Demographics and Financial Assets

The impact that demographic changes can have on the financial markets is a relatively new topic in the field of financial economics. One possible explanation for the sudden emergence of interest in the topic is the increase in the number of middle aged baby boomers in many developed countries.[19]

The first investigation on the topic was conducted by Bakshi and Chen (1994) who tested two hypotheses on how demographic shifts affect financial markets. The first hypothesis they examined was that an individual invests in housing during the early stages of her working years and then switches to financial assets at the later stage; therefore, stock

[19] The developed countries consisting of: Canada, United States, Japan, United Kingdom, Italy, Spain, France & Germany. These are the countries that have been analyzed in most studies on this topic.

prices should rise and housing prices should decline. The second hypothesis tested for a relationship between the level of an investors risk aversion and her age. Both of the hypotheses examine the life-cycle pattern of investing.

They concluded that demographic shifts can affect the capital markets in various ways. For the first hypothesis, Bakshi and Chen found there to be a positive relationship between stock market prices and middle aged individuals in the United States; as the demands for stocks rise, there is a decline in the demands for housing. This result is consistent with the finding of Mankiw and Weil (1989) that the baby boomers were a cause of the increase in housing prices during the 1970's and 1980's. Bakshi and Chen's finding did not hold true though prior to World War II, thus indicating that the baby boomers are a cause for the increase in stock prices.

Using an Euler equation model to determine the risk aversion – age relationship Bakshi and Chen found an individuals' level of risk aversion to be an increasing function of age. Therefore, an increase in the average age of the population leads to an increase in the risk premium. One limitation to the results of the second test is that Bakshi and Chen did not consider the level of wealth that an individual has. If an individual is wealthy than she may be willing to take on a greater level of risk, regardless of her age, than that of an individual who has a lower level of wealth. However, Bakshi and Chen note two studies that have examined the wealth – risk aversion relationship. The consensus of the studies is that regardless of an individuals' level of wealth, the proportion of the wealth that is invested in cash and bonds increases with age.[20] Bakshi and Chen quote a Canadian study that examines the relationship between an individual's level of wealth, level of risk aversion and age.

> To quote another piece of evidence, the surveyed asset holdings of Canadian households lead Morin and Suarez (1983) to conclude that the 'investor's life-cycle plays a prominent role in portfolio selection behaviour, with relative risk aversion increasing uniformly with age'. (p.176)

Therefore, this implies that there is evidence for the increasing risk aversion – age relationship in Canada. However, Poterba (2005) states that "…survey evidence on household risk tolerance offers only limited support for the assumption that risk aversion rises with age" (p.179). Thus, without further examination a conclusion cannot be drawn if the relationship does hold true in Canada.

To further explore the relationship between changing populations and financial markets Erb, Harvey, and Viskanta (1996) replicated Bakshi and Chen's (1994) model using international data. Using the demographic data of 18 countries the authors concluded that Bakshi and Chen's model did not work in an international framework; they found little evidence of a relation between demographics and expected returns. The lack of support for the relationship likely arises through the use aggregated data and the independent variables: average age, population growth, and life expectancy growth. While these variables do capture the increase in the proportion of middle aged people, it likely understates the number of middle aged investors. As suggested by Yoo (1997) the limitations to this type of model are the assumptions that financial asset prices grow at the population

[20] See Baskhi and Chen (1994) p. 176.

growth rate, and that the average age variable remains relatively constant. Therefore the use of average age, population growth, and life expectancy as independent variables does not capture the true age specific-asset returns relationship.

4.2 The Asset Meltdown Hypothesis

Assuming that the baby boomers are following the life-cycle theory of consumption, speculation has been made that between the years 2010 and 2030 when these currently middle-aged folks choose to retire, there will be a decline in equity prices and in the rates of return earned on equities. Poterba (2001) referred to this phenomenon as being the "asset meltdown hypothesis". Given that the current average age of retirement in Canada is 60, the asset meltdown should start in 2007. It is still far too soon to determine if this will be the case though as there has not been a comparable baby boom in Canada, and given the uncertainty of using forecasted future market returns.

To better understand the relationship between demography and the financial markets Poterba (2001) offers an explanation with the use of an overlapping-generations model (OLG).[21] Numerically, the model is:

$$p^*K = N_y{}^* s \tag{5}$$

This model assumes that an individual lives for two periods: during the first period she works and saves (*y*), and in the second period she retires and consumes her savings (o). $N_y{}^*s$ represents the demand for assets during any given period. The individual normalizes

[21] Poterba (2001) p.566.

her production while working to one unit of a numeraire good; this durable good does not depreciate and is in fixed supply (K).The relative price of the asset in terms of the numeraire good is (p).

This model is consistent with the life-cycle hypothesis of consumption. An increase in the size of the working cohort will drive up the asset prices (as we have seen with the baby boom generation), while the following small working cohort (baby bust and echo) will lead to a decline in asset prices. Therefore as the large cohort works its way through the life cycle, the large cohort will purchase equities at high prices. Given that the following cohorts are not large enough to purchase all of the assets to keep equity prices constant, the large cohort will have to sell their assets at lower prices, thereby earning a lower rate of return. Thus, the liquidation of equities by the baby boom generation for consumptions purposes drives down both the stock prices and the rates of return.

There is evidence that the baby boomers are a cause for the increase in financial asset prices over the last 15 years. This evidence has been noted by many authors, including Poterba (2001), Yoo (1994), Goyal (2004), Abel (2001), and in a Canadian RRSP study conducted by Fougère (2002). The relationship between the proportion of the middle aged population who are in their "asset accumulating years" and the increase in stock prices is graphically evident as illustrated by Poterba (2005) for the United States (Figure 6).[22] By replicating Poterba's graph I find the same relationship to hold true (graphically) for Canada, as illustrated in Figure 7. However, during the period from 1968-1985, there appears to be a negative relationship between the real S&P/TSX

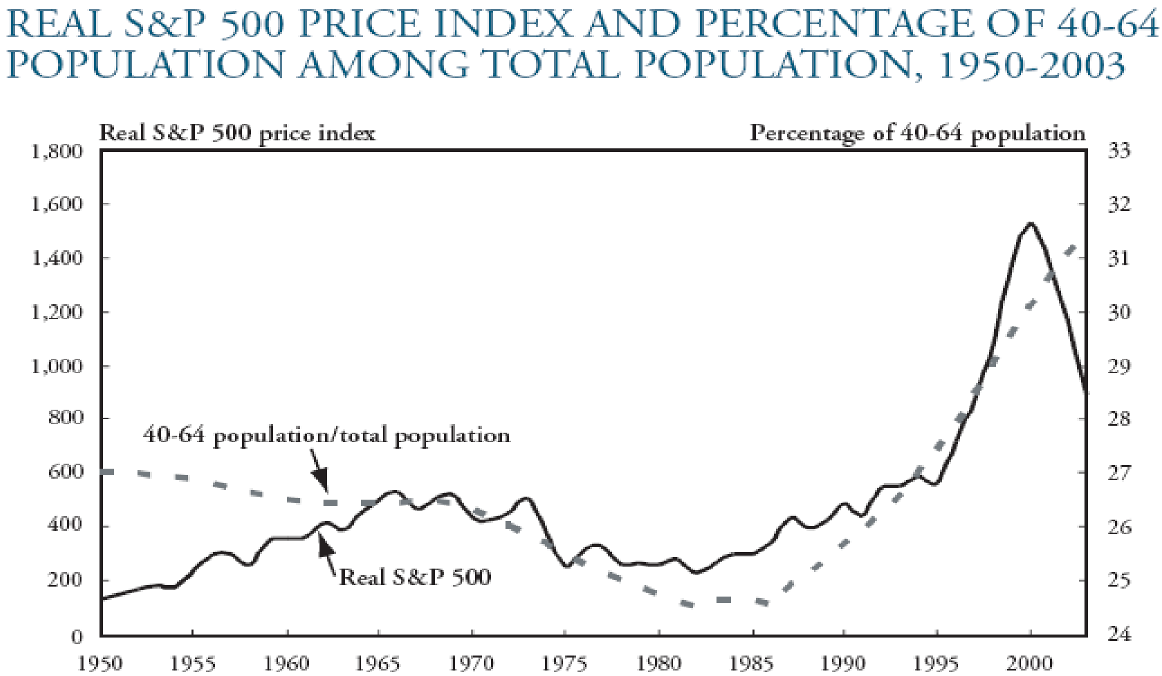
[22] Graph is from Poterba (2005), p.168.

composite price index and the percentage of the middle aged population (same relationship appears for the U.S.).

The results of a time split regression analysis (see Appendix C) indicate that during this time period when the "blessed ones" fell into this age category there was a statistically significant negative relationship between the rates of return earned on the S&P/TSX and the middle age cohort (the coefficient is -47.161). For the period 1986 – 2005 there is also a statistically significant negative relationship between the age 40-64 cohort and equity returns (the coefficient is -35.777). However, these regression results are for the *return on equities and not for the price*, which is the relationship that is illustrated in the graph. While the results of the regression for the entire time period from 1957-2005 does indicate there to be a statistically significant negative relationship between the middle aged population and the return on equities, the size of the coefficient is drastically smaller (-7.13, see Appendix C).

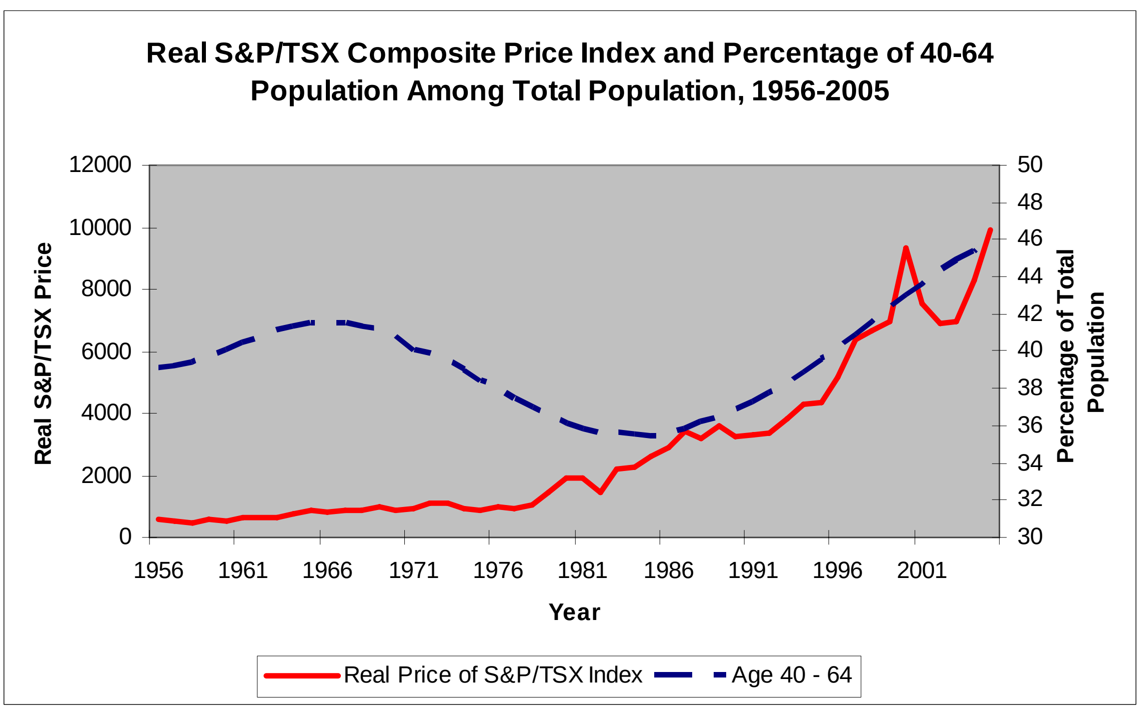
As Poterba (2005) notes, for the time periods when the positive relationship between the middle age cohort and stock prices does not hold there are "high-frequency movements in stock prices that are not related to demographics" (p. 166). Therefore, whether this pattern shows evidence of a relationship between demographic shifts and stock prices is debatable.

Figure 6: Poterba's Graph for the United States



Source: Calculated from U.S. Census Data

Figure 7: Canadian Relationship between the Real S&P/TSX Index Prices and the Middle-Aged Population



Source: Statistics Canada

The hypothesis of the asset meltdown intuitively does not make sense for the U.S. or the Canadian market. The Canadian market is assumed to be strong-form efficient, thereby implying that stock prices reflect all available information.[23] If demographics do have an impact on the rates of return earned on financial assets then this impact should occur at the time when the cohort is born. Therefore, the impact of the demographic shift should already be reflected in current share prices. Given that the population structure of Canada remains relatively constant (ceteris paribus) and projected future population statistics are available, there is no reason for an individual to not consider the potential affects of future demographic variations when she makes investment decisions. However, this does not mean that an individual remembers or considers all of the available information when making investment decisions. In a study by Della Vigna and Pollet (2003) the authors found that because investment analysts do not forecast corporate earnings beyond a five year time frame investors do not incorporate long-term trends such as demographic shifts into their investment decisions. Therefore, the assumption of a strong-form efficient market in Canada may be overstated.

Poterba (2001) drew the conclusion that the decline in asset demand will not cause a "meltdown" in the market but, there will be a small decrease in market prices. The small decrease is likely to occur because the liquidation of assets during the retirement years occurs at a slower rate than the accumulation of asset did during the prime saving years.[24]

[23] Bodie, Kane, Marcus, Perrakis & Ryan (2005), p.353. For the case of this study, I have assumed that the Canadian market is strong-form, though documented studies have shown that anomalies in Canada last longer than in the U.S.
[24] Poterba (2001), p. 583.

Also, the meltdown is unlikely to occur as some baby boomers will choose to remain invested in the market for precautionary and bequest purposes.

The relationship between the individual's level of risk aversion and age also has the potential of causing a downturn in the market. As noted by Bakshi and Chen (1994) that a person's level of risk aversion increases with age, Yoo (1994b) found that near the age of retirement an individual will switch from risky equities to safer assets like T-bills and government bonds. Given that the increase in an individual's age, and, that the estimated age of retirement is foreseeable, this implies that equity prices should not be driven down. The switch from risky to safe assets should already be reflected in share prices. Again, the ability of an investor to recognize this beyond a five year horizon is limited as found by Della Vigna and Pollet (2003).

4.3 The Empirical Relationship between Demographics and Asset Returns

Around the turn of the century there was an increase in the number of researchers who focused on the baby boom cohort and its potential impact on the economy. The interest in this relationship likely rose from the 'First Phase' of the baby boom generation having entered their middle aged years.

In an attempt to try and offer possible explanations between changes in financial asset prices, returns and demographics, researchers commonly use the OLG model that I have explained in the previous section (see equation 5). The simplicity of the model is likely the reason for its popularity amongst researchers. As later noted by Poterba (2005) the simplicity of the model leads to the necessity of very strong assumptions. The four key assumptions are:

1. Fixed saving rate for young workers
2. Fixed supply of capital
3. Closed economy without international capital flows, and,
4. Other economic effects of population aging (pp.173-174).

These strong assumptions of the model omit many realistic influences on the market such as floating interest rates, changes in the supply of capital, international investment, and immigration/emigration. The other limitation of the OLG model is the assumption that investors are forward-looking, and are aware of all available information regarding demographics and financial markets. Despite the strong assumptions, I have chosen to use an OLG model in this study.

One of the first studies to be conducted using an OLG model was done by Yoo (1994a). In his model Yoo assumed that an individual's life consisted of 55 periods: the first 45 were spent working and saving, and the last 10 the individual is retired and consuming her savings. The results of his simulation model suggested that demographic variables do have a significant relationship with the rates of return earned on financial assets following 1946. The conclusion was also drawn that the proportion of the population between the ages of 45 and 54 had a significantly negative relationship with the returns earned on financial assets. Yoo found evidence that the impact of a demographic shift can explain nearly 50% of the variance for the real return earned on T-bills. The relationship found by Yoo is economically logical; demographic shifts move slowly and therefore will have a greater impact on less volatile financial assets.

Similar to Yoo's (1994a) study Brooks (2000) uses an OLG model to simulate the American postwar baby boom and bust. The model uses two assets: shares of risky capital, and a risk free bond. For a more realistic examination of the life-cycle Brooks has agents living for four periods: childhood, young working-age, old working-age, and retirement.[25] The agent saves during the young and old working-age, consumes a portion of savings during the young working-age, and the remainder during retirement. The findings of model indicate that when the individuals are in their prime saving years (40-64) the bond yield rises from 4.5% to 4.8%, as it is during this time that the individuals are purchasing the equities (the risky assets). Upon the retirement of the baby boomers the risk-free rate subsequently falls to 4.1%, as the boomers are now switching to from the risky assets to the risk-free assets.

The result of Brooks's (2000) simulation model provides for a better reflection of what will potentially occur in real life. An old working-age boomer switches from the risky asset to the risk-free asset in an attempt to smooth out consumption for her upcoming retirement. Therefore, the increase in the demand for bonds raises the bond prices, thereby decreasing the rate of return (yield) earned on the risk-free asset. Simultaneously, the decrease in the demand for the risky asset (equities) leads to a decline in the rates of return earned by the boomers, as they have (presumably) purchased the equities at a higher price than the selling price.[26] As Brooks acknowledges, his model is not without

[25] Brooks (2000) p. 2.
[26] By this I mean that share prices change because of supply and demand. If more people want to buy a stock (demand) than sell it (supply), then the price moves up. Conversely, if more people wanted to sell a stock than buy it, there would be greater supply than demand, and the price would fall.

criticism; it uses all of the strong assumptions of the OLG model that have been previously stated.

To account for the possibility that agents do not consume all of their savings prior to death, Abel (2001) developed a rational expectations model to account for the possibility of a bequests motive. Using a general equilibrium OLG model with the inclusion of the bequests motive, Abel found that there will be a slight decline in the prices of stocks when the boomers retire (for the U.S.). This result is consistent with Poterba's (2001) findings. The outcome of Abel's study though is an indication that an individual may not choose to entirely withdraw from the market upon retirement. However, the bequest motives assumed in Abel's study are very general, and do not consider that possibility that agents remain invested for the purposes of precautionary savings.

Following up Abel's (2001) study, Lim and Weil (2003) use a model made up of demographic cohorts proportional to the American economy. As they emphasize in their paper "…the continuous time structure of our model is more amenable to calibration than his (Abel's) OLG structure, we are able to asses the quantitative impact of a baby boom on asset prices."(p.361). The results of Lim and Weil's model indicate that with the baby boomers exiting the market the likelihood of this demographic shift having an effect on stock prices is weak. However, their model does predict that there will be a decline in stock prices in the coming years of 2010-2030, though the impact would not be significant enough to be classified as a meltdown. The limitation of Lim and Weil's result is that the decline would be the case as long as the number of participants in the labour force remained relatively constant, and that the discovery of a large demographic shift is foreseeable.

Empirically the relationship between demographics and asset returns appears to be relatively weak. A more recent study conducted by Goyal (2004) found that the use of demographic variables in regressions involving rates of return significantly added to the models predictive power in the United States. The results of his regression analysis support the life cycle hypothesis; outflows from the stock market were positively related to an increase in the portion of retired people (age 65+) and negatively related to the portion of middle aged people (45 – 64). International studies such as the ones conducted by Ang and Maddloni (2005) and Davis and Li (2003) also found this relationship to hold true. The interpretation of international studies though can be misleading as aggregated data is used, and each of the developed markets used vary in size as does each nations population.

Poterba (2005) did not find a relationship between asset returns and demographics in his most recent study for the United States. Poterba conducted regressions using both demographic and non-demographic (control) variables on the rates of return for stocks, long term bonds, T-bills, and the price-divided ratio on common stocks.[27] As Poterba (2001) acknowledge in his previous study that non-demographic variables should be included in the regressions, this time he included two such control variables: the three year average GDP growth rate, and the real interest rate. However, the control variables

[27] Poterba's (2005) demographic variables are: the share of the total population between the ages of 40-64, the share of the total population over the age of 65, the share of the adult (ages 20+) population between the ages of 40 and 64, and the share of the adult population over the age of 65.

were only included in the regression that examined the relationship between the price-dividend ratio on common stocks and demographic variables.

Overall there was no indication of a relationship existing for the United States. Conversely, in his earlier study Poterba (2001) found there to be a significant positive relationship between the yields earned on long-term bonds and the proportion of the middle-age population (40-64) for Canada. Poterba clearly states that the limited number of degrees of freedom is likely a factor behind finding no significant relationship for the United States. Also the exclusion of non-demographic variables that influence the rates of return earned likely contributed to the insignificance of his models, as he only regressed the four demographic variables on the bond yield, the equity return and the T-bill return. To help eliminate this problem I have chosen models that use four or more macroeconomic variables in the regression.

4.4 The Trends amongst Past Literature and Empirical Studies

After conducting a review on previous literature and empirical tests the certainty regarding a relationship between demographics and the return on financial assets remains unclear. While most studies conclude that there is a relationship, the significance of the relationship appears to be weak at best. The empirical specifications that are used in each study are also open to debate. The lack of Canadian studies does not allow for a conclusion to be drawn if historically the relationship holds true. It cannot be assumed that because Canada and the United States are closely related that the empirical results of Canada will be close to those of the U.S., as Poterba's (2001) evidence has shown.

Canada is also commonly left out of the international studies given its smaller total population relative to other OECD countries.[28]

In this study I examine the effect of the demographic shift of the baby boomers from middle age to retirement, and if demographic shifts have an impact on the rates of return earned on stocks and bonds in the Canadian market. The review of previous literature and empirical studies has helped to set out the framework for this study. The next section lays out the data and the methodology that I have used to examine the relationship.

5.0 Data and Methodology

In the follow section I present the data used for in the empirical analyses along with the models that I have chosen to examine the relationship between demographic variables and asset returns. Also, I clarify all of the data transformations that were necessary for the analyses.

5.1 Canadian Data

For both of the models I have used annual data from the years 1956 – 2005. The beginning year of 1956 was selected as the data for the S&P/TSX composite index prices is available starting in this year.[29] The analysis that I have done provides results for nearly the last 50 years in Canada, including approximately ten years (1956-1966) prior

[28] Canada is omitted from the international studies of Erb, Harvey & Viskanta (1996), Ang & Maddaloni (2005) and Davis & Li (2003).

[29] Prior to the year 2000, the composite index of the Toronto Stock Exchange was the TSX300.

to the entrance of the baby boomers in the workforce. The most current data analysis conducted on demographics and asset returns for Canada was done by Poterba (2001), and his sample period ended in 1997. The analyses that I have conducted include the last seven years, 1998 – 2005. These additional years help to provide for a better analysis as this time period includes a bull market for equities and the boom and bust of the technology sector, as well as the beginning of its recovery. Also, these additional years help to capture the beginning of the retirement period of the baby boomers.

The Canadian population by age, forecasted population by age, life expectancy, and vital statistics data sets are from Statistics Canada.[30] Annual and monthly S&P/TSX composite index prices, the S&P/TSX annual dividend yield, as well as annual and monthly CPI index values are also from Statistics Canada.[31] The annual nominal GDP and GDP deflator, nominal rate on T-bills, nominal yield on 10 year government bonds, and the nominal long term interest rate (end of period bank rate) statistics for the years 1956-2005 have be taken from the IMF Financial Statistics yearbook.

All transformations of the data have been conducted using Excel. All real variables have been calculated by taking the annual nominal value and subtracting the annual rate of inflation. The annual rate of inflation is calculated as the annual change in the CPI index. The regression analyses for equities and bonds have been run using the Shazam Professional Edition 10.0 econometric software package.

[30] See data sources under References
[31] See data sources under References

5.2 Selection of the Econometric Models

After the review of previous empirical studies I considered various factors in the selection of the models that I would use for this study. As stated in section 4.1 the model used by Bakshi and Chen (1994), and by Erb, Harvey and Viskanta (1996) used average age as one of the independent variables. This variable is not the best to use given that it is not representative of the proportion of the middle-aged agents who make up the total population. Poterba's (2005) use of regressing four demographic proportions of the total population on asset returns does not consider additional macroeconomic variables that can affect the rates of return. The omission of macroeconomic control variables could be part of the reason as to why he found the demographic variables to be insignificant.

Following the suggestions made by Poterba (2001) regarding model specifications, Davis and Li (2003) developed a model with control variables for macroeconomic influences on stock, and on bond returns. The results of their model are significant and robust in comparison to those of Poterba's (2001). Therefore, I chose to use the models developed by Davis and Li for this study to see if the results for Canada will be different from those of Poterba's (2001). The specifications of the models are explained in the following section.

5.3 The Equity Model

As I have chosen to use the models developed by Davis and Li it is important to explain their choice of variables. As Davis and Li state in their study, the use of appropriate measures for share prices and the return on bonds will allow for a better understanding of the affects that demographic variables may have. This method helps to keep the results of the model from being subjected to "omitted variable bias".[32]

One of the dependent (non-demographic) variables of the model is the lagged dividend yield on the composite index of the market that is being studied. The purpose of using the dividend yield is that share prices can be estimated using the present value of the future dividend. Since the values of dividends are relatively easy to predict given a company's history, the current intrinsic value of a stock can be determined using the present value of the forecasted dividend. This is known as the Gordon dividend discount model (DDM).[33] As explained by Bodie et al. (2005) the DDM is clarified mathematically as follows: Let,

V_t *= the present value of the stock at time t, where t = 1,2,…T.*
D_t *= the forecasted dividend at the end of year t*
g *= the growth rate of the dividend, and*
k *= the discount rate (assumed to be the real long rate of bonds).*

Therefore,

$$D_1 = D_0\,(1+g),\ D_2 = D_1(1+g),\ \ldots D_T = D_{t-1}(1+g) \quad (6)$$

$$V_0 = \frac{D_0(1+g)}{1+k} + \frac{D_0(1+g)^2}{(1+k)^2} + \frac{D_0(1+g)^3}{(1+k)^3} + \ldots + \frac{D_0(1+g)^T}{(1+k)^T} \quad (7)$$

$$Vt = \frac{D_{t+1}}{k-g} \quad (8)$$

From the above equations of the DDM it is evident that the present value of the future dividend yield is reflected in the current stock price.[34] As shown in equations 6 and 7, the value of the stock will grow by the same rate as that of the dividend. This verifies the importance of including the dividend yield in the econometric model for the composite

[32] Davis and Li (2003) p.18.
[33] See Bodie, Kane, Marcus, Perrakis and Ryan (2005) p. 564.
[34] All of the equations illustrating the DDM model have been taken from Bodie, Kane, Marcus, Perrakis and Ryan (2005) pp.564-567

index prices. The dividend yield must be a lagged value, as the *expected future price* of the dividend is a key determinant in the current valuation of share price, as seen in equation 8. This is verified in the studies of Campbell and Shiller (1989), and of Fama and French (1988) as stated by Davis and Li. The restriction of the constant DDM model is that the value of $\boldsymbol{k}$ must be greater than that of **g** which may not always be the case.

In specifying their model Davis and Li (2003) state that the growth level of the gross domestic product (GDP) serves as a proxy for the rate of dividend growth, $\boldsymbol{g}$. This is because "capital's share of GDP is bounded" (p.18). Davis and Li used GDP trend growth and cyclical growth variables in their model. Both of these variables were determined by Davis and Li through the use of the Hodrick-Prescott (HP) filter on the first difference of natural logarithm of GDP. The cyclical effects are then measured as being the difference between the real GDP and the trend GDP variable.

Davis and Li made an error in their use of the HP filter; the growth rate of annual GDP is not what should be run through the HP filter.[35] Rather, the natural logarithm of the real annual GDP should be used, not the first difference (growth rate). The purpose of the HP filter is to decompose an observable macroeconomic time series Y_t, into a nonstationary time trend (g_t) and a stationary residual component (c_t), which represents the cyclical effect, that is:[36]

$$\boldsymbol{Y_t = g_t + c_t} \qquad \textbf{\textit{(9)}}$$

[35] I am grateful to Professor Hashmat Khan for pointing out this error.
[36] The HP filter equations are from the website http://www.er.uqam.ca/nobel/d241504/HP.pdf

Note that both g_t and c_t are unobservable. Rearranging equation 9 it is evident that an estimate for the cyclical component c_t can be extracted by taking the difference from Y_t and g_t, as illustrated in equation 10.

$$c_t = Y_t - g_t \tag{10}$$

Through the use of an econometric software package it is easy to find the values of both g_t and c_t. The Y_t variable that I have used in this study to correct for Davis and Li's error is the natural logarithm of real annual GDP (lnGDP). I have used a HP filter with a smoothing factor of 100 on the lnGDP variable to generate the variables trend GDP (g_t), and the cyclical effect of GDP (c_t).[37] For the results of the HP filter see Appendix A.

5.4 Econometric Specifications of the Equity Model

Following the theoretical discussion of Davis and Li's empirical model, the econometric specifications of the model are presented below. The necessary changes that I previously stated have been made.

[37] In Shazam the default values for the HP filter are 100 for annual data, 1600 for quarterly, and 14400 for monthly.

$$\Delta \ln RSP_t = \alpha + \beta_1 AGE20\text{-}39_t + \beta_2 AGE40\text{-}64_t + \beta_3 GDPHP_{(t)} + \beta_4 GDPCY_{(t)} + \beta_5 RLR_t + \beta_6 VOL_t + \beta_7 DIVY_{(t-1)} + \varepsilon_t \tag{11}$$

Where:

$\Delta \ln RSP_t$	=	The natural log of the change in the annual real S&P/TSX composite index price. The real price is calculated by taking the natural log of the average annual nominal share price and then subtracting the annual rate of inflation. The annual rate of inflation is calculated as being the change in the annual Consumer Price Index (CPI). $(CPI_t - CPI_{(t-1)})/CPI_{(t-1)}$.
$AGE20\text{-}39_t$	=	The number of people in the Canadian population between the ages of 20 and 39 divided by the total Canadian population.
$AGE40\text{-}64_t$	=	The number of people in the Canadian population between the ages of 40 and 64 divided by the total Canadian population.
$GDPHP_{(t)}$	=	The HP filter on the natural log of annual real GDP. Annual real GDP is calculated by dividing the nominal GDP by the GDP deflator. Real annual GDP is then put into natural log form (lnGDP).This variable estimates the annual trend of GDP.
$GDPCY_{(t)}$	=	The difference between the annual lnGDP and GDPHP variables. This variable is the annual cyclical effect of GDP.
RLR_t	=	The annual real yield on the 10 year Canadian government bond. The real yield is calculated by subtracting the annual rate of inflation from the nominal yield values.
VOL_t	=	Real share price volatility. This is measured as the annual standard deviation of monthly changes in real share prices.
$DIVY_{(t-1)}$	=	The lagged annual dividend yield on the S&P/TSX composite index.
$\beta_{1,\ldots,7}, \alpha$	=	parameters of the model
t	=	1957, 1958, …,2005
ε_t	=	stochastic error term

The rationale of this model is similar to that of Yoo's (1994a) model. This model is used to determine if age distribution is an indicator of the demand for financial assets. Theoretically an increase in the proportion of the total population between the ages of 40-64 will decrease the rate of return earned on equities. Given that an individuals' level of risk aversion is an increasing function of age (Yoo 1994a) they will choose to liquidate their riskier asset and switch to investing in safer assets (bonds and T-bills). Since the baby bust and echo generations are not a large market there will be less of a demand for equities. The boomers will then have to sell their equities (supply) at a lower price and thereby they will realize a lower rate of return.[38] Therefore, the implication of this hypothesis is that the sign of the coefficient for the AGE20-39 variable (β_1) should be positive, as this cohort is less risk averse and willing to purchase equities. Conversely, the coefficient of the AGE40-64 variable (β_2) should have a negative sign, as the members of this cohort are more risk averse and are selling their stocks.

While Yoo's (1994a), and Poterba's (2001) regression models regress the independent demographic variables on the rates of return and yields, this inclusion of macroeconomic variables allows for a comparison to be made between the significance of the demographic variables and the macroeconomic variables.

The demographic variables in this model as previously explained have been split into two age groups; the proportion of the population between the ages 20-39, and 40-64 as a percentage of the total population. I have not included the proportion of those aged 65 and over as the focus is on the baby boom generation; the eldest of the baby boomers are currently 59 years old. As noted by Davis and Li (2003) the use of fewer demographic variables also helps to avoid the problem of "over fitting" that can occur.[39] In this model I have assumed that at age 20 individuals begin to earn income and continue to earn up until reaching the age of 65. The use of the beginning and end points is open to criticism

[38] This is assuming that the boomers are selling their stocks at a lower price then they had purchased them at.

[39] The problem of over fitting the model was experienced in the studies of Yoo (1994a), and Macunovich (1997).

as many people at the age of twenty are likely to be in school, and the average age of retirement in Canada is now approximately 60.[40] As mentioned in Section 3.3, some individuals may choose to retire later than the age of 65.

The use of the variables GDHP and GDPCY have been explained in section 5.2, as has the purpose of the variable $DIVY_{(t-1)}$. The long-run real return on bonds is used as a proxy for the risk free rate; some investors who are more risk averse use this to determine whether or not to invest in the market. An increase in the real return on bonds may lead to fewer people investing in the market, thereby pushing down the rates of return earned on equities.

The volatility of the market (variable VOL) is included in the model as it directly reflects the rates of return that are earned on assets. The greater the volatility of the market the increased likelihood that fewer people will invest, as volatility is a measure for risk.

5.5 The Bond Model

Davis and Li developed a model that allows for comparison between the effects that demographic and macroeconomic variables have on the real long-term yield of bonds. Given that the long-term yield is derived from the expectations theory of term structure it is a dependent variable of the model.[41] This is because the long-term interest rate is based on the future expected short rates. The change in the short rate is used as a proxy for

---

[40] See Table 3.2

[41] Davis and Li (2003) p.23. The term structure is the nominal long interest rate minus the short rate.

monetary tightening. The lag of the term structure is used as it provides a "mean reversion".[42]

Two consumer price index variables are included in the model for the purpose of providing a measure of the affects that inflation has on the real long-term interest rate. The lag and acceleration of the rate of inflation using the natural log of the change in the CPI index are independent variables in the model to "allow for deviations from the Fisher identity".[43] These variables help to account for the possibility that the real interest rates (long and short) may be lowered by unexpected inflation. The trend GDP and cyclical GDP variables from the use of the HP filter (same as in the equity model) help to forecast future interest rate changes, and capture the effects of the consumers' demand for loans.

As noted by Davis and Li, this model is not without its limitations. It does not allow for the possibility of changes in monetary policy regime, which has occurred in Canada over the years that are being analyzed using this model (1957-2005). It is assumed that investors have no rationale expectations about the future of interest rates. This is unrealistic given that changes to the interest rate are announced well in advance by the government, and are also forecasted at least a year in advance by financial institutions. Davis and Li use the money market rate given by the IFS data bank as their short term interest rate. To allow for a better analysis, I have used the yield on Canadian T-bills as the short term rate. The reason behind this is that the money market rate for Canada was unavailable prior to 1975. A short term interest rate is defined as the rates on loan

[42] The term "mean reversion" is used with reference to time series data. It implies that the data will tend to return to its mean, and that its variance will remain relatively constant at various lags.
[43] See Davis and Li (2003) p.24.

contracts-or debt instruments such as T-bills, bank certificates of deposit, and commercial papers that have maturities of less than one year.[44] Therefore, using the return on T-bills as the short term rate is interchangeable with the money market rate. The use of the T-bill rate also allows for an increase in the number of degrees of freedom for the model.

5.6 Econometric Specifications of the Bond Model

I have used the bond model developed by Davis and Li in this study. I have also made the changes to the trend GDP and cyclical GDP variables as I have explained in section 5.2. The specifications of the bond model are:

[44] Definition for the short term rate comes from www.investopedia.com .

$$\mathbf{RLR_t = \alpha + \beta_1 AGE20\text{-}39_t + \beta_2 AGE40\text{-}64_t + \beta_3 DSR_t + \beta_4 TS_{(t-1)} + \beta_5 \Delta lnCPI_{(t-1)} + \beta_6 \Delta\Delta lnCPI_t + \beta_7 GDPHP_t + \beta_8 GDPCY_t + \varepsilon_t} \quad \mathbf{(12)}$$

Where:

$\mathbf{RLR_t}$	=	The real bond yield on 10 year Canadian government bonds. The real yield is calculated by subtracting the annual CPI inflation rate from the nominal series.
$\mathbf{AGE20\text{-}39_t}$	=	The number of people in the Canadian population between the ages of 20 and 39 divided by the total Canadian population.
$\mathbf{AGE40\text{-}64_t}$	=	The number of people in the Canadian population between the ages of 40 and 64 divided by the total Canadian population.
$\mathbf{DSR_t}$	=	The first difference of the nominal short term interest rate. The short term interest rate used is the annual yield on T-bills. The first difference is calculated as $SR_t – SR_{(t-1)}$.
$\mathbf{TS_{(t-1)}}$	=	The lagged term structure. Term structure is calculated as the annual nominal long term interest rate less the annual nominal short rate.
$\mathbf{\Delta lnCPI_{(t-1)}}$	=	The lagged first difference of the annual CPI. The CPI is put into natural log form. The first difference is calculated as $lnCPI_t – lnCPI_{(t-1)}$.
$\mathbf{\Delta\Delta lnCPI_t}$	=	The second difference of the natural log of the annual CPI. The second difference is calculated as $\Delta lnCPI_t – \Delta lnCPI_{(t-1)}$. This variable measures the acceleration of the rate of inflation.
$\mathbf{GDPHP_{(t)}}$	=	The HP filter on the natural log of annual real GDP. Annual real GDP is calculated by dividing the nominal GDP by the GDP deflator. Real annual GDP is then put into natural log form (lnGDP).This variable estimates the annual trend of GDP.
$\mathbf{GDPCY_{(t)}}$	=	The difference between the annual lnGDP and GDPHP variables. This variable is the annual cyclical effect of GDP.
$\beta_{1,\ldots,8}, \alpha$	=	parameters of the model
$\mathbf{t}$	=	1957, 1958, …,2005
ε_t	=	stochastic error term

The hypothesis that is being tested using the bond model is that as the proportion of the middle aged population rises the yield on long term government bonds should decrease. The theory of this is from the risk aversion age relationship; as individuals' age, their level of risk aversion rises, therefore they choose to sell their risky assets (stocks) and invest in safer assets such as bonds. An increase in the demand for a bond raises the price of the bond. This price increase leads to a decrease in the bond yield. This implies that the bond yield should be negatively related to the proportion of the middle aged population as they are more risk averse and are increasing the demand for bonds. Therefore, the sign on the coefficient ($\beta 1$) for the AGE20-39 variable should be positive as this age group is less risk averse and investing in the stock market. The sign on the coefficient ($\beta 2$) for the AGE40-64 variable should be negative as this age group is more risk averse.

All of the data used in both of the models has been transformed following the specifications given in Davis and Li's paper. However, some differences in data transformation may arise. For example, Davis and Li state that they have taken the logarithmic difference in their appendix on variable and data description, and in the paper they have written state the transformation that has been used in the equations as being the difference between the natural logarithm of a variable.

The natural logarithm of a variable is used as it is a measure of the growth rate of that particular variable. Intuitively this is the reason behind using the natural logarithm of the real share price, GDP, and CPI. The difference between the annual natural logarithms of the real share price is equal to the real annual rate of return when using the holding period return calculation, $(RSPt - RSP_{(t-1)}) / RSP_{(t-1).}$ The difference between the annual natural logarithm of CPI provides the annual rate of inflation.

6.0 Empirical Results

In the following section I explain the diagnostic and specification tests, regression analyses, and the results of the models.

6.1 Diagnostic and Specification Tests

Prior to running the formal tests on time series data it is important to test the variables to determine whether or not they are stationary. A variable is said to be stationary if its mean, variance, and autocovariance at various lags in time remain the same no matter the point in time that they are measured at. Time series data is non-stationary if its mean, or variance, or both are time-varying. As stated by Gujarati (2003),

> …if a time series is non-stationary, we can study its behaviour only for the time period under consideration. Each set of time series data will therefore be for a particular episode. As a consequence, it is not possible to generalize it to other time periods. Therefore for the purpose of forecasting, such (non-stationary) time series may be of little practical value (p.798).

I have tested the equity and bond variables for a unit root using the Dickey-Fuller (DF) test. The null hypothesis of the Dickey-Fuller test is that there is a unit root; the time series in non-stationary. Rejection of the null hypothesis implies that the time series is stationary. I tested the time series for unit roots both with, and without a trend in Shazam.[45] The results of the unit root tests for the variables in the equity and bond equations are shown in Table 6.1.

[45] Let Y_t represent the time series. The DF equations with and without a trend are: $\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t$, and $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t$. In each case the null hypothesis is that $\delta = 0$ - the time series is non-stationary.

Table 6.0 Dickey-Fuller Unit Root Tests

Variable	Dickey-Fuller Test Statistic with no Trend	Dickey-Fuller Test Statistic with Trend
LNRSP	-68999E+06**	-66549E+06**
AGE20*e*	-3.9496**	-2.9596
AGE40*e*	-1.2124	-2.2543
GDPHP*e*	-1.9520	-2.9822
GDPCY*e*	-3.4480**	-3.4055**
RLR*e*	-2.1908	-2.1364
VOL	-1.7264	-3.0213
LAGDIVY	-3.5128**	-5.2667**
RLR*b*	-2.2547	-2.1355
AGE20*b*	-4.0807**	-3.2051*
AGE40*b*	-1.2390	-2.5653
DSR	-2.8469*	-3.2339**
TS	-2.6437*	-2.9624
LNCPI	-1.4242	-1.5777
LNCPII	-2.8058*	-3.0967
GDPHP*b*	-1.8756	-3.1948**
GDPCY*b*	-3.3987**	-3.3549*

**Significant at the 10% level*
***Significant at the 5% level*
e, b, denoted variables for the equity and bond model respectively.
Critical t-values for the DF statistic are -2.57, -3.13, -2.86, and -3.41 at the 10 and 5% levels respectively.

The DF test statistics with no trend indicate that 9 of the 17 variables do not have a unit root: they are stationary. For the DF test with a trend 7 of the variables are stationary. Three of the variables, AGE20e, GDPHP*e*, and VOL are borderline stationary. The variables that are non stationary, AGE40, GDPHP*e&b* (with no trend), and VOL all have an upward trend (see Appendix B for graphical illustration). Therefore, it is logical that these variables have a unit root. The RLR, VOL (with no trend), and LNCPII variables also have a unit root. Generally the variables in the models are stationary or borderline stationary. However, given the presence of some non-stationary variables I have not used either of the models for forecasting purposes.

Following the unit root test I conducted an ordinary least squares (OLS) regression for the equity and bond model using Shazam. After examining the results of the OLS regression I plotted all of the variables and the residuals against time (Appendix B), and tested for the presence of multicollinearity, heteroskedasticity, and autocorrelation in the model (for the numerical results of the OLS and the diagnostic tests see the Shazam output in Appendices C and D).[46]

By plotting the residuals of each OLS regression against time there was no graphical evidence (pattern) to suggest the problem of heteroskedasticity or autocorrelation in either of the models. The residuals appeared to be normally distributed. I used Jarque-Bera test to verify that the residuals were normally distributed. The *p*-value for the Jarque-Bera test was 0.93 and 0.747 respectively for the equity and bond models. Therefore, the residuals of both models are normally distributed.[47]

Next, I tested for the presence of multicollinearity in each of the models. The term multicollinearity means that there a linear relationship between some or all of the explanatory variables of the regression model.[48] If multicollinearity is present in the data,

[46] The spelling of heteroskedasticy is quoted in the Shazam guide, "A 'c' is often used instead of a 'k' in the spelling of heteroskedasticity. The research by McCulloch (1985) concludes that the word is derived from Greek roots and the proper English spelling is with a 'k'". Therefore I have used this spelling of the word.
[47]Gujarati (2003) p.149 states that if the p-value reasonably high than we do not reject the normality assumption.
[48] Gujarati (2003) p. 342.

than the likelihood of accepting a false hypothesis increases. I conducted four different tests to determine if the variables are collinear: the correlation matrix, the condition index (CI), auxiliary regressions, and the variance inflation factor (VIF).

The results of the correlation matrix for the equity model indicate that the AGE40-64 and GDPHP variables are positively correlated, and that the lagged dividend yield and AGE40-64 variables are negatively correlated. The negative relationship between the lagged dividend yield and the middle aged cohort is logical; in the absence of any capital gains, the dividend yield is the return on investment for a stock. As I have previously stated, an increase in the proportion of the middle aged population will decrease the rates of return earned on equities.

For both of the models there is a correlation between the AGE40-64 and GDPHP variables. It is logical that the AGE40-64 and GDPHP variables are collinear as the proportion of those who fall under the AGE40-64 category make up the majority of the workforce; as this proportion (the workforce) increases the GDP should also increase. However, the negative relationship in the bond model between both of the population variables and GDPHP is somewhat puzzling.

The equity model has a CI value of 39,571, and the bond model has a CI value of 483.34, thereby indicating that some (or all) of the variables are collinear. To determine which variables are collinear I ran an auxiliary regression. Regressing each of the variables on each other computes a corresponding R^2; if the computed R^2 is greater than the R^2 of the overall model it suggests that there may be troubles with multicollinearity.[49] Using the R^2 from the auxiliary regression for the equity model, the only non-collinear variable is GDPCY. For the bond model the only collinear variables are AGE40 and GDPHP. To better determine which of the variables are collinear I computed the VIF. (For the VIF values see Appendix E). The results of the VIF indicate that for both of the models the variables AGE40-64 and GDPHP are collinear. This is not surprising, as both of these variables have an upward trend, and as previously explained are correlated. As noted by Gujarati (2003), "Since GDP and population grow over time, they are likely to be correlated" (p.367).

Therefore given that only the AGE40-64 and GDPHP variables are correlated for each of the models I have not attempted to correct for the problem of multicollinearity. Economically it makes sense that these two variables are correlated, and therefore, it is just the nature of the data.

I tested for the presence of heteroskedasticity in both of the models using Shazam (see Appendices C and D). The problem of having heteroskedasticity present in a model is that the true standard errors are overestimated. There was evidence of heteroskedasticity in both of the models, though less severe in the bond model. Therefore I corrected for heteroskedasticity in the bond model through the use of a Shazam command that uses a heteroskedasticity-consistent covariance matrix. The results give White's heteroskedastisic adjusted standard errors. Given that heteroskedasticity was more severe in the equity model I have corrected for the problem by using feasible generalized least

[49] This is using "Klien's rule of thumb" from the Gujarati text (pg.361).

squares (FGLS) regression. For this FGLS I assumed that the form of heteroskedasticity was multiplicative.

It is assumed in multiplicative heteroskedasticity that the variance of the i-th random disturbance is related to a set of (p-1) exogenous variables in the following way:[50]

$$\sigma_i^2 = \exp\{\alpha_1 + \alpha_2 z_{i2} + \ldots + \alpha_p z_{ip}\} = \exp\{z_i'\alpha\} \qquad \textbf{(13)}$$

Therefore to compute a feasible GLS estimator requires a consistent estimate of α using the OLS residuals. This consistent estimate is obtained by regressing the log of the squared OLS residuals on a constant and the set of (p-1) z variables.

The final test conducted was for autocorrelation amongst the variables. I used the Durbin-Watson (DW) *d* statistic test for autocorrelation between the error terms of the model. The *d* statistic for the equity model was 1.7141 which is close to 2; therefore, I have assumed for the equity model that there is no positive or negative first order autocorrelation amongst the error terms.[51] The DW *d* statistic for the bond model 0.8586; comparing this to the critical values of the DW statistics there is the presence of positive autocorrelation amongst the error terms. To determine the degree of autocorrelation I performed an autocorrelation diagnostic test in Shazam. The results of the test indicate that there is the presence of first-order autocorrelation in the model (see Appendix D for the results). Therefore, to correct for autocorrelation in the bond model I used a FGLS

[50] Explanation of multiplicative heteroskedasticity and the equations are from Whistler, White, Wong, and Bates (2004).

[51] Gujarati (2003) p.469, states that if the value of the DW *d* statistic is close to 2 than there is not a problem of autocorrelation amongst the residuals.

regression. Taking the estimated value of rho from the residuals of the model I have used a Prais-Winsten transformation FGLS regression.[52]

6.2 Empirical Results of the Equity Model

As explained in the previous section the methodology for the equity model was FGLS to correct for the problem of heteroskedasticity. The results of the regression are shown in Table 6.1. For the purposes of comparison I have included the OLS, White's corrected standard errors regression in Appendix C.

[52] For an explanation of the Prais-Winsten transformation see Gujarati (2003) p.478

Table 6.1 Estimated Results for a Change in the Real S&P/TSX Annual Rate of Return, 1957 – 2005

Independent Variable	Estimated Coefficient
Constant	2.1680** (0.6838)
AGE20-39	1.3239 (1.088)
AGE40-64	-7.1302** (2.376)
GDPHP	0.14556 (0.1348)
GDPCY	-1.1797 (0.7400)
RLR	-2.2989* (0.9613)
VOL	-0.00024739 (0.0002279)
LAGDIVY	-26.720** (4.066)
R^2	0.5261
Adjusted R^2	0.4451
Number of Observations	49
$F_{(8,41)}$	6.008**
Jarque-Bera Statistic	0.93
Durbin-Watson Statistic	1.789
Joint hypothesis test for the exclusion of AGE20-39 variable	0.00017
Join hypothesis test for the exclusion of GDPHP & GDPCY	0.20743

**significant at the 5% level*
***significant at the 1% level*
p-values are shown for the Jarque-Bera and the joint hypothesis tests..

Looking at the results of the equity model the AGE40-64, RLR, and LAGDIVY variables are all significant with the expected signs on the coefficients. The most important variable is AGE40-64. Contrary to the results of Poterba's (2001) study I find the AGE40-64 variable to be significant in the equity model for Canada. For the examination period from 1961-1997 Poterba found there to be a statistically insignificant positive relationship between the middle aged population and equity returns in Canada (his coefficient was 0.903).[53] Moreover, the positive relationship suggests that an increase in the middle aged population *raises* the return on equities; this is inconsistent with theory.

A possible explanation for the result that I have found could be from the inclusion of macroeconomic variables in the regression, and from the examination of a longer time period. I find that for a one percentage point increase in the proportion of the total population between the ages of 40 and 64 there is a decrease in the real rates of return on equities of 713 basis points. The negative sign is consistent with the macroeconomic theory; an individual becomes more risk averse as he or she ages and therefore, the level of risk aversion is an increasing function of age [as found by Bakshi and Chen (1994)]. This implies that the middle aged individual is choosing to sell her riskier assets (equities). The negative sign is also an indication that the baby bust cohort is unable to keep the rates of return constant as they are not a large enough market to buy the liquidated assets of the boomers. This can be interpreted as being a sign that as the size of the middle aged cohort grows (as it is forecasted to over the next twenty years) there will be a decline in real equity returns. However, this decrease will not likely be large enough to be classified as being an "asset meltdown". Also, from 1998-1999 the proportion of the middle age population increased by one percentage point and during this time we did not see a decline in the rates of return earned on the market.[54] As evident from the regression results of this model, it is more than just demographics that influence the real rates of return earned on equities.

[53] See Poterba (2001) p.579
[54] From 1998-1999 the real return on equities increased by 2.717%.

The negative sign on the real long rate (RLR) variable is opposite to the results of Davis and Li's (2003) RLR coefficient of 0.013 (p.20). The negative sign on the RLR variable is an indication that the negative inflation effect on share prices is not greater than the negative effect of the long rate itself.[55] The negative sign on the lagged dividend yield variable is in line with financial theory as explained in section 5.2 using equations 6, 7, and 8. The share price should decrease by the amount of the expected (future) dividend. Therefore, the real rate of the return on the share should also decrease by that amount. The results of this regression indicate that the real rate of return on a share should decrease by approximately 26.72% for a one dollar dividend. The constant variable of the regression was significant indicating that if all other variables are zero than the real annual rate of return will increase by approximately 2%.

Individually the AGE20-39 variable was not found to be significant. By conducting a joint hypothesis test with the AGE40-64 variable the coefficient of the AGE20-39 variable was found to be statistically different from zero. Therefore, the variable was not excluded from the model. Neither the trend GDP nor GDP cyclical effect variables were statistically significant. I ran a regression with the exclusion of the GDPHP and GDPCY variables. The results of the regression did not change the signs of the AGE40-64 or AGE20-39 coefficients (see Appendix C for the results). However, the coefficient for the AGE40-64 variable decreased to -4.2351. Therefore, the results of the regression with all of the variables may have overstated the decrease in the return on equities that an increase in the middle aged population may have. Nonetheless, I chose to keep the GDPHP and GDPCY variables in the model. The reason for this is that theoretically the

[55] Davis and Li (2003) pg.21

variables should be included in the model as I have explained in the previous section. Exclusion the variables could lead to specification bias in the variables for the model.

Overall the R^2 and adjusted R^2 values indicate that approximately 44 - 52% of the variation in the real return on equities can be explained using this model. Therefore, contrary to the results of Poterba's (2001) study I find the evidence that demographic shifts do play an important role in determining the real returns earned on equities in the Canadian market. Also, the inclusion of non-demographic variables greatly increases the significance of the model.[56]

6.3 Empirical Results of the Bond Model

To correct for the presence of autocorrelation in the bond model I have used the Prais-Winsten transformation on the variables. The results of the FGLS with White's heteroskedastistic adjusted standard errors are reported in Table 6.2.

[56] I ran a regression with only the demographic variables, and the variables were found to be insignificant. For the results of the regression, see Appendix D.

Table 6.2 Estimated Results for a Change in the Real 10 Year Government Bond Yield, 1957 - 2005

Independent Variable	Estimated Coefficient
Constant	0.082985* (0.03782)
AGE20-39	0.26431** (0.09506)
AGE40-64	-0.65455** (0.1139)
DSR	0.0010832 (0.0007141)
LAGTS	0.022916 (0.1176)
LAGCPI	-0.79200** (0.09099)
LNCPII	-0.90310** (0.7371)
GDPHP	0.043378** (0.0077)
GDPCY	-0.18754** (0.06186)
R^2	0.822
Adjusted R^2	0.7864
Number of Observations	49
$F_{(9,40)}$	53.710**
Jarque-Bera Statistic	0.747
Durbin-Watson Statistic	1.799
Joint hypothesis test for exclusion of LAGTS and DSR variables	0.05358

**significant at the 5% level*
*** significant at the 1% level*
p-values are shown for the Jarque-Bera and the joint hypothesis test.

For the bond model all of the variables were significant with the exception of the LAGTS and DSR variables. The insignificance of the lagged term structure is consistent with the results of Davis and Li's (2003) model. Exclusion of the DSR and LAGTS variables was not warranted though under the joint hypothesis test. The signs on all of the coefficients are consistent with economic theory.

First and most importantly, both of the demographic variables are significant. The positive sign on the AGE20-39 variable is logical; individuals in this category are less risk averse and therefore are more likely to invest in stocks. Also, these individuals heavily borrow for their mortgages. Given that fewer members of this cohort are purchasing bonds they increase the real long term yield. For a one percentage point increase in the proportion of the total population between the ages of 20 and 39 there is an increase in the long term bond yield of 26.4 basis points. The middle aged proportion of the total population has a negative impact on the long term bond yield. Following intuition, as an individual ages he or she becomes more risk averse and therefore is likely to switch from investing in risky assets (equities) to investing in safer assets such as government bonds and T-bills. Therefore, an increase in the proportion of individuals who are switching from risky assets to government bonds decreases the yield of the bonds. I have found that a one percentage point increase in the proportion of the middle aged population leads to a decrease in the bond yield of approximately 65.5 basis points. This is an indication that as this cohort is increasing in size the yield on bonds is decreasing and will likely continue to decrease over the next twenty years. The only significant demographic relationship that Poterba (2001) found in his model was between the age 40-64 population and the yield on bonds for Canada. Conversely, he found there to be a positive relationship, which as Poterba notes is inconsistent with theory.

The negative signs on the level of inflation (LNCPI) and acceleration of inflation (LNCPII) variables are consistent with theory; as inflation rises, the interest rate decreases. Thereby both the level and acceleration of inflation should (and do) reduce the real long rate. The trend of GDP (GDPHP) increases the yield on the bonds, whereas the cyclical effects (GDPCY) decrease the yields.

When comparing the results of the FGLS to the OLS model it is evident that the use of the Prais-Winsten transformation eliminates the problems of autocorrelation, as the new DW statistic is close to 2 (see Appendix D for OLS results). The R^2 and adjusted R^2 values are sizeable, suggesting that the explanatory variables can collectively explain 80% of the variation in the real long term yield on bonds. Therefore, the main empirical finding of the bond model is that the demographic variables are significant, and most importantly, that as the boomers switch to safer assets there will (likely) be a decrease in the real rates of return earned on bonds. Again, the exclusion on macroeconomic control variables greatly reduces the significance of the model.[57]

6.4 Summary of the Principal Results

I find that for both the equity and bond model there is a significant relationship between the proportion of the population who is aged 40-64 years and the real rates of return earned on stocks and bonds in the Canadian market. The inclusion of macroeconomic variables in both of the models allowed for a better analysis to be made of the impact that demographic shifts can and do have on asset returns.

[57] The results of a regression for the bond model using only the demographic variables finds that both of the variables increases the bond yield. See Appendix D for the results.

I have provided a better analysis than that of Poterba's (2001) study for Canada, as I have included macroeconomic variables in the model and, included the years 1998 to 2005. The inclusion of these years is important, as these years capture the boom, bust and recovery of the technology market, the bull market of the last year, and the beginning of the retirement of some of the baby boomers.

7.0 Implications of the Study

In this study I have empirically found evidence that there is a relationship between demographics and the rates of return earned on equities and bonds in the Canadian market. Specifically, I have focused on the relationship between the return on financial assets and the baby boom generation. The results of the negative relationship between the baby boomers and asset returns implies that the Canadian government must consider the impact of the demographic shift and reform their current pension policy, if the impact has not already been accounted for. The implications of the study are also applicable to private pension systems.

Given that the baby boomers have already begun to retire and the number of baby boomer retirements is going to grow until the year 2020, this will cause strain on the pension system. Primarily, the amount an individual earns annually from her pension will decrease as time goes on. Given the increase in average life expectancy, the decrease in the rate of birth, and the increase in the dependency ratio, it is unlikely that the baby bust and echo generations will be able to keep the pension payouts constant over the next thirty years. Therefore, reform needs to be made to current public and private pension policies if consideration has not already been made for the demographic shift.

Since an increase in the proportion of the middle aged population will (likely) lead to a small decrease in the rates of return earned on equities and bonds, the government should encourage foreign investors to invest in the Canadian market. The investments made by foreigner investors will help to maintain the rates of return at their current levels. Given the increase in the average age of life expectancy, the government could also consider a raise in the age of retirement. However, as noted in the study by Fougère and Mèrette (1999a) regarding the aging of the Canadian population there are other factors that are helping to offset the strain on the pension system.

> …despite upward pressure on government spending stemming from health care services and higher public pension payments due to ageing, favourable government revenue effects coming from tax-sheltered private pension plans will at least partially compensate for the increase in government spending. (p.2)

The results that I have found are not without criticism. There is a very good possibility that I have overstated the impact of the demographic shift. I have assumed that Canada is a closed economy and that it is only domestic investors in the Canadian market. In reality, this is not the case. However, these assumptions have been made to provide for a better analysis of the impact that a domestic demographic shift has on the Canadian market. Also, I have not considered immigration. The encouragement of educated immigrant workers would help to prevent decreases in the pension payouts; this is very important for the government to consider.

8.0 Summary and Conclusion

In this study I have examined the relationship between demographics, the rates of return earned on equities, and the yield on long term government bonds. Principally, I have focused on the impact that the baby boom generation has had on the rates of return earned on stock and bonds for the last fifty years in the Canadian market. The empirical results that I find suggest that there is a negative relationship between the rate of return on equities and bond yields, and the proportion of the middle aged population in Canada. Therefore, as the percentage of the middle age population increases there will be a decrease in the returns on stocks and bonds. However, I have made some very strong assumptions in this study: that there is neither immigration nor emigration, that Canada is a closed economy, and that there are no foreign investors in the Canadian market.

Consistent with the theory of Bakshi and Chen's (1994) study, I find that an increase in the middle aged population will cause negative changes in asset prices, as the level of an individuals risk aversion is an increasing function of her age. However, the decrease will only be brought about assuming that the investment decisions of the investor and her attitude towards risk depend on the life-cycle hypothesis. Conversely, the evidence of this study and Yoo's (1994a) suggests that generally an investor is likely to switch from investing in risky assets to safer assets as she ages, and thereby will have an impact on the rates of return earned.

Analysis of the relationship between the baby boom generation and the returns on stocks and bonds can be taken in many different directions for future studies. I recommend that the regression analyses be replicated in ten years time, as by the year 2016 approximately half of the baby boomers will be retired. Another suggestion is to replicate the study with consideration for immigration and foreign investors, as this would provide for a more realistic examination. And finally, I recommend that an examination be conducted that accounts for the changes in the allocation of wealth made by baby boomers. This type of study would help to further uncover the risk aversion – age relationship for Canada.

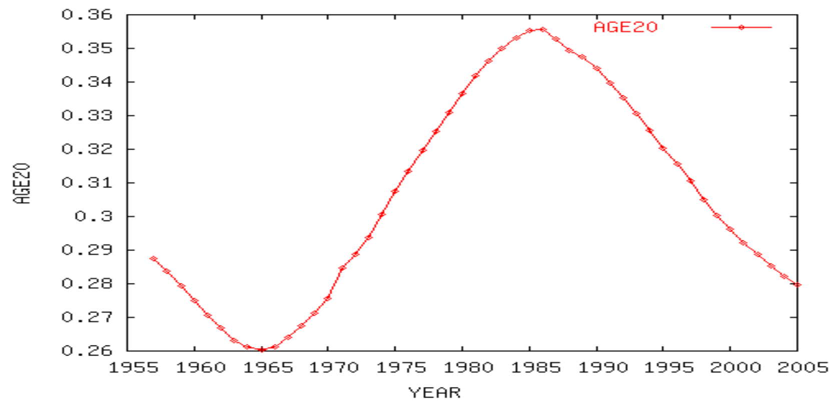
Appendices

Appendix A. HP Filter Shazam Output

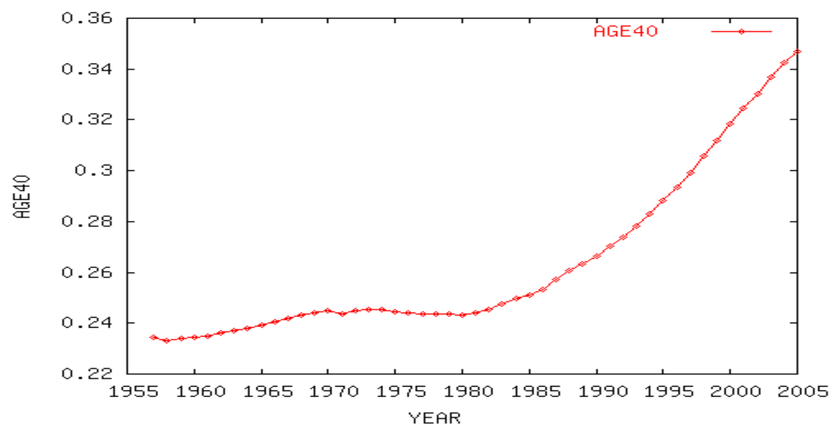
```
Welcome to SHAZAM - Version 10.0 -  JUL 2004 SYSTEM=WIN-XP   PAR=  4000
 CURRENT WORKING DIRECTORY IS: C:\SHAZAM
 |_sample  3 56
 |_read lngdp        year
    2 VARIABLES AND       54 OBSERVATIONS STARTING AT OBS       3
 |_smooth lngdp / hpfilter lambda=100 samave=gdpp

 REQUIRED MEMORY IS PAR=       5 CURRENT PAR=    4000
 HODRICK-PRESCOTT FILTER FOR                  LNGDP    LAMBDA=   100.00
 OBSERVATION                 LNGDP        TREND      STATIONARY
         3                 0.80501      0.77273      0.32275E-01
         4                 0.82962      0.81405      0.15574E-01
         5                 0.85112      0.85569     -0.45707E-02
         6                 0.88977      0.89813     -0.83580E-02
         7                 0.91846      0.94180     -0.23341E-01
         8                 0.94933      0.98706     -0.37732E-01
         9                  1.0169       1.0340     -0.17118E-01
        10                  1.0686       1.0824     -0.13806E-01
        11                  1.1314       1.1318     -0.44981E-03
        12                  1.1931       1.1816      0.11456E-01
        13                  1.2574       1.2313      0.26105E-01
        14                  1.2861       1.2804      0.57155E-02
        15                  1.3338       1.3287      0.50632E-02
        16                  1.3829       1.3761      0.68649E-02
        17                  1.4128       1.4224     -0.96118E-02
        18                  1.4531       1.4676     -0.14515E-01
        19                  1.5061       1.5117     -0.55578E-02
        20                  1.5735       1.5543      0.19143E-01
        21                  1.6097       1.5952      0.14534E-01
        22                  1.6278       1.6342     -0.63741E-02
        23                  1.6785       1.6713      0.72074E-02
        24                  1.7125       1.7064      0.60335E-02
        25                  1.7512       1.7397      0.11515E-01
        26                  1.7886       1.7712      0.17388E-01
        27                  1.8100       1.8010      0.89252E-02
        28                  1.8444       1.8297      0.14786E-01
        29                  1.8154       1.8575     -0.42066E-01
        30                  1.8423       1.8852     -0.42926E-01
        31                  1.8988       1.9129     -0.14143E-01
        32                  1.9455       1.9404      0.50514E-02
        33                  1.9694       1.9673      0.20619E-02
        34                  2.0110       1.9933      0.17697E-01
        35                  2.0596       2.0181      0.41476E-01
        36                  2.0855       2.0415      0.43922E-01
        37                  2.0874       2.0639      0.23506E-01
        38                  2.0662       2.0859     -0.19630E-01
        39                  2.0755       2.1085     -0.32954E-01
        40                  2.0981       2.1324     -0.34349E-01
        41                  2.1450       2.1582     -0.13171E-01
        42                  2.1727       2.1858     -0.13117E-01
        43                  2.1888       2.2153     -0.26533E-01
        44                  2.2301       2.2464     -0.16307E-01
        45                  2.2703       2.2788     -0.85098E-02
        46                  2.3241       2.3118      0.12342E-01
        47                  2.3754       2.3447      0.30707E-01
        48                  2.3945       2.3770      0.17429E-01
        49                  2.4267       2.4084      0.18294E-01
        50                  2.4437       2.4389      0.48109E-02
        51                  2.4741       2.4684      0.56422E-02
        52                  2.5011       2.4973      0.37984E-02
        53                  2.5209       2.5256     -0.47173E-02
        54                  2.5417       2.5536     -0.11974E-01
        55                  2.5751       2.5816     -0.64926E-02
        56                  2.6085       2.6095     -0.10016E-02
```

Appendix B. Graphs of variables and residuals

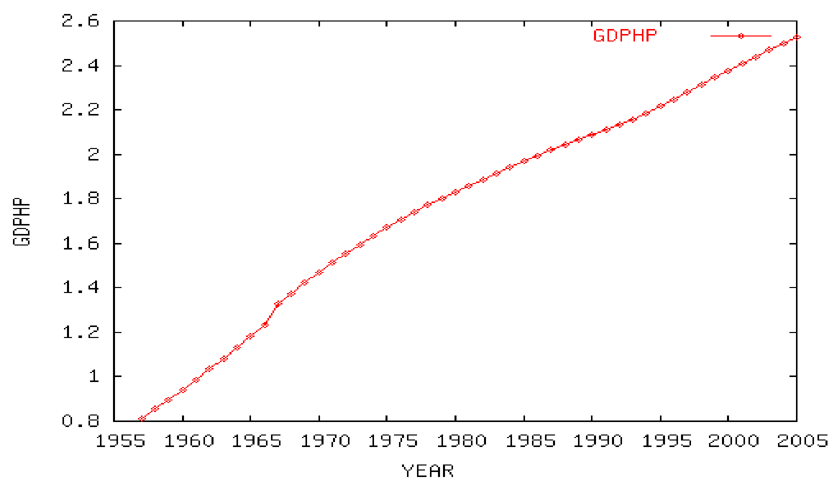
B.1Graph of AGE20-39 variable against time



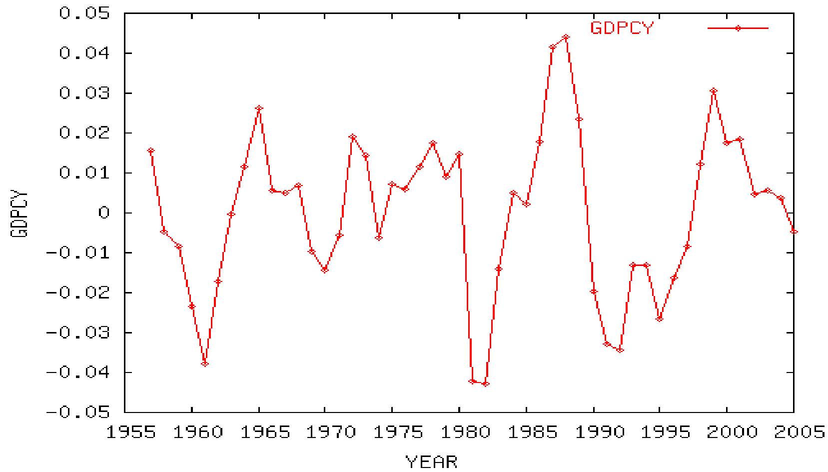
B.2 Graph of AGE40-64 variable against time



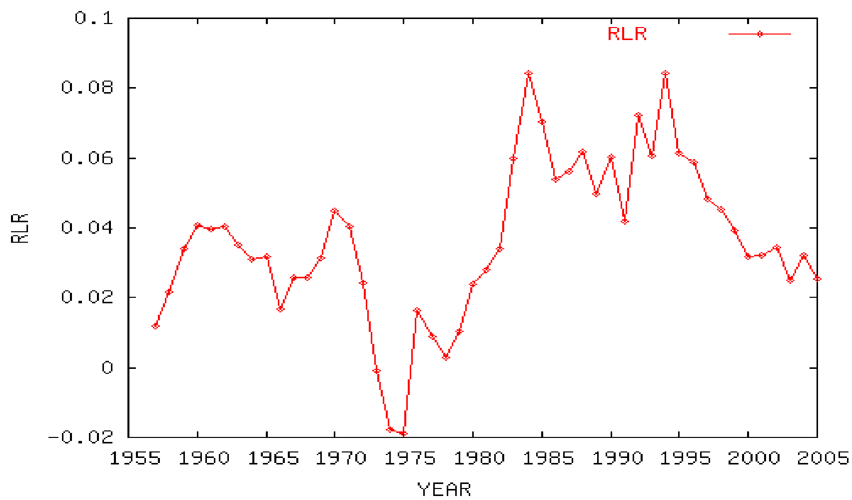
B.3 Graph of GDPHP variable against time



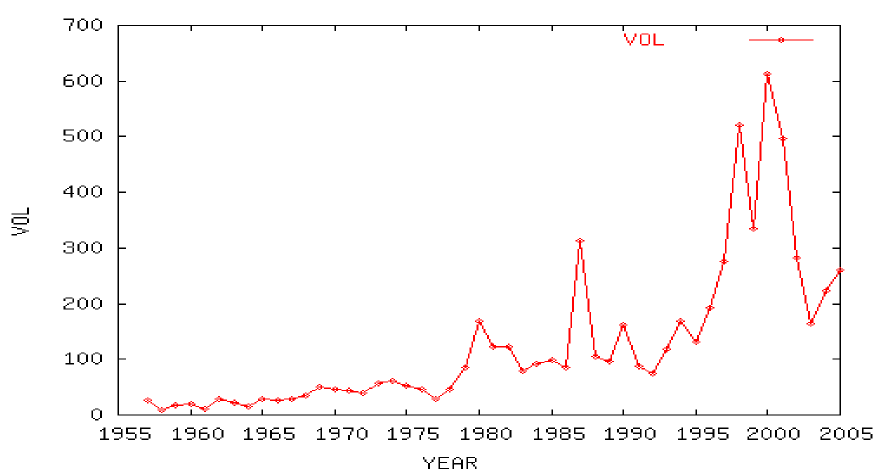
B.4 Graph of GDPCY variable against time



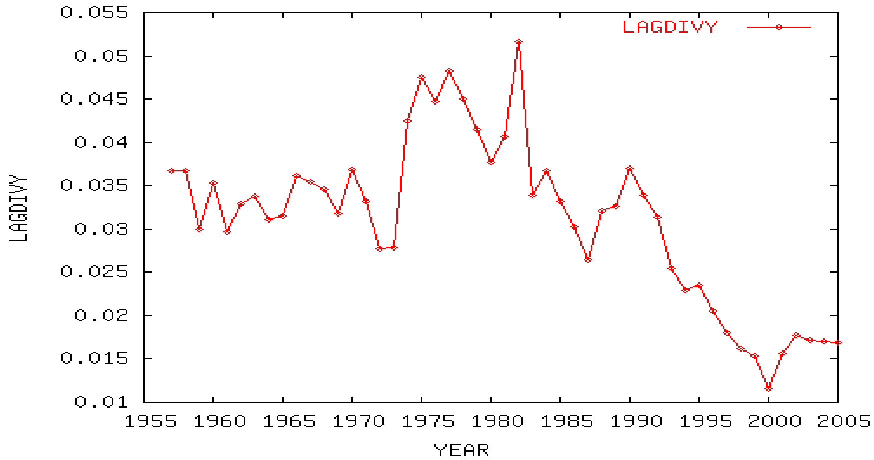
B.5 Graph of RLR variable against time



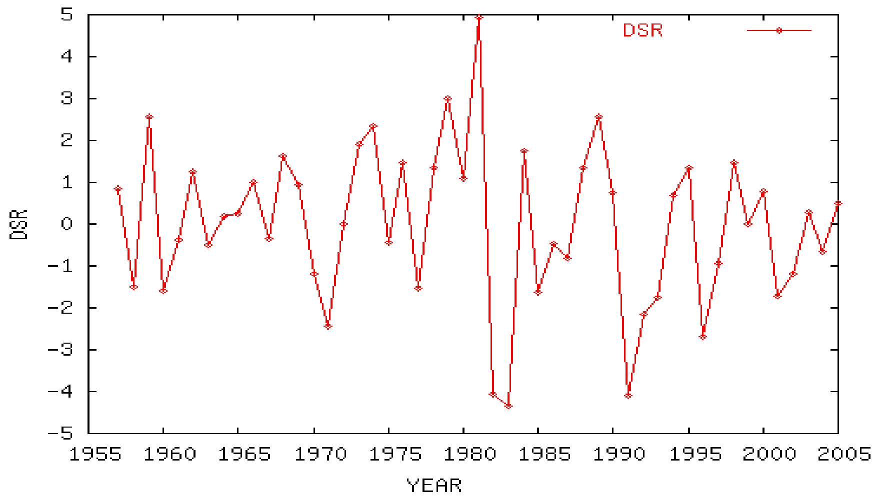
B.6 Graph of VOL variable against time



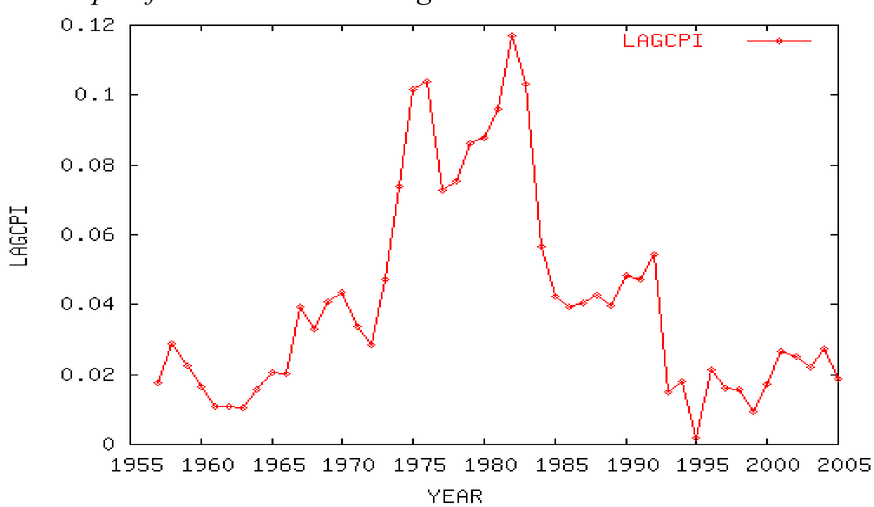
B.7 Graph of LAGDIVY variable against time



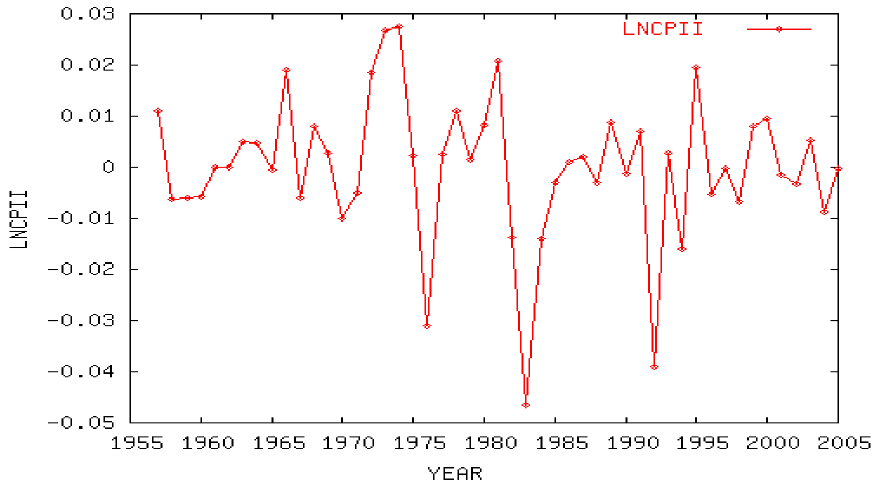
B.8 Graph of DSR variable against time



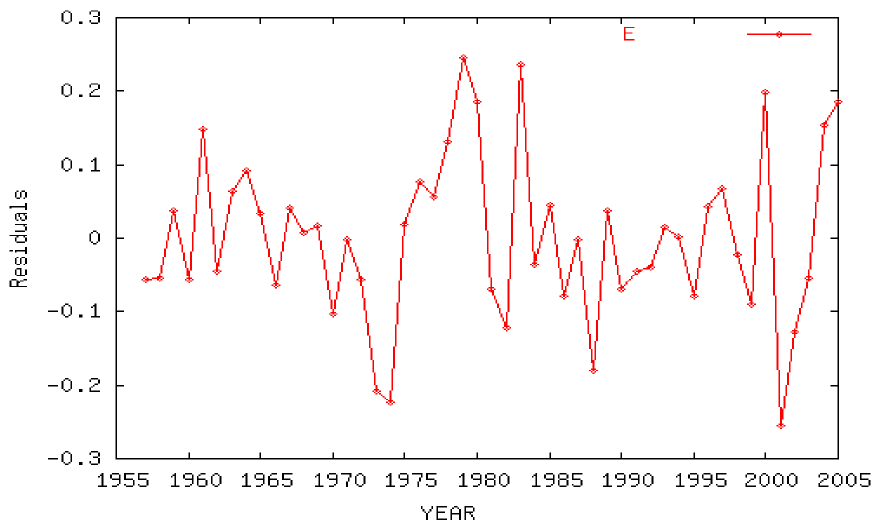
B.9 Graph of LAGCPI variable against time



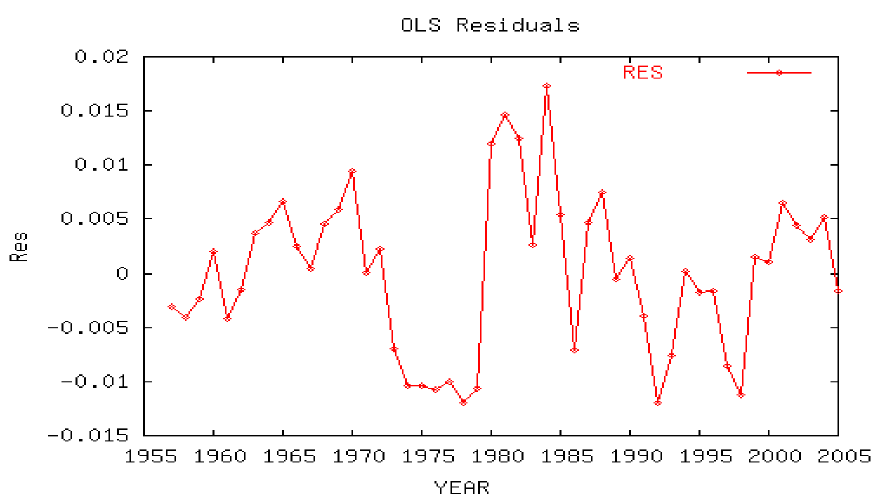
B.10 Graph of LNCPII variable against time



B.11 Graph of equity regression residuals against time



B.12 Graph of bond regression residuals against time



Appendix C. Shazam Output for the Equity Regression

C.1 Shazam code

```
sample 2 50
stat lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy/pcor
pc age20 age40 gdphp gdpcy rlr vol lagdivy
ols lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy/dwpvalue
ols lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy
diagnos/het
?ols lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy
ols lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy/auxrsqr
ols lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy/hetcov
GLS code
?ols lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy/resid=e
genr loge2=log(e*e)
?ols loge2 lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy /pred=loge2hat
genr e2hat = exp(loge2hat)
genr sigma = sqrt(e2hat)
genr lnrspg=lnrsp/sigma
genr c = 1
genr cg = 1/sigma
genr age20g = age20/sigma
genr age40g = age40/sigma
genr gdphpg = gdphp/sigma
genr gdpcyg = gdpcy/sigma
genr rlrg = rlr/sigma
genr volg = vol/sigma
genr lagdivyg = lagdivy/sigma
ols lnrspg  cg age20g age40g gdphpg gdpcyg rlrg volg lagdivyg/noconstant
test
test gdphpg =0
test gdpcyg=0
end
test
test age20g=0
test age40g=0
end
*without GDPHP and GDPCY
ols lnrspg cg age20g age40g rlrg volg lagdivyg/noconstant
*without macrovariables
ols lnrspg cg age20g age40g/noconstant
*break 1957-1985, 1986-2005
*1957-1985
sample 2 30
ols lnrspg  cg age20g age40g gdphpg gdpcyg rlrg volg lagdivyg/noconstant
*1986-2005
sample 31 50
ols lnrspg  cg age20g age40g gdphpg gdpcyg rlrg volg lagdivyg/noconstant
```

C.2 Shazam Output

```
Welcome to SHAZAM - Version 10.0 -  JUL 2004 SYSTEM=WIN-XP   PAR=  4000
 CURRENT WORKING DIRECTORY IS: c:\shazam
 ALL VARIABLES HAVE BEEN DELETED
 |_sample 2 50
 |_stat lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy/pcor
 NAME         N    MEAN         ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 LNRSP        49  0.16557E-01 0.14285     0.20406E-01 -0.38322      0.30851
 AGE20        49  0.30595     0.31129E-01 0.96904E-03  0.26025      0.35548
 AGE40        49  0.26366     0.32829E-01 0.10778E-02  0.23312      0.34686
 GDPHP        49   1.7761     0.49536     0.24538      0.81405       2.5256
 GDPCY        49  0.20378E-04 0.20160E-01 0.40643E-03 -0.42926E-01  0.43922E-01
 RLR          49  0.36124E-01 0.22500E-01 0.50627E-03 -0.18975E-01  0.84355E-01
 VOL          49   126.71      136.75      18701.       9.8291       612.92
 LAGDIVY      49  0.31146E-01 0.95414E-02 0.91039E-04  0.11500E-01  0.51675E-01

  CORRELATION MATRIX OF VARIABLES -       49 OBSERVATIONS


 LNRSP      1.0000
 AGE20    -0.49975E-02   1.0000
 AGE40     0.13843      0.17467E-01   1.0000
 GDPHP     0.10789      0.51765      0.82395      1.0000
 GDPCY     0.17547     -0.21023E-01  0.93129E-01  0.89975E-01   1.0000
 RLR       0.23184      0.42279      0.19454      0.32447     -0.19988
            1.0000
 VOL       0.14641      0.14544      0.76351      0.70200      0.24491
           0.17859      1.0000
 LAGDIVY  -0.42074      0.20069     -0.80142     -0.52144     -0.19254
          -0.35028     -0.70044      1.0000
              LNRSP        AGE20        AGE40        GDPHP        GDPCY
              RLR          VOL          LAGDIVY

 |_pc age20 age40 gdphp gdpcy rlr vol lagdivy
  PRINCIPAL COMPONENTS ON    7 VARIABLES     MAXIMUM OF    7 FACTORS RETAINED

 EIGENVALUES
  0.89767E+06   6.0003      0.42996E-01  0.23825E-01  0.14374E-01  0.29125E-02
  0.57329E-03

 SUM OF EIGENVALUES =  0.89768E+06

 CUMULATIVE PERCENTAGE OF EIGENVALUES
  0.99999       1.0000       1.0000       1.0000       1.0000       1.0000
   1.0000

 VARIANCE REDUCTION BENCHMARK FUNCTION
   100.00       100.00       99.993       98.946       97.058       93.928
   78.480

 CONDITION NUMBERS
   1.0000      0.14960E+06  0.20878E+08  0.37678E+08  0.62452E+08  0.30822E+09
  0.15658E+10

 CONDITION INDEXES
   1.0000       386.79       4569.3       6138.2       7902.7       17556.
   39571.
```

```
|_ols lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy/dwpvalue

 REQUIRED MEMORY IS PAR=      28 CURRENT PAR=    4000
  OLS ESTIMATION
       49 OBSERVATIONS     DEPENDENT VARIABLE= LNRSP
 ...NOTE..SAMPLE RANGE SET TO:      2,     50
```

DURBIN-WATSON STATISTIC = 1.71414
DURBIN-WATSON POSITIVE AUTOCORRELATION TEST P-VALUE = 0.028723
NEGATIVE AUTOCORRELATION TEST P-VALUE = 0.971277

Standard OLS results with Whites Standard Errors

```
USING HETEROSKEDASTICITY-CONSISTENT COVARIANCE MATRIX
  R-SQUARE =   0.3743     R-SQUARE ADJUSTED =   0.2675
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.14947E-01
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.12226
 SUM OF SQUARED ERRORS-SSE=  0.61285
 MEAN OF DEPENDENT VARIABLE =  0.16557E-01
 LOG OF THE LIKELIHOOD FUNCTION =  37.8178

                     ANALYSIS OF VARIANCE - FROM MEAN
                      SS         DF            MS                 F
 REGRESSION       0.36666          7.       0.52381E-01             3.504
 ERROR            0.61285         41.       0.14947E-01           P-VALUE
 TOTAL            0.97951         48.       0.20406E-01             0.005

                     ANALYSIS OF VARIANCE - FROM ZERO
                      SS         DF            MS                 F
 REGRESSION       0.38010          8.       0.47512E-01             3.179
 ERROR            0.61285         41.       0.14947E-01           P-VALUE
 TOTAL            0.99294         49.       0.20264E-01             0.007


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
   NAME    COEFFICIENT   ERROR      41 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 AGE20     0.76907     0.8087      0.9510     0.347 0.147     0.1676    14.2116
 AGE40     -4.4515      2.044      -2.178     0.035-0.322    -1.0230   -70.8873
 GDPHP     0.13086     0.8890E-01   1.472     0.149 0.224     0.4538    14.0385
 GDPCY     0.12343     0.9336      0.1322     0.895 0.021     0.0174     0.0002
 RLR       -1.2056      1.420     -0.8492     0.401-0.131    -0.1899    -2.6305
 VOL      -0.32160E-03 0.2750E-03  -1.169     0.249-0.180    -0.3079    -2.4613
 LAGDIVY   -19.709      5.241      -3.761     0.001-0.506    -1.3164   -37.0760
 CONSTANT   1.4206     0.5840       2.433     0.019 0.355     0.0000    85.8048

 DURBIN-WATSON = 1.7141    VON NEUMANN RATIO = 1.7499    RHO =  0.11906
 RESIDUAL SUM = -0.88818E-14  RESIDUAL VARIANCE =  0.14947E-01
 SUM OF ABSOLUTE ERRORS=   4.2751
 R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.3743
 RUNS TEST:   24 RUNS,   24 POS,    0 ZERO,   25 NEG  NORMAL STATISTIC = -
0.4303
 COEFFICIENT OF SKEWNESS =   0.1353 WITH STANDARD DEVIATION OF 0.3398
 COEFFICIENT OF EXCESS KURTOSIS =   0.0862 WITH STANDARD DEVIATION OF 0.6681
```

JARQUE-BERA NORMALITY TEST- CHI-SQUARE(2 DF)= 0.1441 P-VALUE= 0.930

```
      GOODNESS OF FIT TEST FOR NORMALITY OF RESIDUALS - 12 GROUPS
 OBSERVED  0.0  1.0  2.0  2.0  8.0 12.0 12.0  4.0  3.0  4.0  1.0  0.0
 EXPECTED  0.3  0.8  2.2  4.5  7.3  9.4  9.4  7.3  4.5  2.2  0.8  0.3
 CHI-SQUARE =    7.2132 WITH  2 DEGREES OF FREEDOM, P-VALUE= 0.027
```

HETEROSKEDASTICITY TESTS

```
                             CHI-SQUARE     D.F.   P-VALUE
                           TEST STATISTIC
 E**2 ON YHAT:                    0.009     1    0.92387
 E**2 ON YHAT**2:                 0.001     1    0.97031
 E**2 ON LOG(YHAT**2):            0.000     1    0.99108
 E**2 ON LAG(E**2) ARCH TEST:     4.358     1    0.03685
 LOG(E**2) ON X (HARVEY) TEST:   10.557     7    0.15916
 ABS(E) ON X (GLEJSER) TEST:     13.176     7    0.06793
 E**2 ON X                 TEST:
           KOENKER(R2):          12.701     7    0.07973
           B-P-G (SSR) :         12.433     7    0.08720

 E**2 ON X X**2    (WHITE) TEST:
           KOENKER(R2):          21.874    14    0.08123
           B-P-G (SSR) :         21.411    14    0.09155

 E**2 ON X X**2 XX (WHITE) TEST:
           KOENKER(R2):          35.756    35    0.43274
           B-P-G (SSR) :         34.999    35    0.46823
```

Auxiliary Regression

```
|_ols lnrsp age20 age40 gdphp gdpcy rlr vol lagdivy/auxrsqr

 REQUIRED MEMORY IS PAR=       9 CURRENT PAR=    4000
  OLS ESTIMATION
       49 OBSERVATIONS     DEPENDENT VARIABLE= LNRSP
 ...NOTE..SAMPLE RANGE SET TO:      2,     50
 R-SQUARE OF AGE20    ON OTHER INDEPENDENT VARIABLES =   0.8360
 R-SQUARE OF AGE40    ON OTHER INDEPENDENT VARIABLES =   0.9402
 R-SQUARE OF GDPHP    ON OTHER INDEPENDENT VARIABLES =   0.9372
 R-SQUARE OF GDPCY    ON OTHER INDEPENDENT VARIABLES =   0.2523
 R-SQUARE OF RLR      ON OTHER INDEPENDENT VARIABLES =   0.5989
 R-SQUARE OF VOL      ON OTHER INDEPENDENT VARIABLES =   0.6836
 R-SQUARE OF LAGDIVY  ON OTHER INDEPENDENT VARIABLES =   0.8566
 R-SQUARE OF CONSTANT ON OTHER INDEPENDENT VARIABLES =   0.0000
```

FGLS regression results (corrected for heteroskedasticity)

R-SQUARE =   0.5261   R-SQUARE ADJUSTED =   0.4451

```
 VARIANCE OF THE ESTIMATE-SIGMA**2 =   3.7423
 STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.9345
 SUM OF SQUARED ERRORS-SSE=   153.44
 MEAN OF DEPENDENT VARIABLE =  0.44216
 LOG OF THE LIKELIHOOD FUNCTION = -97.4937
 RAW MOMENT R-SQUARE =   0.5397
```

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	179.88	8.	22.485	**6.008**
ERROR	153.44	41.	3.7423	P-VALUE
TOTAL	333.32	49.	6.8024	**0.000**

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 41 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
CG	**2.1680**	**0.6838**	**3.170**	**0.003**	0.444	8.3863	99.0978
AGE20G	**1.3239**	**1.088**	**1.216**	**0.231**	0.187	1.6393	18.5189
AGE40G	**-7.1302**	**2.376**	**-3.001**	**0.005**	-0.424	-6.7995	-84.2836
GDPHPG	**0.14556**	**0.1348**	**1.080**	**0.287**	0.166	1.0557	11.4865
GDPCYG	**-1.1797**	**0.7400**	**-1.594**	**0.119**	-0.242	-0.2062	-0.0299
RLRG	**-2.2989**	**0.9613**	**-2.392**	**0.021**	-0.350	-0.7389	-4.5369
VOLG	**-0.24739E-03**	**0.2279E-03**	**-1.085**	**0.284**	-0.167	-0.2138	-1.2486
LAGDIVYG	**-26.720**	**4.066**	**-6.571**	**0.000**	-0.716	-3.7062	-38.1786

DURBIN-WATSON = 1.7890   VON NEUMANN RATIO = 1.8263   RHO = 0.09548

```
RESIDUAL SUM =   3.7764      RESIDUAL VARIANCE =   3.7423
SUM OF ABSOLUTE ERRORS=   71.749
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.5270
RUNS TEST:   20 RUNS,   24 POS,    0 ZERO,   25 NEG  NORMAL STATISTIC = -1.5858
COEFFICIENT OF SKEWNESS =  -0.1105 WITH STANDARD DEVIATION OF 0.3398
COEFFICIENT OF EXCESS KURTOSIS =  -0.2245 WITH STANDARD DEVIATION OF 0.6681
```

Joint-hypothesis tests for exclusion of the AGE20, GDPHP, and GDPCY variables

```
|_test
 |_test gdphpg =0
 |_test gdpcyg=0
 |_end
 F STATISTIC =   1.6348883     WITH    2 AND   41 D.F.  P-VALUE= 0.20743
 WALD CHI-SQUARE STATISTIC =   3.2697765     WITH    2 D.F.  P-VALUE= 0.19497
 UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.61166
 |_test
 |_test age20g=0
 |_test age40g=0
 |_end
 F STATISTIC =   10.763837     WITH    2 AND   41 D.F.  P-VALUE= 0.00017
 WALD CHI-SQUARE STATISTIC =   21.527673     WITH    2 D.F.  P-VALUE= 0.00002
 UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.09290
```

FGLS results with the exclusion of GDPHP and GDPCY

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 43 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
CG	1.3881	0.3495	3.972	0.000	0.518	5.3696	63.4498
AGE20G	1.8926	0.6226	3.040	0.004	0.421	2.3435	26.4744
AGE40G	-4.2351	1.190	-3.558	0.001	-0.477	-4.0387	-50.0617
RLRG	-1.7960	0.9099	-1.974	0.055	-0.288	-0.5772	-3.5445
VOLG	-0.31852E-03	0.2266E-03	-1.406	0.167	-0.210	-0.2753	-1.6077
LAGDIVYG	-23.724	3.765	-6.300	0.000	-0.693	-3.2907	-33.8984

FLGS using only demographic variables

```
R-SQUARE =   0.0068     R-SQUARE ADJUSTED =  -0.0364
```

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 46 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
CG	-0.77443E-01	0.2164	-0.3578	0.722	-0.053	-0.2996	-3.5398
AGE20G	-0.13175	0.4915	-0.2681	0.790	-0.039	-0.1631	-1.8430
AGE40G	0.53552	0.8382	0.6389	0.526	0.094	0.5107	6.3302

FGLS Results, 1957-1985

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 21 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
CG	11.218	3.778	2.970	0.007	0.544	43.2318	745.3933
AGE20G	0.21247	1.516	0.1401	0.890	0.031	0.2497	4.1480
AGE40G	-47.161	16.11	-2.928	0.008	-0.538	-44.7275	-759.4403
GDPHPG	0.86980	0.3335	2.608	0.016	0.495	5.7653	83.3960
GDPCYG	0.67014	1.050	0.6380	0.530	0.138	0.0847	-0.0497
RLRG	-0.86159	1.239	-0.6953	0.495	-0.150	-0.2618	-2.0465
VOLG	-0.12130E-02	0.1124E-02	-1.080	0.293	-0.229	-0.4060	-3.9883
LAGDIVYG	-28.386	4.657	-6.095	0.000	-0.799	-3.6045	-66.3930

FGLS results, 1986-2005

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 12 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
CG	-52.140	12.86	-4.054	0.002	-0.760	-199.8582	-1577.9748
AGE20G	83.566	19.33	4.323	0.001	0.780	114.5590	824.4728
AGE40G	-35.777	16.67	-2.146	0.053	-0.527	-34.5909	-308.8045
GDPHPG	16.818	4.688	3.587	0.004	0.719	129.1423	1114.5825
GDPCYG	-2.4188	0.8765	-2.760	0.017	-0.623	-0.6007	-0.2405
RLRG	-2.8681	1.287	-2.228	0.046	-0.541	-0.9890	-4.8020
VOLG	-0.38838E-03	0.1717E-03	-2.263	0.043	-0.547	-0.4177	-2.4691
LAGDIVYG	-58.323	7.902	-7.381	0.000	-0.905	-7.6300	-43.8034

Appendix D. Shazam output for the Bond regression

D.1 Shazam Code

```
sample 1 50
genr lagts = lag(ts)
genr lagcpi = lag(lncpi)
sample 2 50
stat rlr age20 age40 dsr lagts lagcpi lncpii gdphp gdpcy
pc rlr age20 age40 dsr lagts lagcpi lncpii gdphp gdpcy
ols rlr age20 age40 dsr lagts lagcpi lncpii gdphp gdpcy/pcor
diagnos/het
diagnos/acf
?ols rlr age20 age40 dsr lagts lagcpi lncpii gdphp gdpcy/resid=res
ols rlr age20 age40 dsr lagts lagcpi lncpii gdphp gdpcy/dwpvalue
?ols rlr age20 age40 dsr lagts lagcpi lncpii gdphp gdpcy/auxrsqr
ols rlr age20 age40 dsr lagts lagcpi lncpii gdphp gdpcy/hetcov
genr residl= lag(res)
*using GLS prais winsten to correct for AR(1)
sample 2 50
?ols rlr age20 age40 dsr lagts lagcpi lncpii gdphp gdpcy/rstat
gen1 rho=$rho
sample 3 50
genr rlr1 = rlr-rho*lag(rlr)
genr age201 = age20-rho*lag(age20)
genr age401 = age40-rho*lag(age40)
genr dsr1 = dsr-rho*lag(dsr)
genr lagts1 = lagts-rho*lag(lagts)
genr lagcpi1 = lagcpi-rho*lag(lagcpi)
genr lncpii1 = lncpii-rho*lag(lncpii)
genr gdphp1 = gdphp-rho*lag(gdphp)
genr gdpcy1 =gdpcy-rho*lag(gdpcy)
genr const = 1-rho
sample 2 2
gen1 r=sqrt(1-rho*rho)
genr rlr1 = r*rlr
genr age201 = r*age20
genr age401 = r*age40
genr dsr1 = r*dsr
genr lagts1 =r*lagts
genr lagcpi1 =r*lagcpi
genr lncpii1 = r*lncpii
genr gdphp1 = r*gdphp
genr gdpcy1 = r*gdpcy
genr const=r
sample 2 50
ols rlr1 age201 age401 dsr1 lagts1 lagcpi1 lncpii1 gdphp1 gdpcy1
const/noconstant hetcov
test
test dsr1=0
test lagts1=0
end
*test without macro variables
ols rlr1 age201 age401 const/noconstant hetcov
*test without lagts
ols rlr1 age201 age401 dsr1 lagcpi1 lncpii1 gdphp1 gdpcy1 const/noconstant
hetcov
stop
```

D.2 Shazam Output

```
Welcome to SHAZAM - Version 10.0 -  JUL 2004 SYSTEM=WIN-XP   PAR=  4000
 CURRENT WORKING DIRECTORY IS: c:\shazam
 ALL VARIABLES HAVE BEEN DELETED

 |_stat rlr age20 age40 dsr lagts lagcpi lncpii gdphp gdpcy
 NAME        N    MEAN         ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 RLR         49  0.36124E-01 0.22500E-01 0.50627E-03 -0.18975E-01  0.84355E-01
 AGE20       49  0.30595     0.31129E-01 0.96904E-03  0.26025      0.35548
 AGE40       49  0.26366     0.32829E-01 0.10778E-02  0.23312      0.34686
 DSR         49 -0.40612E-02  1.8816      3.5404      -4.3480       4.9270
 LAGTS       49  0.40608E-02 0.12886E-01 0.16606E-03 -0.33980E-01  0.44670E-01
 LAGCPI      49  0.40892E-01 0.29531E-01 0.87211E-03  0.19627E-02  0.11693
 LNCPII      49  0.12065E-04 0.14083E-01 0.19833E-03 -0.46588E-01  0.27604E-01
 GDPHP       49   1.7761     0.49536     0.24538      0.81405       2.5256
 GDPCY       49  0.20378E-04 0.20160E-01 0.40643E-03 -0.42926E-01  0.43922E-01

   PRINCIPAL COMPONENTS ON    9 VARIABLES     MAXIMUM OF    9 FACTORS RETAINED

 EIGENVALUES
   170.15       11.632      0.73441E-01  0.33097E-01  0.18529E-01  0.94238E-02
  0.31802E-02  0.19832E-02  0.72830E-03

 SUM OF EIGENVALUES =   181.92

 CUMULATIVE PERCENTAGE OF EIGENVALUES
  0.93529      0.99923      0.99963      0.99981      0.99992      0.99997
  0.99999       1.0000       1.0000

 VARIANCE REDUCTION BENCHMARK FUNCTION
   100.00       100.00       99.996       99.428       98.167       95.914
   91.485       78.359       57.312

 CONDITION NUMBERS
   1.0000       14.628       2316.8       5140.9       9182.6       18055.
   53502.       85794.      0.23362E+06
```

```
 CONDITION INDEXES
   1.0000       3.8246       48.133       71.700       95.826       134.37
   231.31       292.91       483.34
```

```
CORRELATION MATRIX OF COEFFICIENTS
 AGE20      1.0000
 AGE40     0.77415      1.0000
 DSR      -0.49110E-01 -0.29151E-01   1.0000
 LAGTS     0.34667E-01 -0.20424E-02 -0.77593       1.0000
 LAGCPI    0.12308      0.53637     -0.31209E-01 -0.70320E-01   1.0000

 LNCPII    0.18905      0.22254     -0.11790E-01 -0.33408      0.28700
            1.0000
 GDPHP    -0.84191     -0.95911      0.31980E-01  0.17696E-01 -0.45264
          -0.21404      1.0000
 GDPCY     0.66871E-01  0.84547E-01 -0.22047      0.12316      0.11066
          -0.11322     -0.11087       1.0000
 CONSTANT -0.91935     -0.95059      0.56083E-01 -0.39693E-01 -0.39877
          -0.22517      0.93382     -0.74333E-01   1.0000
              AGE20        AGE40        DSR          LAGTS        LAGCPI
              LNCPII       GDPHP        GDPCY        CONSTANT
```

HETEROSKEDASTICITY TESTS

	CHI-SQUARE TEST STATISTIC	D.F.	P-VALUE
E**2 ON YHAT:	0.416	1	0.51877
E**2 ON YHAT**2:	0.032	1	0.85697
E**2 ON LOG(YHAT**2):	1.589	1	0.20749
E**2 ON LAG(E**2) ARCH TEST:	4.765	1	0.02904
LOG(E**2) ON X (HARVEY) TEST:	11.368	8	0.18172
ABS(E) ON X (GLEJSER) TEST:	21.519	8	0.00589
E**2 ON X TEST:			
KOENKER(R2):	24.809	8	0.00167
B-P-G (SSR) :	18.920	8	0.01529
E**2 ON X X**2 (WHITE) TEST:			
KOENKER(R2):	27.089	16	0.04050
B-P-G (SSR) :	20.659	16	0.19198
E**2 ON X X**2 XX (WHITE) TEST:			
KOENKER(R2):	47.345	44	0.33773
B-P-G (SSR) :	36.108	44	0.79543

Tests for Autocorrelation

RESIDUAL CORRELOGRAM

LM-TEST FOR HJ:RHO(J)=0, STATISTIC IS STANDARD NORMAL

LAG	RHO	STD ERR	T-STAT	LM-STAT	DW-TEST	BOX-PIERCE-LJUNG
1	0.5683	0.1429	3.9783	4.2340	0.8586	16.8163
2	0.2625	0.1429	1.8372	2.0359	1.4528	20.4790
3	0.1585	0.1429	1.1094	1.2542	1.6549	21.8437
4	-0.0104	0.1429	-0.0731	0.0827	1.9834	21.8497
5	-0.1925	0.1429	-1.3476	1.5865	2.3242	23.9548
6	-0.2633	0.1429	-1.8429	2.0347	2.4645	27.9831
7	-0.3120	0.1429	-2.1841	2.3857	2.5557	33.7758
8	-0.4120	0.1429	-2.8837	3.1949	2.6970	44.1197
9	-0.4496	0.1429	-3.1473	3.7394	2.7254	56.7491
10	-0.3564	0.1429	-2.4951	3.0151	2.5357	64.8900
11	-0.2929	0.1429	-2.0500	2.6970	2.4072	70.5302
12	-0.1032	0.1429	-0.7226	0.8303	2.0198	71.2499
13	-0.0752	0.1429	-0.5266	0.5970	1.9270	71.6428
14	0.0372	0.1429	0.2607	0.3074	1.6109	71.7418
15	0.1258	0.1429	0.8803	1.0392	1.4278	72.9043

LM CHI-SQUARE STATISTIC WITH 15 D.F. IS 60.713

DURBIN-WATSON STATISTIC = 0.85857

DURBIN-WATSON POSITIVE AUTOCORRELATION TEST P-VALUE = 0.000000

NEGATIVE AUTOCORRELATION TEST P-VALUE = 1.000000

Auxiliary Regression

R-SQUARE OF AGE20 ON OTHER INDEPENDENT VARIABLES = 0.8027
R-SQUARE OF AGE40 ON OTHER INDEPENDENT VARIABLES = 0.9356
R-SQUARE OF DSR ON OTHER INDEPENDENT VARIABLES = 0.7145
R-SQUARE OF LAGTS ON OTHER INDEPENDENT VARIABLES = 0.7414
R-SQUARE OF LAGCPI ON OTHER INDEPENDENT VARIABLES = 0.5451
R-SQUARE OF LNCPII ON OTHER INDEPENDENT VARIABLES = 0.4121
R-SQUARE OF GDPHP ON OTHER INDEPENDENT VARIABLES = 0.9474
R-SQUARE OF GDPCY ON OTHER INDEPENDENT VARIABLES = 0.1264
R-SQUARE OF CONSTANT ON OTHER INDEPENDENT VARIABLES = 0.0000

OLS Estimation

```
 USING HETEROSKEDASTICITY-CONSISTENT COVARIANCE MATRIX

  R-SQUARE =   0.8960     R-SQUARE ADJUSTED =   0.8752
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.63190E-04
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.79492E-02
 SUM OF SQUARED ERRORS-SSE=  0.25276E-02
 MEAN OF DEPENDENT VARIABLE =  0.36124E-01
 LOG OF THE LIKELIHOOD FUNCTION =  172.344


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
   NAME    COEFFICIENT   ERROR      40 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 AGE20     0.27386     0.5698E-01   4.806     0.000 0.605     0.3789     2.3194
 AGE40    -0.63922     0.8389E-01  -7.620     0.000-0.769    -0.9327    -4.6654
 DSR       0.14779E-02 0.1001E-02   1.476     0.148 0.227     0.1236    -0.0002
 LAGTS    -0.45106E-01 0.1865     -0.2419     0.810-0.038    -0.0258    -0.0051
 LAGCPI   -0.79617     0.6300E-01  -12.64     0.000-0.894    -1.0450    -0.9013
 LNCPII   -0.93948     0.1286      -7.307     0.000-0.756    -0.5880    -0.0003
 GDPHP     0.41922E-01 0.5943E-02   7.054     0.000 0.745     0.9229     2.0612
 GDPCY    -0.23219     0.6284E-01  -3.695     0.001-0.504    -0.2080    -0.0001
 CONSTANT  0.79175E-01 0.2692E-01   2.941     0.005 0.422     0.0000     2.1917

 DURBIN-WATSON = 0.8586    VON NEUMANN RATIO = 0.8765    RHO =  0.56894
 RESIDUAL SUM = -0.12906E-14  RESIDUAL VARIANCE =  0.63190E-04
 SUM OF ABSOLUTE ERRORS=  0.28419
 R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.8960
 RUNS TEST:   15 RUNS,   27 POS,    0 ZERO,   22 NEG  NORMAL STATISTIC = -
2.9899
 COEFFICIENT OF SKEWNESS =   0.1271 WITH STANDARD DEVIATION OF 0.3398
 COEFFICIENT OF EXCESS KURTOSIS =  -0.3938 WITH STANDARD DEVIATION OF 0.6681

 JARQUE-BERA NORMALITY TEST- CHI-SQUARE(2 DF)=    0.5841 P-VALUE= 0.747
```

FGLS regression results

```
USING HETEROSKEDASTICITY-CONSISTENT COVARIANCE MATRIX

  R-SQUARE =   0.8220     R-SQUARE ADJUSTED =   0.7864
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.41086E-04
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.64098E-02
 SUM OF SQUARED ERRORS-SSE=  0.16434E-02
 MEAN OF DEPENDENT VARIABLE =  0.15824E-01
 LOG OF THE LIKELIHOOD FUNCTION =  182.890
 RAW MOMENT R-SQUARE =   0.9236

                     ANALYSIS OF VARIANCE - FROM ZERO
                      SS         DF            MS                F
 REGRESSION       0.19860E-01     9.       0.22067E-02           53.710
 ERROR            0.16434E-02    40.       0.41086E-04          P-VALUE
 TOTAL            0.21504E-01    49.       0.43885E-03            0.000
```

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 40 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
AGE201	**0.26431**	**0.9506E-01**	**2.780**	**0.008**	0.402	0.3879	2.2397
AGE401	**-0.65455**	**0.1139**	**-5.748**	**0.000**	-0.673	-0.8877	-4.8327
DSR1	**0.10832E-02**	**0.7141E-03**	**1.517**	**0.137**	0.233	0.1675	0.0001
LAGTS1	**0.22916E-01**	**0.1176**	**0.1948**	**0.847**	0.031	0.0234	0.0026
LAGCPI1	**-0.79200**	**0.9099E-01**	**-8.704**	**0.000**	-0.809	-0.9430	-0.8899
LNCPII1	**-0.90310**	**0.7371E-01**	**-12.25**	**0.000**	-0.889	-0.9890	0.0022
GDPHP1	**0.43378E-01**	**0.7700E-02**	**5.634**	**0.000**	0.665	0.6289	2.1711
GDPCY1	**-0.18754**	**0.6186E-01**	**-3.032**	**0.004**	-0.432	-0.2099	0.0012
CONST	**0.82985E-01**	**0.3782E-01**	**2.194**	**0.034**	0.328	0.3345	2.3025

DURBIN-WATSON = 1.7990 VON NEUMANN RATIO = 1.8364 RHO = 0.09395
RESIDUAL SUM = 0.24014E-02 RESIDUAL VARIANCE = 0.41086E-04
SUM OF ABSOLUTE ERRORS= 0.23316
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.8221
RUNS TEST: 25 RUNS, 24 POS, 0 ZERO, 25 NEG NORMAL STATISTIC = -0.1415
COEFFICIENT OF SKEWNESS = 0.6092 WITH STANDARD DEVIATION OF 0.3398
COEFFICIENT OF EXCESS KURTOSIS = 0.3367 WITH STANDARD DEVIATION OF 0.6681

GOODNESS OF FIT TEST FOR NORMALITY OF RESIDUALS - 12 GROUPS

OBSERVED	0.0	0.0	1.0	5.0	11.0	8.0	7.0	11.0	4.0	0.0	1.0	1.0
EXPECTED	0.3	0.8	2.2	4.5	7.3	9.4	9.4	7.3	4.5	2.2	0.8	0.3

CHI-SQUARE = 10.1013 WITH 1 DEGREES OF FREEDOM, P-VALUE= 0.001
|_test
|_test dsr1=0
|_test lagts1=0
|_end
F STATISTIC = 3.1515115 WITH 2 AND 40 D.F. **P-VALUE= 0.05358**
WALD CHI-SQUARE STATISTIC = 6.3030230 WITH 2 D.F. P-VALUE= 0.04279
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.31731

FGLS excluding macroeconomic variables

R-SQUARE = 0.0744 R-SQUARE ADJUSTED = 0.0342

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 46 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
AGE201	0.31516	0.1201	2.623	0.012	0.361	0.4625	2.6707
AGE401	0.10950	0.8300E-01	1.319	0.194	0.191	0.1485	0.8085
CONST	-0.89857E-01	0.4345E-01	-2.068	0.044	-0.292	-0.3622	-2.4932

Appendix E. VIF test results

E.1 VIF results for the Equity model

Variable	VIF
AGE20-39	6.097560976
AGE40-64	16.72240803
GDPHP	15.92356688
GDPCY	1.3374348
RLR	2.493143854
VOL	3.160556258
LAGDIVY	6.973500697

E.2 VIF results for the Bond model

Variable	VIF
AGE20-39	5.06842372
AGE40-64	15.52795031
DSR	3.50262697
LAGTS	3.866976025
LAGCPI	2.198285337
LNCPII	1.700969553
GDPHP	19.01140684
GDPCY	1.144688645

References

Abel, Andrew B. (2001).Will bequests attenuate the predicted meltdown in stock prices when baby boomers retire? [Electronic version] *Review of Economics and Statistics, 83*, 589-595.

Ando, A., and F. Modigliani. (1963). The life cycle hypothesis of saving. *American Economic Review 53*(1), 55-74.

Ang, Andrew, and Angela Maddaloni. (2003). Do demographic changes affect risk premiums? Evidence from international data. NBER Working Paper 9677.

Bakshi, Gurdip, and Zhiwu Chen. (1994). Baby boom, population aging, and capital markets [Electronic version]. *Journal of Business, 67*, 165-202.

Bodie, Z., Kane, A., Macus, A. J., Perrakis, S., & Ryan, P. J. (2005). In Fisher L., Scriabin D., Dickson K., Limebeer J. and Rawlings R., *Investments* (Fifth Canadian Edition ed.). New York: McGraw-Hill Ryerson.

Bosworth, Barry P., Ralph C. Bryant, and Gary Burtless. (2004). The impact of aging on financial markets and the economy: a survey. Washington, DC: Brookings Institution.

Brooks, Robin J. (2000). What will happen to financial markets when the baby boomers retire? IMF Working Paper WP/00/18. Washington, DC: International Monetary Fund.

Brooks, Robin J. (1998). *Asset market and saving effects of demographic transitions*. Ph.D dissertation, Department of Economics, Yale University, New Haven, CT.

Browning, Martin and Thomas F. Crossley. (2001). The life-cycle model of consumption and saving [Electronic version]. *The Journal of Economic Perspectives, 15,* 3-22.

Bryant, Ralph. C. and Warwick J. McKibbon. (2003). Incorporating demographic changes in multi-country macroeconomic models: some preliminary results. Washington, DC: Brookings Institution, revised version April 2003.

Caballero, Ricardo, J. (1990). Consumption puzzles and precautionary savings. *Journal of Monetary Economics, Elsevier, 25*(1), 113-136.

Davis, E. Phillip, and Christine Li. 2003. Demographic and financial asset prices in the major industrial economies. Brunel University Department of Economics and Finance Discusssion Paper #03-07. London: Brunel University.

Demers, F.S. Some lecture notes on consumption. ECON 4201 Handout No. 4, Carleton University, Ottawa, ON: Department of Economics, February 27, 2006.

Diamond, Peter A. (2000). What stock market returns to expect for the future. *Social Security Bulletin, 63*(2), p.38-52.

Della Vigna, Stefano, and Joshua M. Pollet. (2003). Attention demographics and the stock market. Department of Economics, University of California At Berkley, Berkley, California: November 21, 2003.

Dugan, Bob, and Benoit Robidoux. (1999). Demographic shifts and labour force participation rates in Canada [Electronic version]. *Canadian Business Economics*, 42-56.

Elmendorf, Douglas W., and Louise M. Sheiner. (2000). Should America save for its old age? Population aging, national saving and fiscal policy. Federal Reserve Board, Washington, DC: November 1999.

Erb, Claude B., Campbell, R. Harvey, and Tadas E. Viskanta. (1997). Demographics and international investments [Electronic version]. *Financial Analysts Journal (July/August)*, 14-28.

Fisher, I. (1930). *The Theory of Interest*. New York: MacMillan.

Foot, David, K. (1998). *Boom, Bust & Echo 2000: Profiting from the demographic shift of the new millennium* (D. Stoffman, 2nd ed.). Toronto: MacFarlene Walter &Ross

Fougère, Maxime, and Marcel Mèrette. (1998). Population aging and economic growth in seven OECD countries. Department of Finance Working Paper 98-03. Ottawa, Canada: Department of Finance.

Fougère, Maxime, and Marcel Mèrette. (1999a).Population ageing, intergernerational equity, and growth: analysis with an endogenous growth overlapping generations model. Ottawa, Canada: Department of Finance. Retrieved June 6, 2006 from: http://www.carleton.ca/economics/seminars/seminars_archive.htm

Fougère, Maxime, and Marcel Mèrette. (1999b). An econometric examination of the impact of population ageing on personal savings in Canada. Department of Finance Working Paper 99-03. Ottawa, Canada: Department of Finance.

Fougère, Maxime. (2002). RRSP savings and the aging of the baby boom generation. [Electronic version]. *Canadian Tax Journal, 50*(2), 524-548.

Friedman, M. (1957). *A Theory of the Consumption Function*. Princeton, N.J.: Princeton University Press.

Geanakopolos, John, Michael Magill, and Martine Quinzii. (2004). Demography and the long-run predictability of the stock market. *Brookings Papers on Economic Activity*, (2004:1), 241-325.

Goyal, Amit. (2004). Demographics, stock market flows, and stock returns [Electronic version]. *Journal of Financial and Quantitative Analysis, 39*(March), 115-142.

Gujarati, Damodar, N. (2003). *Basic Econometrics: International Edition* (4^{th} Ed.). New York: McGraw- Hill/Irwin.

Hall, Robert, E. (1978). Stochastic implications of the life-cycle permanent income hypothesis: theory and evidence. *The Journal of Political Economy, 86*(6), 971-987. Retrieved May 15, 2006, from http://links.jstor.org/sici?sici=00223808%28197812%2986%3A6%3C971%3ASIOTLC%3E2.0.CO%3B2-K

Lafortune, Jeanne. (2005). Demographic changes and structural shifts towards services, implications and productivity growth in Canada. Department of Finance Working Paper 2005-01. Ottawa, Canada: Department of Finance.

Lee, Ronald, and Jonathan Skinner. (1999). Will aging baby boomers bust the federal budget? [Electronic version] *Journal of Economic Perspectives, 13*(1), 117 -140.

Lewis, Karen. (1999). Trying to explain home bias in equities and consumption. *Journal of Economic Literature, 37*(June), pp. 571-608.

Lim, Kyung-Mook, and David N. Weil. (2003). The baby boom and the stock market boom [Electronic version]. *Scandinavian Journal of Economics, 105,* 1-19.

Luo, Jiang. (2000). *Demographics and the Equity Premium.* Ph.D Dissertation, Anderson Graduate School of Management, Department of Finance, University of California, Los Angles,CA. Retrieved May 19, 2006 from http://repositories.cdlib.org/anderson/fin/32-00.

Mankiw, N. Gregory, and David Weil. (1989). The baby boom, the baby bust, and the housing market [Electronic version] *Regional Science and Urban Economics, 19,* 235-258.

Milevsky, Moshe, A. (1998). Optimal asset allocation towards the end of the life cycle: to annuitize or not to annuitize? *The Journal of Risk and Insurance, 65*(3), 401-426. Retieved May, 17, 2006 from http://links.jstor.org/sici?sici=0022-4367%28199809%2965%3A3%3C401%3AOAATTE%3E2.0.CO%3B2-A

Modigliani, Franco and Richard Brumberg. (1954). Utility analysis and the consumption function: an interpretation of cross-section data, in K.Kurihara ed., *Post-Keynesian Economics*, New Brunswick, NJ: Rutgers University Press.

Narciso, Alexandre and Sandrine Pierloz. (2003). Impact of changes in demographical factors on international capital flows. ASP term paper, Kiel Institute for World Economics, Kiel, Germany: May 2003.

Poterba, James. (2001). Demographic structure and asset returns [Electronic version] *Review of Ecnomics and Statistics, 83,* 565-584.

Poterba, James. (2004). Impact of population aging on financial markets in developed Countries [Electronic copy]. *Economic Review*, 43-53. Retrieved May 17, 2006 from www.kansascityfed.org

Poterba, James. (2005). The impact of population aging on financial markets in developed countries. In Gordon H. Sellor, Jr. (Ed.), *Global demographic change: economic impact and policy challenges*, (pp. 163-216) Kansas City: Federal Reserve Bank of Kansas City.

Poterba, James, Steven Venti, and David A. Wise. (2005). Demographic change, retirement saving, and financial market returns: Part 1. *National Bureau Of Economic Research*, December 19, 2005.

Purdue University Online Writing Lab. (2003). *Using American Psychological Association (APA) format* (Updated to 5th edition). Retrieved July13, 2006 from the Purdue University Online Writing Lab at http://owl.english.purdue.edu/handouts/print/research/r_apa.html

Romer, D. (2005). In Shensa P., Hubbard H. (Eds.), *Advanced macroeconomics* (3rd ed.). New York: McGraw-Hill/Irwin.

Simon, Paul. 2002. Demography and finance – finance and growth. Prepared for a seminar at the Copenhagen Institute for Futures Studies, Copenhagen, Denmark: Presented May, 2002.

Vinette, Anne-Marie, and Xiaoyi Yan. (2004). Canadian individual taxpayers: a changing profile. Research and Strategic Analysis Division, (June). Ottawa, ON: Canada Revenue Agency.

Whistler, White, Wong and Bates (2004). *Shazam Econometric Software, User's Reference Manual*, *Version 10.* Vancouver, British Columbia: Northwest Econometrics Ltd.

White, Ken. (2004). SHAZAM version 10 [computer software]. Vancouver, B.C.: Northwest Econometrics Ltd.

Yakhin, Yossi. (2003). The Hodrick-Prescott filter. Retrieved May 25, 2006 from http://www.er.uqam.ca/nobel/d241504/HP.pdf

Yoo, Peter S. (1994a). Age distributions and returns on financial assets. Working Paper 1994-002A. St. Louis, MO: Federal Reserve Bank of St. Louis.

_____ (1994b). Age dependent portfolio selection. Working Paper 1994-003A St. Louis, MO: Federal Reserve Bank of St. Louis.

_____ (1994c). The baby boom and economic growth. Working Paper 1994-001B. St. Louis, MO: Federal Reserve Bank of St. Louis.

_____ (1994d). The baby boom and international capital flows. Working Paper 1994-031A. St. Louis, MO: Federal Reserve Bank of St. Louis.

_____ (1994e). Boom or bust? The economic effects of the baby boom. *Federal Reserve Bank of St. Louis, (September/October),*13-22.

_____ (1997). Population growth and asset prices. Working Paper 1997-016A St. Louis, MO: Federal Reserve Bank of St. Louis.

Zeldes, Stephen, P. (1989). Consumption and liquidity constraints: an empirical Investigation. *Journal of Political Economy, 97* (2), 305-346.

Data Sources

CANSIM Table 051-0001
Estimates of population, by age group and sex, Canada, provinces and territories, annual (Persons unless otherwise noted) 1971-2005

CANSIM Table 051-0026
Estimates of population, by age group and sex, Canada, provinces and territories, annual (Persons unless otherwise noted) *TERMINATED*1921-1971

CANSIM Table 051-0013
Births by sex, Canada, provinces and territories, annual (Persons), 1972-2005

CANSIM Table 052-0001
Projected population, by age group and sex, Canada, provinces and territories, July 1, 2000-2026, annual (Persons x 1,000)

CANSIM Table 053-0011
Vital statistics, births, deaths and marriages, quarterly (Numbers) 1946-2005

CANSIM Table 102-00251
Life expectancy abridged life table, at birth and at 65, by sex, Canada, provinces and territories (Comparable Indicators), annual (Years) 1979-2006

CANSIM Table 176-00471
Toronto Stock Exchange statistics, monthly (Index, 1975=1000 unless otherwise noted) 1956-2002

CANSIM Table 282-00515
Labour Force Survey estimates (LFS) retirement age by class of workers and sex, annual (Years) 1976-2005

CANSIM Table 326-00021
Consumer Price Index (CPI) 2001 basket content, annual (Index, 1992=100), 1955-2004

International Financial Statistics database